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"It's Fine for Those Who Are Interested, But I Don't Care": Uncovering Energy Flexibility of Everyday Rhythms and Routines for Households with Real-Time Electricity Pricing

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Abstract: Reducing and time-shifting household energy demand is important for a sustainable transition of energy systems, and dynamic electricity pricing, like real-time pricing (RTP), is a popular instrument to incite households to change energy demand. However, the effect of such products relies on the assumption that dynamic price signals incorporate into everyday routines and rhythms. This paper investigates the flexibility of households' everyday routines and rhythms. The study provides three insights based on 11 Danish household visits and interviews with electricity customers who are new to RTP. First, the interviews indicated confusion over terminology for dynamic pricing products and low interest in flexible energy demand. Second, everyday practices (already) appeared flexible but for other reasons than energy demand flexibility. Third, energy habits were important for providing meaning to everyday practices. In addition, the study shows that energy flexibility is not just about energy demand, but rather about all the other activities that form routines and rhythms in everyday life. We suggest 1) designing products that reflect 'natural' or 'societal' daily rhythms, 2) focusing on the engaged households, and 3) being aware that for some households, changes in pricing, including new payment schemes, might put extra pressure on already harried everyday routines.

Keywords: energy flexibility; demand response; energy demand; real time pricing

1. Introduction

The transition towards an energy system with larger shares of renewable intermittent energy production requires more flexibility from the demand side. To promote energy demand flexibility and to balance demand with intermittent production, dynamic electricity pricing, where electricity tariffs vary during the day, has gained increased interest in the last decades as a demand-side management tool [1–4] and has recently entered the Danish electricity market [5].

Studies suggest that energy customers are open to dynamic pricing, although most customers still seem to prefer simple products [6], be concerned about potential financial losses [7] and equity [8], or have doubts about economic benefits [9]. There are several potential benefits of dynamic pricing products, including (peak) demand reduction, cost reductions, and efficiency gains [2], and these benefits appear even more appealing with an emergent need to act on climate and energy crises, for example in the form of decarbonization.

However, these benefits rest on how households respond to dynamic price signals, and if so, on how much and in which ways they respond. The question is whether households and energy practices are sufficiently adjustable to provide such 'flexibility' when introduced to hourly electricity prices.

In the end, demand-side energy flexibility relies on households' capacity to reduce or time-shift energy demand. Even with automated solutions, e.g., smart home technology, energy flexibility is

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not achieved without interacting with, and thereby (partly) relying on, the everyday routines and rhythms, which relate to practices such as cooking, cleaning, and washing clothes.

Several studies indicate modest effects of dynamic pricing on (peak) electricity consumption [3,10–13], but with substantial differences according to geographic and socio-demographic context, research design (methods and data), and type of dynamic pricing product [3,5]. Other studies emphasize the importance of changing focus from *flexible energy consumers* to *flexible everyday practices* [14–19]. Still, most energy policies and the energy industry seem to concentrate on providing the "right" dynamic price signal, assuming energy demand will follow, often in combination with smart control. Denmark is an illustrative case for this. The (short) history of dynamic electricity pricing in Denmark is characterized by discussions over price signals and smart solutions (smart grids and smart cities) [20]. Recent examples include the potential of 'dynamic electricity taxation' [21] and the introduction of the 'Tariff model 3.0' [22]. Such initiatives might add further reliance on (dynamic) price signals, but some research questions the mainstream interpretation of price signals [23–25]. This calls for further investigation of i) *how* dynamic electricity pricing integrates into everyday practices, such as the routines and rhythms of everyday life, and ii) *how* to unfold the potential of energy flexibility in better understanding the temporality of energy-demanding everyday practices.

This study explores the everyday routines and rhythms of 11 households that are among the first in Denmark to have a dynamic electricity pricing product. Thus, the study looks at the initial phases of the implementation of dynamic pricing, where the shift from providing flexibility *for* (passive and predictable) demand to requiring flexibility *of* (active and complex) energy demand presumably causes major changes to energy markets and energy practices. Based on this, it is not expected that dynamic pricing substantially affects everyday practices or has gained widespread attention in households. Based on the Danish case, the paper provides four insights to better understand everyday rhythms and four recommendations for implementing dynamic pricing signals. Combined, this contributes to the implementation of dynamic electricity prices in other contexts, especially in societies that resemble the Danish.

The paper starts with a brief review of the literature on energy demand flexibility and everyday rhythms. Then follows a section presenting data and methods, which leads to the result section that is structured by four insights. Finally, the results are discussed, and the paper's contributions are highlighted in the conclusion.

2. Previous Research

2.1. Energy Flexibility and Household Energy Demand

Energy demand flexibility plays an important role in transitioning to a renewable-based energy system, and dynamic electricity pricing is often viewed as a viable solution [3]. However, interpretations of energy flexibility vary between technical and social science perspectives, and different actors in the energy sector have distinct understandings [16]. For instance, grid companies see flexibility in terms of energy system quality, retailers focus on marketing flexibility, and households are concerned with the flexibility of everyday rhythms and practices [5].

Theoretical perspectives that focus on everyday rhythms and practices tend to downplay the role of individuals and highlight the importance of habits and materiality in shaping energy demand [16,26], whereas a related perspective suggests the term 'flexibility capital' has been suggested to describe households' capacity to, for example, time-shift energy use [18,19] and to highlight social inequality in demand-response initiatives [27].

These perspectives challenge the emphasis on consumers as rational actors that respond to information or price signals [24,28]. Instead, according to this so-called practice theoretical perspective, electricity is consumed for services and practices, not for its own sake [29,30], which places (energy) flexibility as a result of the performances of everyday practices, such as washing clothes and cooking [14,15,31], and response to price signals are viewed as conveying (new) meaning to the performance of practices [23–25,32]. Therefore, rather than focusing on the elasticity of prices,

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then the elasticity of everyday practices, and the socio-material contexts of these, become more present.

2.2. From Flexible Users to Rhythms of Everyday Practices

This section presents social scientific accounts of temporality in conceptualizing everyday rhythms and energy demand flexibility. To understand energy demand flexibility, everyday practices, and the temporal aspects of these one might consider the *intensity*, *stability*, and *flexibility* of energy demand. This can be related to five questions about the temporality of everyday activities:

1) How long? (duration)
2) When? (timing)
3) How often? (frequency)
4) Which order? (sequence)
5) How fast? (tempo)

The temporal aspects emphasized in the five questions indicate a strong social component. Although collective temporal rhythms might have lost some of their power, for example, due to individualized micro-coordination [33,34], electric lighting, and 24-hour opening [35], socio-temporal coordination continues to have great importance on when households do what. However, disruptions might reveal how the apparent stable and stubborn everyday practices also have a flexible side [36]. Also, the material surroundings are important to understand the temporality of practices [37]. For example, energy flexibility might be challenged by networks of materiality in the home [38].

From these insights, it follows that energy flexibility is an outcome of how social practices, like washing clothes and cooking, interconnect [16]. Therefore, analyzing electricity demand patterns should center around social practices including their rhythmic qualities and interconnections [19]. This means that energy demand flexibility should be understood as the flexibility of practices, for example when practices are detached and not tied to a specific time or place or capable of being interrupted [39], or when those who perform the practices embody flexibility capital, i.e. the ability to shift energy use in time and space while taken factors such as financial resources into account [18].

To sum up, in an understanding of energy demand flexibility as the flexibility of everyday practices, the social and shared aspects of temporal rhythms (rather than the flexibility of consumers) are emphasized, entailing a view of the dynamic price signals as working through the dynamics of everyday practices [5].

3. Data and Methods

The qualitative analysis is based on 11 household visits, consisting mainly of semi-structured interviews with one or more persons living in the household (18 persons in total), also including field notes, a home tour, and photos. This paper will primarily draw on the interview material. The visits took place between September 6th and December 22nd, 2021. On average, the interviews took one and a half hours. The sample covered all six administrative regions in Denmark and represented ages from 32 to 77 with most households being older than 60 years old. Appendix A shows a table with an overview of all households and interviewees in the study.

The interviewees were recruited via the customer service departments of two Danish electricity retailers. In total, 16 households were contacted, but because this recruiting procedure was not initially successful, the sample was added to two interviewees recruited via Twitter (now X) and one via personal contacts. The participating households received a voucher as thanks for their participation with a document with information about the project and their rights and options as research participants. The sample was restricted to households that had RTP as their energy supply product. All interviews were transcribed and coded in NVivo together with field notes.

Inspired by previous research presented in Section 2.2, the interviews primarily revolved around the themes of everyday routines, the timing of everyday activities, the choice of electricity pricing schemes, and energy consumption in general.

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4. Results

This section highlights three main insights from the household visits with implications for the discussion of electricity demand flexibility. The first insight concerns the interest in and language around dynamic pricing and products. Secondly, the temporal aspects of everyday routines are expanded, and finally, the importance of habits in shaping energy-consuming practices is highlighted.

Insight 1: Low interest in dynamic pricing and confusion over terminology

When our study started in late 2021, dynamic electricity prices were a relatively unknown phenomenon in Denmark. Where several Danish grid companies had introduced dynamic prices years earlier, in the form of ToU grid tariffs, the Danish electricity retailers had just started to sell dynamic pricing products on the market, predominantly with an RTP structure [5]. Electricity prices that varied during the day were a new thing in Denmark, and this was reflected in the names that the retailers gave them. Similar products thus had different names, for example referring to 'flex', 'spot', or 'climate' [5]. Because of the lack of coherent language around such products, we started our interviews by asking the interviewees what they called it. We tried to ask in a way that did not suggest an answer already. This revealed reluctant language around dynamic pricing. Some did refer to the correct term of their households' product, e.g. 'FlexEl', while others simply did not know how to answer. The male interviewees were more keen to answer this question, like Michael (51 years, Central Jutland): "Well, I just asked for the cheapest solution, and that was 'flex electricity' for us". In contrast, the typical answers from the female interviewees were quite different. For example, Mette (51 years, Central Jutland) said: "Well, I don't call it much. I don't know much about it", and Sabine (31 years, Copenhagen) said: "[the product] was just something, I changed to. Otherwise, it means nothing to me, and I don't care about it. I just have it". This lack of interest was expressed even more clearly by Sybille (71 years, Southern Denmark): "It's fine for those who are interested in that stuff, but I don't care", and when asked what she thought about that, Sybille replied: "I don't give a damn, it doesn't interest me".

This tendency, most evident among female employees, reflects both a lack of interest in the specific product as well as a lack of words to describe the product. This could reflect a division of practices in the household, where those who take care of electricity bills were more familiar with products on the retail market and their respective names. It could also mean that there was generally not much talk about these products in the households. Sylvester (70 years, Southern Jutland) stated this explicitly: "[W]e never really talks about it [the product]. It's actually irrelevant [...] We can't do anything about it anyway. We can change [electricity] company from time to time to make the prices go up or down, but that's basically it. But what do we call it - around here we call it hourly billing". Even though Sylvester's description appeared disengaged, he seemed to have captured the exact sense of the RTP product by referring to it as "hourly billing".

During the interviews, a few critical remarks were made. One interviewee expressed that customers generally have "[…] no idea whether [the product] is cheaper" (Svend, 71 years, Copenhagen). Another critical remark related to the lack of transparency regarding whether the consumed energy stemmed from renewables or fossils: "We can't see if it is green energy. You can't see on the socket, if it is coal or green energy […] It is a bit like saying; 'do you believe in Santa Claus' […] They [the retailers] can make us believe anything" (Signe, 71 years, Copenhagen). From these findings, it appears that there is still some way to go when it comes to electricity customers being fully conversant with dynamic electricity pricing.

Insight 2: Everyday practices are (already) flexible but for other reasons than striving for energy flexibility

The second insight concerns the temporal aspects of everyday routines and what could be referred to as socio-temporal rhythms [33]. In this study, we focused on five key aspects of the

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temporality of practices: 1) duration (how long?), 2) timing (when?), 3) frequency (how often?), 4) sequence (which order?), and 5) tempo (how fast?). With reference to these aspects, we asked the interviewees about the flexibility and fixity of their everyday routines and rhythms

When asking the interviewees directly, there was a reluctance to change the temporality of everyday routines such as cooking and eating dinner. However, during the interviews, we got multiple examples of everyday strategies to create flexibility. Although the households did not express any interest in changing the timing of their everyday practices when asked directly about energy flexibility, plenty of examples of flexibility nevertheless came to the surface when we asked about other activities, for example in relation to creating more time in a busy daily schedule. As Sara explained: "It's not more set in stone than that there is room for flexibility in the form that if Sigurd is not home because he has to work extra, or if I am not home because I have to attend classes, then the other one just eats alone". This was a recurring example showing how the practice of having dinner is flexible. For example, dinner can be prepared the day before or can take the form of heating a frozen pizza from the freezer. Rye bread open-faced sandwiches (in Danish: "rugbrødsmadder") were recurrently mentioned in the interviews to create flexibility in eating practices, for example when confining with less or economizing.

This indicates that flexibility is already an integrated feature of everyday routines and rhythms, and it appears easier to talk about everyday routines and rhythms, for example concerning cooking and dinner, than on energy demand. This links to insight 1 indicating low interest in energy consumption matters, where in contrast, several households did talk about electricity use, which primarily concerned EVs (or hybrid cars) or PVs.

The interviews touched upon several aspects of temporality. For example, Michael (51 years, Central Jutland) mentioned the touchy subject of the tempo and duration of vacuum cleaning: "[vacuum cleaning] needs to be done as quickly as possible", whereas his wife, Maren (55 years), replied: "Yes, too quickly sometimes". Michael continued to talk about how he might enjoy it a bit (relating this to the Danish notion of "hygge", translating to "coziness"), wearing wireless headphones during, but still regard it as something that needed to be done quickly. Sabine also mentioned tempo, in combination with timing and sequence, regarding her practice of washing clothes: "I prefer to do it as early as possible to get it over with. […] If I have vacation or something, then I might set my alarm for seven o'clock when it [the laundry room] opens and start a load of laundry". A final example concerns the sequence of practices, which refers to how activities follow one another in a particular order. Signe said: "I have a thing about clothes lying there and getting wrinkled [in the dryer], so when you come in the morning, you also have to iron them. I prefer that when I know it's finished, I can take it out, shake it right away, and stretch it out. So, actually, only Sylvester's shirts get ironed. Everything else just gets pulled into shape".

The examples mentioned so far have concerned activities inside the household, but an important aspect of everyday flexibility is that everyday practices need to accommodate temporal structures outside the home, such as working hours and events. Furthermore, social relations in the form of family visits or guests might also demand flexibility from everyday practices. This was illustrated by Sybille who talked about how life as a pensioner is not necessarily restricted by the same temporal structures: "When, for example, I think about going out to shop and such. Well, us who stay at home, pensioners, and such. We can shop at other times than right now when people get off work".

These examples show that flexibility in the form of changing the temporality of practices is an integral part of everyday life. This insight relates to another valuable lesson on energy flexibility. Energy flexibility is not just about changing the timing of activities, for example time-shifting energy use, but also about other temporal aspects of everyday life, like sequence, tempo, and duration.

Insight 3: Habits are important for what is meaningful in everyday practices

The third insight concerns the notion of habits which has a long intellectual history, from Aristotle (hexeis) [40] via Bourdieu (habitus) [41] to modern self-help literature (habits) [42,43]. Habit has many meanings but can popularly be described as the combination of an "automatic, 'mechanical' reaction" and "[a] settled disposition or tendency to act in a certain way" (Oxford English Dictionary).

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The present analysis focuses on the learned dispositions of habits through repetition or intergenerational transmission, referring to concepts of embodied (energy) practices [44,45], or what simply could be referred to as habitus [46] where certain ways of performing practices 'stick' to us [47].

There are many examples of how previous experience forms current energy practices. One example was Noa (30s, Northern Jutland) who explicitly mentioned the concept of habits concerning the use of lights: "[I] was raised with [the idea] that you don't have lights on in rooms you are not in it […]. It's not something I think about".

Sybille and Sylvester (70s, Southern Jutland) tried to pass on their energy-saving routines to their children and grandchildren, for instance reminding them to turn on the lights. As Sylvester said: "[…] they [the children] sure don't save on anything", and Sybille continues: "Well, they have lights on everywhere. The first thing I say [to them] is 'Shouldn't we just turn them off', and 'Remember to turn them off', and blah, blah...". Sylvester linked these practices to his upbringing: "For I sure won't give more [e.g., money] than absolutely necessary, for neither one thing nor the other. That's just how we were raised".

While Sybille and Sylvester focused on frugal habits, Nikolaj and Nikoline (30s, Northern Jutland) focused on impacts on the climate and environment in the parenting of their two children living at home. As Nikolaj said: "[the children] are aware that there's something about climate issues because it's significant. […] Regarding the garden, I think about trying to be a bit self-sufficient, like trying to grow something we can eat ourselves. […] So, we try to install some awareness in their heads about how the things we spend money on also has effects on other things".

Previous experiences that were not related to upbringing and family relations also formed energy habits. For example, Signe and Svend (70s, Copenhagen) talked about how their past as scouts has formed them; Signe said: "We are both former scout leaders and have been scouts for many years. You know [as a scout] what it means if you suddenly find yourself lacking things […]. So, it's strongly ingrained in us that when you leave a room, you turn off the lights and all those things that might be annoying to some". In this case, the scout experiences appear to influence energy-saving practices, but previous experiences can also 'stick' to restrict future practices, which in this case could be energy-flexible practices. Michael and Maren (50s, Central Jutland) talked about how the fear of fire when running appliances during the night, e.g., dishwasher and washing machine, related to stories about things setting on fire. Sybille and Sylvester mentioned something similar, including "accidents" and "short-circuited systems". As Sylvester explained: "We have read about it [e.g., accidents]. It happens quite regularly. On television". Sylvester continued with his personal experiences: "I have responded to fires before when I worked for Falck [emergency service], then we went out at night to fires in different places. It often turned out that it was a short circuit that caused it". This places the practice of Sylvester to a specific previous working practice.

The energy habits that people rely on when performing everyday practices are found to have a great impact on energy flexibility. The examples from this study point to how energy habits are learned, carried, and transmitted, including the non-reflexive and sensory aspects of habitual actions. In this way, energy habits influence how energy is used and point to how energy use is sometimes inflexible and stuck in everyday routines.

Everyday routines and habits are per definition characterized by (automatic) repetition and stability. However, there seems to be some flexibility in these routines, and the potential for change (and flexibility) might hide in the non-reflexive patterns and rhythms of everyday life.

5. Discussion

This study aimed at better understanding how dynamic electricity pricing influences the routines and rhythms of everyday practices of Danish households. Through 11 qualitative interviews (18 people in total) and household visits, we found generally low interest in dynamic electricity pricing. This result is in line with previous literature suggesting that electricity consumption happens (non-consciously) through the performance of everyday practices [29]. Most interviewees did not know what it was or what they should call it, and they were generally not interested in it. This is not

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surprising as dynamic electricity pricing was rather new at the time of the interview and Danish energy suppliers used various terms for similar products [5].

The analysis showed examples of the potential of dynamic pricing to appeal to consumers, either for environmental or financial benefits. However, the strongest impression from the interviews and household visits was a lack of interest in the product and a lack of engagement with time-shifting everyday practices for the sake of energy flexibility. Based on the findings presented in this paper, particularly three insights can be highlighted. First, the terminology of dynamic electricity pricing was very confusing. Second, creating 'everyday flexibility' already occurred as an integrated part of everyday routines and rhythms. However, the purpose was not energy flexibility, but instead to make routines and rhythms run as smoothly as possible, being prepared for guests, or simply enjoying extra time to relax or do other kinds of housework. Like previous studies, this suggests that energy demand flexibility reflects the flexibility of routinized practices rather than deliberate decisions [16,19,48]. Third, and final, energy habits, or what could be referred to as embodied practices formed by previous experience [44,47], appeared meaningful and influential in guiding everyday practices, especially when linked to sensory experiences, such as the smell or sensation of clothes that were dried outside as opposed to tumble drying.

These insights share that energy flexibility does not necessarily have something to do with energy. This means that all the everyday things that do not relate to energy matter to everyday flexibility, and thereby energy demand flexibility. In addition to the analysis, and based on the interviews, this also extends to the importance of noise from TVs, guests that 'disturb' everyday routines, diagnoses like autism and anxiety that restrict planning of everyday activities, and not least household pets that for example require (vacuum)cleaning.

These findings indicate that energy flexibility is for the few rather than the many. While some households manage to perform everyday practices to provide energy flexibility, most households are less able to do so, which could be referred to as having lower levels of flexibility capital [18,49]. The households with lower flexibility capital struggle with everyday practices being more temporally fixed or determined by other factors that carry a heavier weight to people than energy demand currently does.

6. Conclusion and Implications

Intending to reduce peak energy demand, we make four recommendations for better implementation of dynamic electricity pricing based on this study. First, we suggest concentrating efforts on households that *will* and *can*, and leave does who cannot, for example, due to time pressure. Second, we suggest focusing on large energy end-use, such as big houses or households with electric vehicles and/or electric heating. Third, we suggest considering time-varying prices as an instrument to save energy, rather than time-shifting practices for example by reducing standby consumption or excess electricity consumption. Fourth, we suggest sending signals to consumers on fluctuations in electricity supply through more than price signals, for example by relating to well-known temporal rhythms, such as rush hour or weather conditions. More drastically, electricity blackouts or brownouts would also send a stronger signal of the availability of electricity, but the electricity provision is extremely high in Denmark [50].

Finally, we encourage energy policy and the energy industry to lower expectations of the potential of steering energy demand flexibility, to effects of dynamic pricing, and what can be imposed on everyday energy practices.

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Appendix A

Table A1. Overview of interviewees and home visits. All interviewees have been given pseudonyms. Ages in parentheses.

Pseudonym (age)	Danish region	Housing type	Household and family composition
Magne (57)	Central	Rented room in farmhouse	He lives alone but shares a house with his landlord. He has adult children.
Michael (51) and Maren (55)	Central	Single-family dwelling	They have a daughter, a grandson, and a dog.
Mette (51) and Morten (60)	Central	Single-family dwelling	Morten has an adult child from a previous marriage.
Nikolaj (37)	Northern	Single-family dwelling	Married to Nikoline (38). They have two children living at home.
Nina (NA) and Niels (65)	Northern	Apartment	They have an adult daughter who lives nearby.
Nicklas (32) and Nikita (33)	Northern	Single-family dwelling	They have a dog.
Noa (35)	Northern	Apartment	He lives alone and has a girlfriend living nearby.
Sabine (31)	Capital	Apartment	She lives alone.
Sylvester (70) and Sybille (68)	Southern	Farmhouse	They have adult children, grandchildren, and a dog.
Solvej (65) and Sami (77)	Zealand	Terraced house	They have an adult son who lives abroad.
Sigurd (59) and Sara (59)	Zealand	Terraced house	Sigurd has four adult children from a previous marriage.

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