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Aggeli, Aggeliki; Christensen, Toke Haunstrup; Larsen, Simon Peter Aslak Kondrup

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RESEARCH

The gendering of energy household labour

AGGELIKI AGGELI

TOKE HAUNSTRUP CHRISTENSEN

SIMON PETER ASLAK KONDRUP LARSEN

*Author affiliations can be found in the back matter of this article

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ABSTRACT

Gender considerations, such as the division of household labour and the coordination of everyday household practices, are important for the energy transition of households. Household labour involves everyday practices (*e.g.* cooking, laundry and caring for others) and practices of energy household labour (*e.g.* managing digital technologies and energy systems). Emerging smart energy technologies require energy flexibility and efficiency, thereby introducing new forms of household labour can have implications for the household which are not well understood. Through a literature review and some empirical insights from a European Horizon 2020 project, mental aspects of energy household labour are identified: practices of coordination and multitasking, remembering and anticipating, and powerful emotional labour which shapes the practices. Smart technologies and energy systems add more physical and mental labour to households due to the need for additional coordination and change of practices. This additional demand for coordination can exacerbate existing gender inequalities in the division of household labour: technological strategies and designs need to engage with this and reduce new burdens. Considerations for future research are proposed and a gender-sensitive framework for understanding the transition of energy household labour is outlined.

PRACTICE RELEVANCE

Despite the balancing of more stereotypical gender roles in everyday life at home, the mental load of household labour still overburdens women. Technology design and strategies for its domestication need to recognise this load and adopt more gender-sensitive ways of supporting the mental aspects of household labour performed for the organisation of home and provide appropriate digital literacy opportunities for those who use them, without undermining their contribution in the process. Technology-assisted support for the mental aspects of household labour should allow for better negotiations and distribution of household labour required for a successful energy transition, without at the same time adding extra work for both men and women. The initial empirical insights call for a gender-sensitive framework for investigating the emerging practices that this involves, for the energy transition of households.

CORRESPONDING AUTHOR:

Aggeliki Aggeli

Department of the Built Environment, Aalborg University, Copenhagen, DK

agag@build.aau.dk

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1. INTRODUCTION

The home is the site of the performance of a multiplicity of household labour practices involving a large range of everyday tasks and routines that are performed to maintain home, care for others and keep the household organised. Household labour encompasses a complex of interconnected practices, including physical, emotional, mental and spiritual dimensions (Eichler & Albanese 2007), and requires appropriate communication, collaboration and alignment between household members. Overall, household labour studies point towards an overrepresentation of women in the performance of these everyday tasks (OECD 2019; Tai & Treas 2013). On the other hand, with few exceptions (Sinanan & Horst 2021), recent studies of digital housekeeping practices show a larger representation of men in the undertaking of such activities (Kennedy *et al.* 2015; Tirado Herrero *et al.* 2018), possibly partly replacing their involvement in ordinary, everyday tasks of household labour (Johnson 2020; Kennedy *et al.* 2015; Strengers *et al.* 2019). This might widen the gender gap in the performance of household labour bringing about the risk of miscoordination of practices and additional complications for the successful integration in the home's existing rhythms (Kennedy *et al.* 2015).

Everyday household labour has an impact on energy infrastructures and is therefore important in the transition to more energy efficient systems of energy provision and consumption (Johnson 2020). This energy transition of households requires the development of new roles and responsibilities for household members, within both the household and their community. In this transitional period households are installing new smart energy technologies and systems, such as heat pumps and solar energy systems (De Wilde 2021), which require new skills and practices. Departing from Tolmie *et al.*'s (2007) concept of digital housekeeping, Martin's (2022) definition of energy housekeeping is used as a more appropriate term for referring to practices of control, maintenance, interpretation and orchestrating of energy at home. The present paper refers to these emerging energy-related practices as energy household labour.

Further to the development of new skills, smart energy technologies require new understandings and negotiations on behalf of householders, who often need intermediation to normalise them in their everyday life (De Wilde 2021). Furthermore, these newly introduced practices of energy household labour, such as controlling and managing PVs and batteries, bring the expectation of householders being 'co-managers' of their energy, and therefore imply significant changes to people's everyday life (Smale *et al.* 2017: 132). This requires that households learn to operate complex technical systems and adjust their energy consumption to respond to the supply of renewable energy (Smale *et al.* 2019), thereby becoming more 'flexible'. However, this flexibility means that households need to time-shift or amend their often well-established everyday social practices, which is complicated (Friis & Christensen 2016; Nicholls & Strengers 2015).

In addition, smart energy technologies and systems introduce not just new material and physically performed practices but also non-material and mental practices into homes (Smale *et al.* 2017: 134). As practices are always both bodily and mental (Reckwitz 2002), changing practices according to a new purpose (*telos*) also has a mental dimension, which relates to what Schatzki defines as practical intelligibility (Schatzki 2002). The engagement of people with smart energy technologies is emotionally charged, not always rational and implicated in people's meanings and lived experiences (Ransan-Cooper *et al.* 2020). In this context, and taking into consideration the different ways in which householders perceive their home (*e.g.* home as a safe place or as a project), it is really important to consider the mental aspects of these practices, paying particular attention to emotions, which Schatzki considers to be part of teleoaffective structures. Teleoaffective structures relate to general understandings and rules relevant to a social practice, as well emotions and moods (Schatzki 2002: 80), and they can hold practices together (Smale *et al.* 2017: 134). For example, this can be by coordinating the relevant meanings and emotions that householders carry about the new smart energy systems. By putting more emphasis on the emotional aspects of household labour, the paper contributes to practice theoretical studies that place emotion more centrally in their analysis (*e.g.* Smale *et al.* 2017; Molander & Hartmann 2018; Weenink & Spargaaren 2016; Sahakian 2022) and also contributes to understandings of how emotions can shape practice change.

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This paper focuses on the role that gender plays in the process of adopting new 'energy flexible' practices, paying attention to how, in particular, it shapes the mental aspects (teleoaffective structures) of these practices. Gender is becoming an increasingly important consideration in such studies of energy transitions, despite it often being treated as a secondary aspect (Petrova & Simcock 2021). Gender inequalities are present in different areas of energy provision and consumption, such as the unequal representation of energy poverty (Petrova & Simcock 2021), the role of gender in energy consumption (Lazoroska *et al.* 2021; Mechlenborg & Gram-Hanssen 2020), as well as gender inequalities in the undertaking and negotiations of everyday household labour (Doan & Quadlin 2019; Nakamura & Akiyoshi 2015). Following Mechlenborg & Gram-Hanssen (2020), gender is understood as something that is enacted rather than a form of identity, and as a general understanding implicated in the performance, materiality and meanings of social practices. Gender is something that can change while people of different sexes perform practices under different social settings (Hui *et al.* 2016). Men and women perform household labour in different ways, therefore generating several gendered versions of the same practice (Pink 2004), while these practices are also affected by the infrastructure and local context in which they are situated (Mechlenborg & Gram-Hanssen 2020). To inform the analysis, inspiration is derived from studies showing an unequal gender distribution of the 'mental work' related to the performance of the everyday household labour, which disproportionally concerns women, but at the same time affects the whole household's everyday life (Daminger 2019; Offer 2014).

This paper addresses two key questions:

- In what ways are the emerging practices of energy household labour coordinated with existing household labour practices?
- In what ways are these gendered?

These are explored by examining how energy household labour practices are meaningful to people (Molander & Hartmann 2018), especially considering the mental (cognitive and emotional) aspects along with the gender dynamics these involve. A practice–theoretical perspective is used, putting social practices at the centre of the analysis. A critical review of the literature and some empirical insights from an EU Horizon 2020 project called Hestia (Holistic dEmand response Services for European residenTIAl communities) on electricity demand response are presented. The empirical examples inform the mainly theoretical discussion of this paper by providing empirical insights that can help raise new analytical questions as well as elaborate the existing literature.

Some indirect mentions are found in recent research relating to the mental aspects of energy household labour, such as observations with regard to smart technologies' opportunity of relieving time and effort (therefore removing some of the mental load) from householders (Tirado Herrero *et al.* 2018; Strengers *et al.* 2019, Strengers 2013), issues of cognitive learning of technologies (Strengers & Nicholls 2018; Hargreaves *et al.* 2018), the role of emotions in the shaping of household automation (Sinanan & Horst 2021), issues of care and cognitive labour (Aagaard 2022), household management (Johnson 2020) and cognitive labour for the embedding of smart technologies into the home (Strengers & Kennedy 2020). However, these examples do not explicitly identify the mental aspects of energy household labour as the combination of cognitive and emotional aspects required for the coordination and orchestration of energy household labour with everyday routines.

The remainder of the paper is structured as follows. Section 2 presents a theoretical positioning within theories of practice, explaining the different aspects of practices (bodily and mental) and discussing the way emotions are perceived. Section 3 reviews the literature on the gendering of household labour and discusses its implications for the coordination with new energy household labour practices. Section 4 presents the concept of mental load of both everyday and energy household labour and elaborates it further theoretically and empirically. The empirical examples from the research project in relation to how households engage bodily and mentally with everyday energy household labour are discussed. Section 5 evaluates these findings by discussing emerging themes and implications. Section 6 concludes by proposing a gender-sensitive framework for

understanding and researching energy household labour as well as identifying some key foci for further research on energy household labour.

2. HOUSEHOLD LABOUR PRACTICES AND ENERGY TRANSITIONS

Household labour is framed as a group of interconnected and co-evolving practices. Practices are defined as bodily performed and mental activities composed of different elements such as materials, know-how and understandings (Reckwitz 2002). Following Reckwitz (2002: 252), mental routines and knowledge are seen as 'integral parts and elements of practices'.

Mental activities are therefore aspects of a practice, rather than a capacity of the individual. According to Schatzki (2001), mental states (the mind) play a key role in organising practices as (bodily) doings and sayings. They do so through the practical intelligibility, which is 'what makes sense to a person to do' and that:

> governs action by specifying what an actor does next in the continuous flow of activity.
>
> (Schatzki 2002: 74–75)

The practical intelligibility is embedded in the individual, but is essentially shaped by practice-related understandings, sets of rules and teleoaffective structures — with the latter two emphasised by Schatzki (2001). As the term 'teleoaffective' indicates, Schatzki sees the goal of practices (their *telos*) as closely related to the emotional (affective) element of practices. Thus, emotions in theories of practice are usually considered as part of teleoaffective structures (Schatzki 2002). Furthermore, it is important to understand how practices are meaningful to people, because the way in which things matter to people structures their behaviour (Schatzki 1996). Therefore, it is necessary to examine not only how energy household labour practices are performed but also in what ways the practitioners find it meaningful to do them (Molander & Hartmann 2018).

The intention is to highlight the gendering of the different aspects of the practices of household labour to reflect issues of coordination and negotiation of everyday household practices essential for the successful energy transition of households. Following Dean *et al.* (2022), the definition 'mental load' of household labour is adopted and used here. This comprises elements of cognitive labour, which Daminger (2019: 609) identifies as 'anticipating needs, identifying options for filling them, making decisions and monitoring progress', and elements of emotional labour, comprising the complexity of orchestrating and caring for the household and its members, such as looking after children or other adults.

This emotional aspect has an important place in the shaping of household labour practices (bodily and mental). An awareness of its impact is necessary when introducing new technologies and therefore new or revised household labour practices. In everyday life, people often show preference or a desire to perform practices because of certain emotions (Molander & Hartmann 2018). Therefore, it is important to explain in what way emotions relate to household labour practices.

Energy household labour also consists of another type of practice. This is less tightly bound to other integrated everyday practices: reading meters, maintaining the technical installations or monitoring energy consumption via apps. These practices resemble digital housekeeping and are often performed by men. They form a subcategory of the digital household labour practices.[1]

It is argued that the energy household labour is emotionally charged, particularly during the early stages of adopting and domesticating new energy technologies. This paper further emphasises the importance of the agency of emotions (as part of the teleoaffective structures of practices), along with other cognitive processes such as thinking, planning and anticipating, seeking particularly to identify the gendering of these processes and their implication for the energy transition of households.

Household labour is conceptualised as a group of practices (Figure 1) consisting of bodily and mental aspects and investigated through the gendering of these practices and their implications for the coordination of the practices.

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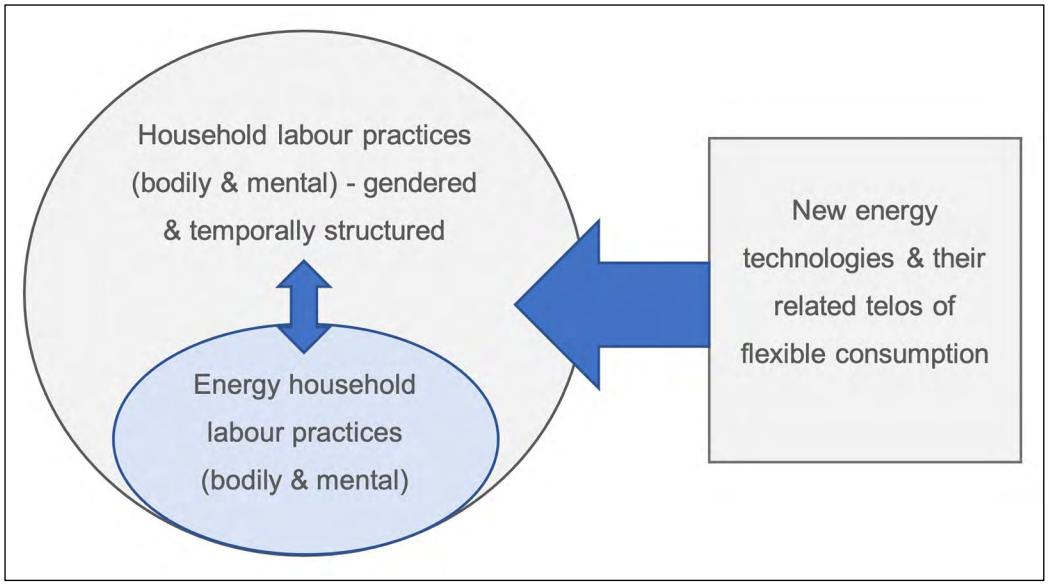

Figure 1: Household labour practices.

Source: Authors.

3. THE GENDERING OF HOUSEHOLD LABOUR

The household remains one of the 'most gendered spheres of society' (Petrova & Simcock 2021: 850). However, when smart technologies are discussed, the household is often portrayed as a gender-neutral, indistinctive space (Furszyfer Del Rio *et al.* 2021; Richardson 2009). This is contradicted by research showing that the energy technologies and systems that people bring into their homes are typically gendered and tend to be inscribed for male, digitally literate users (Mechlenborg & Gram-Hanssen 2020; Strengers 2013). Furthermore, households are 'social assemblages with variable gender, age, class, ethnic and familial structures', and people form relationships with the social, material and infrastructural context in which these belong (Head *et al.* 2013).

Household labour includes stereotypically female-dominated 'routine tasks', such as cooking and cleaning, and other less regular and more 'intermittent tasks', which are stereotypically male-dominated activities, such as repairing the house or car (Lachance-Grzela & Bouchard 2010). Despite the increasing participation of men in everyday tasks and childcare, household labour remains gendered and, in its majority, still undertaken by women (Ciciolla & Luthar 2019; Hamada 2021; OECD 2019).

The literature suggests that women are primarily responsible for the efficient organisation of household labour and often characterised as 'captains of the ship' for their role as managers of households (Ciciolla & Luthar 2019; Winkler & Ireland 2007). In addition, women are primarily responsible for maintaining notions of comfort, order and wellbeing at home (Ciciolla & Luthar 2019; Richardson 2009). Yet, household labour is largely invisible in the eyes of other household members who are not present when it is performed, to the designers of household technologies and, in some cases, to society overall (Richardson 2009). Part of this invisibility is because household labour involves cognitive and emotional aspects, which are difficult to acknowledge since they are internalised and can be performed both in- and outside the home (Dean *et al.* 2022). The following section elaborates on this mental aspect of household labour.

Regardless of their prominence in everyday life, forms of household labour practices are absent from visions of smart homes (Dourish & Bell 2011; Strengers & Nicholls 2018). Rather, these visions promise to reduce the time and emotional engagement required to perform ordinary tasks of everyday household labour (Strengers 2013; Strengers & Nicholls 2017). Furthermore, the technologies involved in these smart homes, such as digital networks, devices and energy systems, are thought to allow less thinking and worrying on behalf of householders, or as Tirado Herrero *et al.* suggest, they offer the opportunity for 'setting and forgetting' (Tirado Herrero *et al.* 2018: 67; also Strengers *et al.* 2019: 7). Therefore, a better understanding of what this promise of

'setting and forgetting' means for the lived experience of households is needed. This will be done by exploring the mental load of household labour.

4. THE MENTAL LOAD OF HOUSEHOLD LABOUR

The mental aspect of household labour entails cognitive aspects, such as preparing and responding to others' needs (Daminger 2019: 609) and emotional aspects, which are associated with these cognitive engagements (Dean *et al.* 2022). The emotional engagement of household labour requires a substantial amount of time and energy from its practitioners, especially in multiple members' households (Erickson 2011). This emotional aspect of household labour is also directly linked to practices of care and being responsible for others, which disproportionately affect women, mothers in particular (Dean *et al.* 2022).

Mental household labour has been conceptualised as either an organisational aspect of household labour, explained as a cognitive labour and therefore excluding its emotional dimension (Daminger 2019), or as a combination of cognitive labour and emotional support (Dean *et al.* 2022). In all cases this mental aspect of household labour has been rendered as invisible, since it is not observable (Dean *et al.* 2022; Harrington & Reese-Melancon 2022), in some cases even by the practitioners themselves, who doubt whether their thinking and planning processes can count as 'real' work (Daminger 2019). Furthermore, this mental aspect, or 'worry work' (Grose 2019), becomes a mental load through the combination of the continuous cognitive and emotional labour, which become endless and is an inseparable part of performing and coordinating daily household labour, and can often become overburdening (Dean *et al.* 2022). The mental load of everyday household labour, often investigated as part of family life in research (Robertson *et al.* 2019), disproportionately affects women, who take most of its responsibility (Ciciolla & Luthar 2019; Dean *et al.* 2022).

On the other hand, evidence from studies of digital household labour, such as engagements with smart home systems, suggests that both women and men are affected by the introduction of these technologies into the home, particularly as men tend to take a lead in their management and control (Strengers & Nicholls 2018; Strengers & Kennedy 2020), and that gender, smart technologies and home are concerns for negotiation rather than 'formal features' (Mechlenborg & Gram-Hanssen 2020: 4). Therefore, it is important to understand how household labour divisions are delegated and negotiated and in what ways the introduction of new energy systems, and their required *telos* of flexibility, are shaping the reproduction of gender roles and practice performances at home.

In addition, the mental aspect of household labour can be considered as part of the 'holding things together' which takes place mostly in busy family households and comprises the management and overall organisation of the everyday routines and activities (Christensen & Røpke 2010). As women tend to have the role of orchestration and management of household labour, more empirical insights are needed in order to understand in what ways this orchestration and management are affected and delegated through the new energy household labour practices that are adopted. The following section discusses these energy household labour practices, as identified in the pilot studies, as well-emerging themes and characteristics.

4.1 ENERGY HOUSEHOLD LABOUR AND MENTAL LOAD

Since the early days of their introduction, household appliances have promised to reduce everyday household labour (Cowan 1983). Instead, this resulted in increased levels of standards, including comfort, cleanliness and convenience (Shove 2003), as well as in new gendered labour divisions with male household members becoming less involved in many household tasks (Cowan 1983). Modern smart home technologies and smart energy systems promise a similar 'utopia' by offering people the chance to take some load off their minds (Strengers 2013). These technologies also promise a financially and energy efficient, predictable and secure everyday life (Gram-Hanssen & Darby 2018; Shirani *et al.* 2020). But domestic smart energy systems and devices (*e.g.* solar

panels and heat pumps) also generate new needs for expertise regarding their management and coordination with existing household routines.

As discussed in the introduction, energy household labour entails people's engagement with the energy systems of their home. These practices also involve the domestication of new technologies in the existing digital 'ecology' of the home (Kennedy *et al.* 2015). This requires substantial work and expertise and a good understanding of how these technologies can fit within established routines of the household (Tolmie *et al.* 2007). Taking as a starting point that homes are now becoming hubs of emerging technologies that shape the households' everyday routines and labour (Sadowski *et al.* 2021), and that technologies have allowed for the reduction or reallocation of household labour, the present paper explores in what ways practices of energy household labour, as identified below, are shaping the gender roles and performance of household labour, paying attention to the mental aspects of it.

4.1.1 Energy households labour practices

Empirical data collected by the authors have indicated a range of practices related to energy household labour. The data come from two pilot sites that are both part of an EU Horizon 2020 project titled Hestia. The project aims to demonstrate the potential of a new demand response platform for energy flexibility. The sites are located in the Netherlands and Italy and differ quite substantially in terms of infrastructural, climatic, market and regulatory contexts.

The Dutch pilot study comprises recently built smart, detached and semi-detached homes, with a fully electric energy system for space heating, hot water and other uses. It is focused on the management of the photovoltaic (PV) batteries to improve household and community consumption and production of energy. The Italian pilot study includes a wide variety of older homes and apartments with some newly installed smart energy technologies, such as PVs and batteries. It is focused on the optimal use of local (PV) energy within the local energy community, encouraging household consumption and energy exchange among citizens.

The data in this paper represent 15 households from the Dutch pilot (out of a pool of 33 households participating) and 24 households from the Italian pilot (out of a pool of 30 households participating). The Hestia project involves a participatory methodology, employing workshops, home tours, interviews and focus groups as methods for achieving a diverse inclusion. The households were recruited through direct contact with participants, as well as personalised letters, social media posts and community-board announcements, with the assistance of the local municipalities and the pilot partners, comprising energy companies, technology developers and research consultancies.

These empirical examples are taken from a qualitative content analysis of these homes, using an abductive identification of themes derived from semi-structured interviews and home tours and two participatory workshops. The initial intention was not specifically to investigate issues of gender and energy housekeeping. However, during the data collection, the authors realised that the gender dynamics and gendered division of labour at home were significant factors shaping households' flexibility and people's engagement with technologies. The empirical work continues and now involves the running of gender-specific focus groups and workshops in order to investigate the emerging issues in greater depth.

The following list represents the initial observations. It is not an extensive record of practices but rather an attempt to recognise the different aspects of energy household labour as seen in the pilot studies:

- controlling and managing PVs and batteries
- monitoring smart meters
- coordinating energy settings through applications and devices
- maintaining energy devices
- paying bills/settling financial issues

- anticipating amendments in the operation of energy systems
- coordinating energy settings with ordinary housekeeping practices
- planning and anticipating maintenance of energy systems and devices
- worrying about troubles/dysfunctions of energy systems
- mitigating dysfunctions of systems
- worrying for the long-term embedment of energy systems in the home

This mapping of practices of energy household labour is not extensive or generalisable, but highlights areas for further investigation, particularly with regard to the gendering and coordination of energy household labour practices. The following sections elaborate on four themes that the empirical study in Hestia has identified as of particular importance to the mental aspect of energy household labour in the pilots.

4.1.2 Coordination and multitasking

An important characteristic of mental labour is that it takes place over both short or long periods of time and happens simultaneously with bodily performed labour. This flexibility of the mental aspect of household labour, such as anticipating needs or remembering things, can be an advantage in terms of the coordination of household labour overall; however, it can also compete with the physical performance of tasks or interfere with the practitioners' availability for leisure time (Ciciolla & Luthar 2019; Daminger 2019). Women are more often multitasking and occupied with the mental labour of organising the home (Strengers & Nicholls 2018), even when they are at work or at leisure. The mental load that women disproportionately carry, in terms of household management, might be challenged further with the introduction of new demands, such as time-shifting certain practices, as the quotation below suggests:

> Look, I got so many things on my mind, if I have to take into account different times of the day to do laundry, no, I'm sorry, I can't be bothered.
>
> (Emilia)

This is consistent with the literature suggesting that the introduction of new energy technologies in the household, such as time-shifting practices and anticipating how appropriate comfort or cleanliness can be achieved, can be unevenly distributed amongst householders (Johnson 2020; Morosanu 2016; Strengers & Nicholls 2018). While the digital part of energy household labour is seen to be men's domain (Kennedy *et al.* 2015, Strengers & Kennedy 2020), women as 'captains of the ship' (Ciciolla & Luthar 2019) might end up with extra mental considerations in terms of orchestrating the energy labour with the everyday household labour and other obligations such as work commitments and their role as carers (Strengers & Nicholls 2018). As the quotation from Emilia suggests, she already performs most of the household labour, which brings her an added mental load, and even when her husband contributes to it she has to 'educate' or instruct him how to do things such as the laundry. She suggests that time management, or 'keeping it all together', is a heavy load for the household, in which they would welcome some assistance from technology. In other words, women might be more heavily affected by the need to integrate the energy flexibility *telos* into household labour practices, while also continuing to undertake the fair share of everyday household labour and therefore carry more mental load for their coordination (Strengers & Kennedy 2020).

The challenges of limited time and the busyness of everyday life, combined with the ability of technologies to make everyday life more efficient, have resulted in the concept of new technologies 'giving us more time to do more' (Strengers *et al.* 2019: 7). So, whilst smart technologies allow improved convenience in terms of reducing physical and mental labour for performing everyday household labour, they also involve the potential of increasing expectations, particularly for women, to both coordinate households and go to work, while attending to the needs of others (Strengers *et al.* 2019). At the same time, the introduction of smart energy technologies and systems at home have brought 'more work for father or men', who are heavily involved in the 'manual, cognitive and digital' labour required by these systems (Strengers & Kennedy 2020: 43). Therefore, better

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insights are required in order to understand in what ways technologies can assist households' flexibility and everyday household labour, and how the gendered roles in doing so are developing.

4.1.3 Remembering and anticipating

Insights from the Hestia pilot studies suggest that while men are the main managers of the apps that control their energy system, women prefer to engage directly with the installed appliances such as batteries. Chiara, for example, physically checks the battery display in the basement despite her husband suggesting that the app on his phone is more accurate. And while they are both interested and engaged with following their consumption, it is Chiara who takes care and remembers to pay the bill. Gender stereotypes and societal expectations render women as good carers, responsible for remembering things, such as when practices need to be performed (Niedźwieńska & Zielińska 2021). This expectation is particularly strong when women are in relationships or mothers (Harrington & Reese-Melancon 2022; Niedźwieńska & Zielińska 2021). Remembering when to act or plan particular practices, such as paying a bill, is a heavy mental load for women, particularly in family households, which can sometimes cause conflict between family members (Daminger 2019; Harrington & Reese-Melancon 2022).

Remembering can be perceived as providing householders 'peace of mind', which Strengers *et al.* (2020: 7) discuss as part of the 'pleasance' that smart technologies can bring to a home. This is a particular aspect of mental load, along with multitasking, in which there is an opportunity to use smart technologies as assistants, by providing, for example, a platform for visualising what needs to be remembered or artificial intelligence (AI) assistants. However, it is important to consider that technologies cannot simply replace certain practices, as these are implicated in more complex interconnected routines of the organisation of home. And most importantly, attention should be put to not undermine the coordination labour that women carry as this is not always a straightforward activity (Strengers & Kennedy 2020).

4.1.4 Care

The mental aspect of household labour is mixed with other expectations and roles such as being a good parent (Sinanan & Horst 2021). For example, keeping the household on track is another way of explaining the mental load of household labour, which Morosanu (2016) describes as the role of Mother-Multiple. The Mother-Multiple 'mode of being' involves the anticipation of others' 'needs, habits, preferences and dislikes' (Morosanu 2016: 112). While the word 'mother' connotates gendered and stereotypical roles of care, Morosanu suggests it is a concept that can be applied to different people regardless of their age, gender or child-bearing status. According to this, every member of the household can perform this role, showcasing emotions and practices of care for other people's needs and knowing when things should be done. But in practice this is heavily gendered.

In the pilot studies, engagement with the energy household labour was linked to expressions of worry, such as that of energy systems breaking down, and interwoven with notions of care and convenience in the home. For example, in the Dutch pilot, the residents experienced frequent issues of malfunctioning of both the energy system (batteries in particular) and the app that controlled it. This resulted in the disruption of everyday comfort, such as residents experiencing cold rooms, and unreliable or even unpredictable operation of their system, such as roof windows opening at night. This consequently brought more mental worry to the women who were the ones anticipating and planning how to mitigate the loss of comfort or order in the everyday life of their home. So, while most men engaged with the practical resolution of technical issues and faults in the long term through contacting technicians or manually checking technologies, women took the lead of the mental load of mitigating notions of care, comfort and convenience, attempting to keep the running of everyday life intact.

There were also aspects of care that were shared equally amongst partners. For example, fire safety or health-related issues of energy devices were shared equally or in some cases overrepresented by men. Women often identified or anticipated the issue of concern regarding caring for others,

while men took the practical steps to mitigate these issues. For example, a couple in the Dutch pilot installed some extra blinds to help make better indoor conditions for their baby's daytime sleep, supplementing their smart cooling system. The couple jointly identified and resolved this installation. Care can be an interchangeable role within families, with both men and women taking turns caring for others; however, women showed more engagement in the continuous process of embedment and coordination of care with other household routines, such as coordinating washing, cooking and cleaning with the newly introduced energy technologies. So, this certainly is not a clear-cut distinction of the gendering of energy labour practices, but just an indication that more empirical insights are needed to explore further in what way practices of energy household labour are gendered and how they are continuously shaped by advances in technologies and infrastructures.

4.1.5 Emotional labour

Engagement with smart energy systems can be emotionally charged and responsive to the complexity of the lived experiences of households (Ransan-Cooper *et al.* 2020). This was also evident in the pilots. Confusion, uncertainty and agitation were frequently encountered emotions, particularly in the Dutch pilot. Women seemed to be more apprehensive about the technicality of new energy technologies, despite their interest in the overall integration of the system within the household, as the quotation below suggests:

> I want to stay informed, but he [husband] mainly does the technical things. But I also want to understand something, because if he's gone, or whatever, I have to know something about everything.
>
> (Louise)

In the pilot studies a larger representation of men appears to engage more with the control and management of smart energy systems. Despite some interest and awareness from their partners, the monitoring of smart meters as well as the management of energy devices such as batteries and PVs are mostly performed by men. In some cases, as the following quotation suggests, particularly within households of senior citizens, women were even intimidated by the entanglement of new technologies introduced in the home:

> Should my husband die before me and things continue the way they are now, I'll sell the house. I'll leave. It's all the technical malfunctions. It makes me nervous.
>
> (Anouk)

Because of ongoing issues with the operation of the batteries and the app used as an interface for the system, many residents started to lose their interest, patience and faith in smart technologies. Their initial enthusiasm for the new systems slowly turned to disappointment and even a refusal to engage or learn further about their devices. A participant suggested that their home was supposed to be a 'home for the future', but its performance had disappointed them. This was an unexpected emotion, which also influenced the way in which they experienced home overall. In this case the materiality of the practice of energy household labour shaped the meanings of the practitioners and afflicted the development of their skills.

On the other hand, positive or optimistic expectations were expressed by male participants for the new energy systems. Both men and women experience strong emotional engagement when dealing with energy systems. Men were more likely to become disappointed if the technologies did not perform as expected. These gendered expressions of excitement or joy were particularly evident when discussing issues of controlling devices or monitoring consumption. Men expressed joy and pride in the installation of their energy technologies, presenting them as ways to showcase responsibility for the community and evidence of a 'good home'. However, in some of these family households, where men took the lead of taking care of their energy system, there was also an observed miscoordination or misalignment between the existing everyday household labour and the newly introduced practices of energy labour. This was more prominent in extended family households in the Italian pilot study, where more traditional gender roles and expectations shaped

the everyday household labour, whilst engagement with the energy labour was often seen as an additional or 'extra' concern. This detachment of the two kinds of household labour suggests the need for a more careful and gender-sensitive integration of energy technologies in homes in order to assist their embedment to the existing routines and competences of households.

It is evident that practices of energy household labour compete for people's time and emotions (Sahakian & Bertho 2018). Therefore, identifying people's emotions with regard to practices of energy household labour, such as knowing what is frustrating or is pleasurable to do, can help people understand what makes sense for them to do. In the pilot studies, accordingly, the emotional (affective) elements of people's practices shaped their overall sense of their practical intelligibility, therefore giving an indication of what steps could be taken to fix or reorganise these practices. One important observation is that women need to be more involved in the making of these smart energy visions for homes, providing a better diversity for the reshaping of roles, visions and functions that emerging technologies need to achieve.

5. EMERGING ISSUES AND IMPLICATIONS

The mental aspects of the energy household labour practices bring complexities to both the coordination of everyday routines and the negotiations between household members. It was argued above that the mental aspect of household labour can be invisible, continuous and interfere with people's work or leisure engagements. Some implications with regard to gender are now discussed.

5.1 PHYSICAL AND MENTAL LOAD OF ENERGY HOUSEHOLD LABOUR

Smart technologies and smart energy systems bring additional and, in some cases, significant bodily performed and mental labour to the everyday life of households. Despite promises of efficiency, accuracy and carefree operation, their everyday management seems to bring a considerable additional physical and mental workload to householders. Men appear to carry more load with regard to the operation and management of the energy technologies and their long-term integration into the home. Women carry extra load in the coordination and short-term operation of both types of household labour. Integrating the flexibility *telos* into day-to-day household labour involves work with synthesising different—and often contradicting—teloi through daily practice performances. Coordinating household labour requires a larger proportion of mental effort or mental load than individual practices of energy household labour, such as controlling solar panels or batteries. Therefore, the practical intelligibility required for practices of energy household labour might be easier to develop compared with this required for the coordination and management of the overall household labour routines. However, it becomes more complicated when interconnected practices of energy labour and household labour are performed in parallel or require appropriate negotiation.

Energy technologies also require the development of new competences and meanings by householders who are called to multitask and develop new understandings about notions of comfort, convenience and care. Householders adopt new smart technologies, which are designed with certain assumptions, such as the concept that people hold the knowledge and appropriate understandings of how to use them. However, the diversity of households, infused with needs and characteristics shaped by gender, age, stage of life and cultural background, often makes it challenging for them to be operated and domesticated as their design intended. Furthermore, the emotionally charged performance of energy household labour often results in the further disconnection of the collective practices of households, who, as seen in the pilots, can become disappointed or disengaged with repetitive operation failures.

The load of the emerging energy household labour, therefore, needs to be further investigated in order to get a clearer understanding of what it involves for different types of households, and in what ways it can be supported for a more efficient and meaningful energy transition.

5.2 TECHNOLOGIES SHAPE GENDER ROLES, NORMS AND MEANINGS OF HOUSEHOLD LABOUR

It is evident that people mostly cared about maintaining home as a safe, comfortable and secure place. Technologies, initially seen as assistants, became problematic when they interfered with their accepted thresholds of comfort, care and convenience. This was primarily a challenge of trust. Households need reliable systems that enable the performance of everyday comfort and convenience, while maintaining and improving their vision of a good home. The Dutch pilot study suggests that visions of a 'home for the future' were shaped through the experiences of householders with their energy systems. Emotions of frustration and agitation through their everyday experiences lead to the reduction of their expectations and affected the performance of energy household labour practices.

Women, particularly seniors in the pilot studies, often lack interest in the uptake of smart technologies in comparison with men (Strengers *et al.* 2019), or need to be 'taken on board' when new home technologies are to be successfully domesticated (De Wilde 2021). Most women in this study suggested that they do not have the time or interest to invest in smart technologies in their everyday lives. However, they acknowledged a need to understand how their homes can perform better and to be aware of how to 'restore' things back to 'normal' if systems do not work as they should. This expectation of 'normality' has been evident in most of the studied households, where people tried to use technologies to maintain 'life as usual' (Strengers *et al.* 2020). This responsibility of keeping life as usual, by maintaining the expected levels of comfort, cleanliness and coordination of activities, appears to be gendered and disproportionately affects women. It was evident that the additional mental load of coordination of household labour falls mostly on women. Visions of smart technologies need to take this into account in order not to reproduce or exaggerate these gender roles and performances in households and help people progress to a more just distribution of labour. A more diverse smart technology development can also help define and recognise both contributions and roles of men and women in the smart home.

5.3 GENDERING OF HOUSEHOLD LABOUR FOR THE ENERGY TRANSITION

The gendering of technologies and their frequent unattractiveness for women suggest that efficiency will not be achieved unless the knowledge and insights from these technologies and energy systems are appropriately communicated and coordinated with all members of the household and become appropriately integrated with routines, meanings, emotions and understandings of people.

Despite the balancing of more stereotypical gender roles, the mental load of household labour still overburdens women. Technology design and strategies for its domestication need to recognise this load and adopt more gender-sensitive ways of supporting the mental aspects of household labour performed for the organisation of home, as well as to provide relevant digital literacy opportunities for those who use them, without undermining their contribution in the process. This technology-assisted support for the mental aspects of household labour should allow for better negotiation and distribution of household labour required for a successful energy transition, without at the same time adding extra work for both men and women (Strengers and Kennedy 2020).

6. CONCLUSIONS

New insights regarding the mental load of energy household labour suggest a large burden falls on women. This is comprised of practices of coordination and multitasking, remembering and anticipating, care and powerful emotional labour. New smart technologies and energy systems are adding more daily, physical and mental, labour to households. These additional demands to coordinate and amend household practices arise from the demands of energy flexibility and efficiency. These new demands can exacerbate existing gender inequalities in the division of household labour.

Technologies and emotions are continuously (re)shaping gender roles, norms and expectations in households. While gender roles are becoming more balanced and the division of everyday

household labour is less noticeable than before, the mental coordination and overall management of the home continues to be unevenly distributed and gendered. Further critical investigation is needed to understand what the mental aspect of energy household labour involves and how it can be better supported by new smart technologies and energy systems.

NOTE

1 It might be speculated to what extent these practices resemble what Schatzki defines as dispersed practices (similar to other dispersed practices such as describing and explaining) (Schatzki 1996). Is the capability of accessing, reading and understanding information conveyed through digital systems, such as apps or in-home displays, a general practice that ideally needs to be integrated across a variety of integrated household labour practices such as cooking, dishwashing or cleaning? A certain similarity exists between such digital housekeeping practices and Schatzki's dispersed practices. Schatzki (1996: 92) emphasises that dispersed practices can be identified by their lack of teleoaffective structures, but this may not apply to the digital and energy household labour practices, as these also involve the *telos* of the flexible energy consumption. The main reason for householders to engage with the new digital technologies follows from the goal of changing the household's energy consumption patterns, and thus entails a clear *telos*. An important distinction remains between these digital housekeeping practices and the previously described energy household labour practices, as the digital housekeeping practices often seem to be performed in isolation from the integrated household labour practices of cooking, taking care of others, *etc.*

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AUTHOR AFFILIATIONS

Aggeliki Aggeli orcid.org/0000-0003-0337-0261
Department of the Built Environment, Aalborg University, Copenhagen, DK
Toke Haunstrup Christensen orcid.org/0000-0002-5473-6369
Department of the Built Environment, Aalborg University, Copenhagen, DK
Simon Peter Aslak Kondrup Larsen orcid.org/0000-0002-9367-4500
Gate 21, Copenhagen, DK

AUTHOR CONTRIBUTIONS

The authors developed the first idea for the paper together, in the process of analysing the data of an EU Horizon 2020 project. AA and SPAKL together designed the methods for collecting the empirical data. AA and THC developed the theoretical concept of the paper further, developing the structure and analysis framework for it. AA drafted the final version of the paper and THC contributed by discussing, reviewing and editing it.

COMPETING INTERESTS

The authors have no competing interests to declare.

ETHICAL APPROVAL

Informed consent was acquired from the participants in the Horizon 2020 project. Personal data have been anonymised and all names used in the paper are pseudonyms. The research performed for this project was approved by Aalborg University and by the collaborating partners' institutions in the Horizon 2020 project.

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