



Masculine roles and practices in homes with photovoltaic systems

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ABSTRACT

Privately owned, domestic photovoltaic (PV) panels can play an important role in the transition to a low-carbon society by producing renewable energy for the grid and engaging households in energy management. In both aspects, gender is an issue, leading to the development of new theoretical concepts, e.g. the ‘resource man’, the ‘flexibility woman’ and the ‘mother-multiple’. However, a deeper understanding of the role of masculinity may reveal gender complicity and can inform the design of these technologies to be more inclusive. This ethnographic study investigates masculine roles, practices and domesticities for energy management activities in the home. It examines Danish PV owners as domestic prosumers based on in-depth qualitative interviews of 18 participants in 12 households. The use of PV technologies (and their interfaces) reproduces several masculine domesticities that work both productively and counterproductively with feminine domesticities. Technology and energy management are often situated as male hobbies related to masculine self-expression, identity and homemaking. To unlock the full potential of sustainable energy engagement consumption and practices, both masculine and feminine approaches are needed at the conceptual and practical levels.

PRACTICE RELEVANCE

The successful deployment and operation of domestic PV systems depends on aligning the timing of production and consumption of energy in a household. This involves both traditional male and female domains within a household. Significant gaps in understandings, communication and practices were found in many households due to gendered roles. This compromises the potential of domestic generation of renewable energy. Awareness of gender relations can promote the integration and improve practices by providing households with information about technical and less technical aspects of time-shifting practices. Both feminine and masculine understandings of technology, practices and energy consumption are necessary for a more effective transition to the use of smart energy technologies, and with a more equal distribution of these competencies and practices in households with heterosexual couples. In addition, the design and usability of smart energy technology should embrace the needs of both female and male users.

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1. INTRODUCTION

Renewable energy production plays an important role in the transition to a low carbon society. Renewable energies, e.g. solar and wind, have fluctuating energy outputs, and this presents significant challenges in terms of balancing consumption and production. Private domestic photovoltaic (PV) panels have the potential to expand the amount of renewable energy in the system, and they may affect energy consumers' practices in terms of flexible consumption (Mechlenborg *et al.* 2020). However, when entering the private home, these technologies also change gender dynamics and create new practices and understandings (Cockburn & Fürst-Dili 1994; Giles 2004).

The present research is informed by a practice theory perspective (Schatzki 1996). It starts from the assumption that social practices must be considered a key component in the sustainable transition to a low carbon future (Gram-Hanssen 2021). Mechlenborg & Gram-Hanssen (2020) previously argued that gender is embedded in these practices and needs to be considered in sustainable transitions. This is also the point of theoretical concepts such as the 'resource man' (Strengers 2013) and the 'flexibility woman' (Johnson 2020), which show that new technologies are placing more pressure on women as de facto responsible for the flexibility and adjustment of most household tasks. Similarly, other studies suggest that while men often initiate home improvement projects or buy new technology, women are responsible for implementing transformations in household practices (Organo *et al.* 2013). More specifically, research on PV ownership in Denmark has revealed a strong gender bias (Hansen *et al.* 2022). The register analysis of PV owners shows that men—specifically technically educated men—are strongly overrepresented among Danish PV owners, and survey data confirm that men to a much larger degree than women indicate that they were the one in their household who made the decision to buy PVs (Hansen *et al.* 2022).

The investigation of gender in homes with new technology is not simply a matter of determining who is doing what. Other questions involve how technology is gendered in the space (Adams & Coltrane 2005), how technology is represented in gendered stories (Foucault 1988) and how technology embodies different experiences of everyday life, especially when it comes to masculine practices (Pink 2004). Several studies have already made influential contributions to a more in-depth understanding of technology, gender and practice.

In order to fully comprehend the impact gender has on technology and everyday practices, ethnographic studies on masculine domesticities can be insightful. The present study adds to this understanding by focusing primarily on masculine domesticities and how technologies such as PVs emerge within and in response to these domesticities (Organo *et al.* 2013). Specifically, the focus is on how technologies such as the PV system contribute to the transition to a more sustainable future by focusing on how masculinities form—and are being formed—by the material, social and cultural aspects of PVs. It will be shown that PV technologies are adapted into inherited masculine domesticities, most of which are peripheral to the core understanding of home and household labour, especially in households with strong binary gender roles.

The paper is structured as follows. The next section introduces understandings of gender, home and technology. The study's methods are then described, followed by an analysis and conclusions.

2. THE CONCEPT OF MASCULINE DOMESTICITY IN MODERN WESTERN HOMES

The conventional notion is that gender is constructed as a binary opposition between male and female, and that femininity is defined as 'the other' in relation to masculinity (Butler 2004). Theoretically, this involves an understanding of masculinity and femininity as:

inherently relational concepts, which have meaning in relation to each other, as a social demarcation and a cultural opposition.

(Connell & Messerschmidt 2005: 43)

Gender thus emerges as a dynamic order in and through situations and practices, forming a hierarchy of different positions and identities, all subordinated by the ideal masculine identity (Connell 1995). In recent years, Crenshaw's (2017) concept of intersectionality has also changed the way gender is perceived. Intersectionality underscores how age, race, sexuality, education, income, religion and other factors influence how gender is performed and understood. It highlights that these factors—in combination with gender—add to different modes of privilege and discrimination, and that gender is only one aspect of asymmetry in human relations (Crenshaw 2017).

Since the 1990s, men in most industrialised countries have taken on a larger role in the home (Chapman & Hockey 2002). Nonetheless, the division of household labour is still gendered, including in Denmark. A 2018 study based on time-use diaries in Denmark showed that, on average, women spent almost one additional hour a day on housework compared with men, as was the case a decade previously in 2008 (Bonke & Wiese Christensen 2018). The time-use diaries indicate nothing about what kind of household tasks Danish men and women do (e.g. whether men undertake do-it-yourself (DIY) projects and women do the laundry); however, they indicate that even in an egalitarian society such as Denmark, significant gender divisions exist in the home. As some researchers have suggested, however, household practices tend to be conservative and are part of a complex gender history (Giles 2004; Mechlenborg & Gram-Hanssen 2020). As Cahn (1999: 526–527) has argued, while 'the power structure of the household is patriarchal', women also exercise power when they manage and control aspects of their households, their children and their partners. This female 'powerbase', as Cahn defines the modern Western home, is both cultural and practical:

[It] has developed not just through an ideology of domesticity that celebrates women's maternal roles, but also because women have actually performed the work of childcare and housekeeping.

(526–527)

Seeing the household core as essentially female is also echoed in research on energy consumption and everyday life. When Morosanu (2016: 112) writes about the 'mother-multiple', she bases her definition of a feminised version of the modern home on the acknowledgement of 'the close association between caring and mothering in Euro-American contexts'. Similarly, Daminger's (2019: 609–610) identification of cognitive labour as a mental dimension of household work also promotes strong associations with a female domestic core in describing the 'work of anticipating needs, making decisions, and overseeing family logistics'. The same goes for Johnson's (2020) conceptual figure, the 'flexibility woman', which she introduces as a direct response to Strengers's (2013) 'resource man', a male consumer figure symbolising many utilities, governments and smart technology providers' gendered vision of a smart utopia in which all kinds of smart technology will be unlocked by a technically competent (male) consumer. With the flexibility woman, Johnson (2020: 1) draws attention to the inherent inequality between the resourceful (typically male) housekeeper, able to transform his household to achieve a low carbon future using smart technology and artificial intelligence (AI) tools, and the not-so-resourceful (female) housekeeper who is forced to rely on adjustment and flexible practices and household activities or forever be 'excluded from accessing the cheaper, greener electricity of the future'.

However, gender studies, especially masculinity studies in the 1990s, have shown that modern domesticity also permits men to negotiate alternative masculinities and to gain access to homemaking, self-expression and meaning within the private sphere (Adams & Coltrane 2005; Kimmel & Messner 2010). Masculine domesticities, however, differ from traditional female domesticities in terms of spaces, activities, language and themes. In fact, several masculine domestic roles are directly linked to the development of the modern Western home, such as the DIY man (Cox 2016; Silverstone 1997), the modern father (Gillis 1997), the bachelor living alone or the gay couple in the suburban house (Gorman-Murray 2008). One general understanding is that,

from a masculine perspective, home is a place of labour, maintenance and DIY. Gelber (1997: 66) shows men's access to the private sphere has led to domestic spaces such as the workshop, the outdoor barbecue area and the garage (or the 'man cave', as it is called in popular media). These are all part of the dwelling, yet spatially and mentally detached from the female core of the household, permitting:

men to be both a part of the house and apart from it, sharing the home with their families while retaining spatial and functional autonomy.

Similarly, Kimmel (1987: 262) refers to these male spheres within the home as 'islands of untainted masculinity and purified pockets of virility', where patriarchy coexists with domestic masculinity.

More recent studies of masculinity, with a direct link to energy and climate, develop concepts such as 'eco-modern masculinity' and 'ecological masculinity' (Hultman 2021). Based on an analysis of Arnold Schwarzenegger as both an actor and a politician, Hultman (2021) describes how, at the start of his movie career, Schwarzenegger embodied an industrial-breadwinner masculinity as an aggressive action man. Later, when Schwarzenegger entered politics, he moved towards what Hultman terms an eco-modern masculinity, celebrating new eco-friendly technologies as a way of dealing with environmental degradation without questioning the American lifestyle. Finally, according to Hultman, Schwarzenegger has recently shown signs of changing towards what can be termed an ecological masculinity, evident in his active support for the youth-led Fridays for Future movement for climate justice. Thus, different strands of masculinity studies contribute a deeply nuanced understanding of what masculinity can embrace in relation to both home and energy.

3. METHODS AND EMPIRICAL DATA

The empirical data used in this paper come from a project on PV owners' motivations and practices as prosumers. The project investigated motivations for buying PVs and their effect on everyday activities, electricity consumption and load profiles via surveys, sales records, register analysis and in-depth interviews. The project has previously been presented in Danish reports (Hansen *et al.* 2018; Jacobsen *et al.* 2019; Mechlenborg *et al.* 2020) and papers (Gram-Hanssen *et al.* 2020; Hansen *et al.* 2022).

The present paper is based on 12 in-depth interviews performed in the fall of 2020. The informants were chosen to represent variation according to housing type, age of house, gender, family type and other energy-saving factors as well as geographical distribution. Informants' contact information was obtained through two local energy utilities. As reported, most Danish PV owners have a technical background (Hansen *et al.* 2022). This pattern was also reflected in the informants' profiles, especially, but not exclusively, among male informants. Of the 12 interviews, five were conducted with heterosexual couples living together, with both partners present during the interview (A, B, D, J and L); four were with heterosexual men living with a partner who did not participate in the interview (C, E, I and K); one was with a single female (G); another was with a single male (F); and the final interview was with a heterosexual couple living apart, with both participating in the interview and both having PVs (H). All informants were cis-gendered. An overview of participants is presented in Table 1.

The interview guide was informed by the understanding that adapting a PV system to one's home should be compared with domestic renovation and home improvement projects. Thus, the theoretical framework was bound not only by theories of practice, but also by other studies of homemaking, social status, housing culture and, of course, gendered domestic practices. All interviews were recorded, transcribed, and analysed based on the initial themes and new themes that arose during the interview process. In the report, as in this paper, all informants were anonymised and given a pseudonym.

Table 1: Informants listed by pseudonym and including gender, professional background, age, family type (with or without children) and year of installation of private photovoltaic (PV) panels
 Note: COLA = couple living apart.

INTERVIEW	PSEUDONYM	GENDER	PROFESSIONAL BACKGROUND	AGE (YEARS)	ADULTS' FAMILY STATUS/ TYPE OF INTERVIEW	CHILDREN AT HOME	YEAR OF INSTALLATION
A	Anders	Male	Machine engineer	67	Couple, interviewed together		2011
	Anja	Female	Office/administration assistant	68	Couple, interviewed together		2011
B	Bente	Female	Housewife	68	Couple, interviewed together		2013
	Børge	Male	Electrician	73	Couple, interviewed together		2013
C	Carl	Male	Math/physics teacher	70	Couple, only man interviewed		2018
D	Dennis	Male	Machine operator	70	Couple, interviewed together		2013
	Dorit	Female	Office assistant	71	Couple, interviewed together		2013
E	Eric	Male	Information technology (IT) consultant	53	Couple, only man interviewed	1	2019
F	Frank	Male	Grocer, now porter	53	Single	1	2014
G	Grethe	Female	IT consultant	57	Single	(son just moved)	2012
H	Helge	Male	Math/physics teacher	77	COLA, interviewed together		2012
	Hanne	Female	Local politician	75	COLA, interviewed together		1998
I	Ivar	Male	Constructor	62	Couple, only man interviewed		2001
J	Jette	Female	Seamstress		Couple, interviewed together		2012
	Jens	Male	Janitor		Couple, interviewed together		2012
K	Knud	Male	Constructor	68	Couple, only man interviewed		2012
L	Lars	Male	Land inspector	47	Couple, interviewed together	2	2012
	Lærke	Female	(No information)	40s	Couple, interviewed together		2012

4. ANALYSIS: MASCULINE DOMESTICITIES IN HOMES WITH PRIVATE PVS

Based on the history of masculine domesticities in modern Western culture, the PV system does not enter the home as a neutral object but is already embedded in gendered traditions of technology, DIY as self-expression, spaces and roles. However, according to previous studies (*e.g.* Gelber 1997; Giles 2004; Kimmel & Messner 2010), these masculine traditions are not solely restricted to men. Gelber (1997: 70) noted that masculine domesticities are formed not (only) in opposition to the female core of the home, but as an autonomic:

male sphere inside the house, implicit and socially related to other masculine identities outside the dwelling.

The present study found that the female informants also became involved and participated in PV-related practices and tasks, learned about and liked technology, and conducted energy management. However, because these practices are historically and predominantly rooted in virtues that are understood as masculine, these practices are examined from a gendered perspective, focusing not only on what the male informants did and said, but also on how both male and female informants reflected on practices, roles and domestic spaces related to their private PVs.

4.1 MALE SELF-EXPRESSION THROUGH TECHNOLOGY AND TECHNICAL KNOW-HOW

The participants in this study were both male and female, but the male participants were generally more explicit about the technical aspects of PVs. In fact, interviews with male participants often turned into a technical discussion about whether one software product or technical solution was preferred over another. An explanation given by many (male) informants was that the PV system requires technical skills, and that the PV system is part of the technical infrastructure of the house.

For most of the male participants, buying a private PV, having it installed and living with it also entailed great enjoyment and self-expression. In general, they reported finding personal satisfaction in scanning the market for the right PV system, reading about different solutions online, or visiting showrooms and talking to experts. The joy of picking the right model, getting it installed and learning to use it represented what Watson & Shove (2008) have identified as the double effect of home improvement projects: they change the house as well as the person doing it. The double perspective of doing something good for the household—whether to reduce energy costs or contribute to a green future—while enjoying taking on a technological challenge was mostly presented to the authors by the male informants.

Compared with the explicit technical talk, technical enjoyment and self-expression, most of the interviewed females were reluctant to discuss technical topics. Even those who had the knowledge, such as Hanne and Grethe, both single-living female PV owners, did not want to discuss technical aspects. Hanne mostly turned her answers into political statements on sustainability, while Grethe mentioned homemaking, home comfort and sustainability as her primary arguments for buying a PV. Neither of the two women associated the PV with their own individual interests or competence, but made a clear demarcation between themselves as individuals and their PVs.

Grethe eventually revealed at a late stage of the interview that she regularly monitored consumption, sales and purchases. In many cases she was able to make precise statements regarding price, kilowatt usage and savings, and her approach to sustainability also relied on technical solutions. When asked why she had played down these aspects early in the interview, she paused, obviously confused about herself. She then answered that she had just realised that she was a ‘technical nerd’, and that this aspect of her identity was not something she expressed to anyone except her son-in-law, who also liked technology. Thus, Grethe is not only an example of how technical competence and enjoyment can be possessed by women as well as men, but also of how women may downplay this because it does not contribute to a positive self-expression for women, in contrast to what it may do for men.

The technical–male aspect is also supported by the physical placement and aesthetics of the PV system. Solar panels, inverters, monitors, pipes and wires are all placed on the periphery of the core home: the solar panels are on the roof and the inverter is often in a shed or garage, while the energy consumption meter is hidden in a cabinet. These characteristics of spatial distribution underscore that private PVs are systems that support the home environment, yet they are not a part of it. This relates to the distinction between the house as masculine and the home as feminine (Blunt & Dowling 2006; Easthope 2004), and to the paradox of masculine domesticities as both within and yet detached from the home, as with Gelber’s (1997) list of sheds, garages, attics and other man caves. In combination with the strong technical requirement, PVs enter already existing male domains in the private sphere, which allow men to conduct home activities without the risk of compromising their traditional masculinity.

Despite these different gendered practices and understandings, this study revealed that technical knowhow is needed for PV owners to get the most out of their PV system. This was exemplified in the case of a household with an older couple, Anders and Anja (interview A), who both failed to understand the technical aspects of the PV system and were therefore unable to figure it out. Moreover, they did not move their own level of consumption to harmonise with the time of production, because they did not know when their production occurred. Thus, they could not benefit economically from using their own produced electricity. To them the PV system was a bad technological investment that reminded them of their technological incompetence and failure to secure for themselves low energy costs and economic freedom. In addition, on a more personal level, it was a failure for Anders, who had worked as an electrician and had initially made an economic budget for his wife to show her how much they could save. Explaining this in the interview prompted his wife to defend him on several occasions, saying that they were tricked into buying an insufficient model, or that the installation might have been done incorrectly. Thus, not all men possess technical competence, and rather than the PV supporting a male identity and self-expression, it might also do the opposite, reminding both informants of what the man, especially, is not capable of.

4.2 MALE ENERGY MANAGEMENT AND GENDER DIVISION

It has been claimed that men often take responsibility for introducing new projects and technologies into their homes, while women feel obligated to implement them in everyday life (Organo *et al.* 2013). In the present study, the gender division is located elsewhere, as mastering the technical aspects of the PV system often overlaps with the development of co-producing energy practices and cognitive labour. Within energy research, these practices have been defined using concepts such as energy management, energy monitoring and energy control (Foulds *et al.* 2017).

All participants agreed that understanding one’s energy production and consumption were important for releasing the potential of the PV. However, both female and male participants perceived monitoring the PV system and managing the information flows as a male task. Some had developed their own calculation models and management systems either by hand or on a computer spreadsheet (interviews H and B), while others used digital apps and webpages from the electricity companies, often in addition to their own records (interviews A and C–F). This indicates that technical competencies that are important in the initial phase of buying and installing PVs become co-components in understanding connections and identifying potentials for energy management and control.

Most households shared a common understanding of the relationship between consumption and production, and what appliances and practices they could move around or reduce. But there were also households in which understandings of production and consumption were entirely removed from the practices of everyday life. This was the case in Knud’s household (interview K). Knud recorded his consumption and production regularly, but did not really use this information to make improvements. He noticed that when the weather was bad, production went down, and he knew when his children took long baths, but this information did not lead to any action on his part. When asked if he and his household had ever considered changing their energy-consuming practices, Knud’s answer was a prompt ‘no’. This lack of willingness to change household practices could

be explained by Knud's argument that he had installed the PV mostly for his own sake, meaning that he finds satisfaction in monitoring energy production and consumption as a purpose in itself. However, later in the interview, after persistent questions from the interviewer, Knud gave a more insightful answer:

You know [...] it is my wife who controls all that. She decides when to wash [the laundry], and so we wash.

This reveals that he has no authority to make any changes to household practices as it is not his domain. He respects—and supports—this division of household labour, even though it is counterproductive to his interest in saving energy.

Another example showed that women also contribute to maintaining this gender division. Dorit and Dennis are an older couple who have lived together for 10 years. Dorit explained that she used to do the monitoring herself when she lived alone, and that she has an in-depth understanding of production and consumption. But when Dennis moved in with her, she immediately gave this task to him. 'Then you got it,' she said during the interview, looking at Dennis but giving no further explanation for this shift in responsibility. Now Dennis controls the system monthly, takes notes, and does the budget and accounting for their energy management. However, Dorit still occasionally sneaks in to check the production meter, especially when she is considering using appliances with high energy demand (such as the dryer or washing machine). This is done surreptitiously when Dennis is not looking—when he is away for a short moment. This suggests that Dorit recognises and supports some kind of non-discussable, normative gender division between monitoring as a masculine domain and consumption adjustment as a female domain. Or perhaps she understood that monitoring was important for Dennis's masculine identity, and a way for Dennis to enter her home and find his own space—even though she also needed the information to be brought into the household.

One way of understanding energy monitoring and management is as a socially accepted, masculine homemaking practice. This also aligns with other (gender blind) studies, which suggest that monitoring also brings personal satisfaction (Foulds *et al.* 2017). Energy management is both invisible and abstract. It entails specific economic and ecological information on household consumption, which has significant potential if used. It gives the practitioner some sense of control over the house as a place fixed in time and space, according to Douglas's (1991) definition of home. This is exemplified through Helge, the male part of the COLA couple, in one of the interviews. Helge used various apps for monitoring production and consumption. He lived part-time with his wife in her house and part-time alone in his own house. When he was at his wife's house, he used the apps to keep an eye on his own house. He continuously checked his electricity production and electricity consumption, thereby maintaining some form of control over his own home when he was not there. For example, when there had been a thunderstorm, he checked for updates immediately to see if the relay had been switched off, as an indication that something was wrong. He was then able to react almost with the same speed as if he had stayed in his house. Sometimes he also checked the app just because 'I can', he said. This approach to monitoring is less about energy management and more about homemaking via control. It allowed Helge to maintain some form of embedded practice in his home, even if he is physically absent.

4.3 SOLAR PANELS AS SYMBOLS OF MASCULINE IDENTITY

The solar panels often played a double role in the (male) participants' stories. The panels are not only perceived as an instrument of energy production (energy technology), but also as symbol of social status and self-expression. In all but one case, the solar panels in this study had been placed on the roof and were visible to passers-by, guests and household members when arriving at and leaving the house. The physical nature of solar panels and their visibility on the roof of the house also meant that many of interviews started with an invitation to go and 'have a look at it', as one said (interview L). The researchers were then taken to the best spot to see the panels. In the double interviews, the female partner sometimes joined, but mostly stayed quiet during the presentation. Several couples expressed that the solar panels as objects could be better designed

aesthetically (interviews A–C, E, F and H), although the general opinion was that the panels add a positive symbolic value to the house, signalling ‘green energy’.

Several male stories revealed that having panels on the roof is an aid for identifying and communicating with other PV owners and the technologically interested (male) community. Anders, for instance, described how he had gone for a walk in his neighbourhood to find and talk with other owners who could offer him know-how and good advice. Now he likes to offer his own know-how and advice to others when asked. This illustrates that PVs are also used for socialising with (male) peers in the neighbourhood (Després 1991). For many male and some female PV owners, the PV system, such as other elements in the home, is internalised and transformed into a symbolic mirror for identity and self-expression. According to Goffman’s (1959) distinction between the front- and backstages of one’s home, solar panels are PV owners’ front stage, while inverters and monitors are the backstage.

The male identification with and social status of the PV system was revealed during a visit to Lars and his wife Lise. Lars took the interviewers into the garden, where the solar panels were visible, and insistently tried to make the authors confirm to him that his specific model was particularly beautiful compared with his neighbours:

They are very nice [...] I actually think so [...] with that roof [behind them]. I do not think you can do much better. I certainly do not think they spoil [the impression of] the house. [Especially] if you stand here like this.

(Lars, interview L)

Lars said he enjoyed looking at the panels every time he was in his garden and when he mowed the lawn. Thus, the PVs contribute to the (re)production of an inherited masculine ‘power structure of the household’ (Cahn 1999: 526–527) and to a socially accepted masculine homemaking strategy combining self-expression and social status.

4.4 MASCULINITIES AND POWER

According to some gender studies, masculinity emerges as a hierarchy with different positions and ideas of what masculinity is, in relation to both femininity and coexisting and intersecting masculinities (Connell 2013). The question of power was indeed a crucial theme that emerged from male participants’ stories in this study. In particular, their perception of status was linked to their ability to exercise power over and through their PVs. This power exercise bridged their double argument of doing something good for the household/sustainability and doing it for their own enjoyment (see above). The power aspects in these stories were constructed through the dynamic relation between the specific model of technology (the capability of the PV), the PV owner’s (technological) mastery, and the effect both technology and mastery have on a household’s energy consumption, especially compared with common knowledge within the (male) PV community (see above).

The relation between masculine power and PVs is embodied by Erik. Erik is an information technology (IT) consultant and had a home full of smart technology, a Tesla car in his garage and a German PV battery which he claims could make his household self-sufficient. Erik had spent enormous effort surfing the internet and reading technical instructions and surveys. He truly believed that smart technology was the solution to the global crisis, and that the right technology would compensate for the adjustments of practices and energy use reduction. In some sense, Erik is an incarnation of Strengers’s (2013) ‘resource man’ in body and soul. He also fits the concept of eco-modern masculinity defined by Hultman (2021), as he liked to impress with his technical competence and know-how. He emphasised that he had the same expert knowledge as the consultant in the firm that eventually sold him his PV system, and that performing his technical know-how is a sport to him:

Yes, it’s a lot of fun. It probably has to do with the competition [I have] with them. That’s it [...] he should not come and teach me anything. Then I whack him.

The metaphorical ‘whack’ in Eric’s quotation and the deliberate simulation of a sports competition is not coincidental. A study of men’s access to the kitchen suggests that sports metaphors and street language are often used as a way to maintain a masculine identity while doing something domestic (Hollows 2003). In this case, it underscores Eric’s identity as a man who can exercise power, defeat his combatants and win the race (towards sustainable consumption, according to Hultman 2021).

Masculine exercise of power is not restricted to technological mastery and over-performative technology, although these methods were generally seen as primary. Another subordinate or alternative way of exercising power through PVs was exemplified by Frank, a single father who had invested in a small PV system after years of saving. Frank said he would have preferred a bigger, better system, but his budget did not allow it. In 2016, Frank encountered a Facebook post with a claim that provoked him deeply. A male PV user wrote that the average PV system can only generate a maximum of 20% of one’s total electricity consumption. Frank decided to disprove that claim. For three years, Frank worked to find new ways to shift and limit his consumption. He implemented several energy-reducing measures, e.g. replacing old light bulbs with LEDs and buying a low-energy fridge and a washing machine. In wintertime he started cooking his meal early in the afternoon before the sun went down. He filled the fridge with bottles of soda (preferably Pepsi!), so the fridge would stay cool when he turned it off at night to save energy. He started only boiling with lids on, cutting his vegetables into small pieces so they need less boiling and making porridge for dinner several days a week, which he prepared under the duvet. Frank finally reached his goal. But he did not stop there, as there are several experiments that he wanted to try. While the element of competition in Frank’s behaviour is obvious, as with Eric, the focus on practical details and tasks to save energy can also be related to femininity, as in the concept of flexibility woman (Johnson 2020). During the summer Frank enjoyed sleeping in the auto camper parked outside his house, as this prevented him from turning on lights and using electricity in his house, and he felt he was on vacation. Frank managed only to use electricity when the sun was shining. When it was cloudy or wintery, he always considered alternatives, such as watching television and showering in the fitness centre instead of at home. His power exercise was also made possible by the fact he was a single father and did not need to coordinate his practices with anyone other than his son, over whom he still had some parental power. Thus, Frank can be seen as an example of masculine competition and flexibility woman joined together.

Both Erik and Frank described their relationship to their PV systems as ongoing, involving constant innovation, new initiatives and improvements. The overall goal may be energy reduction and sustainable consumption, but the method is essentially implemented in terms of self-expression and self-amusement. This points directly back to the enabler of these improvements: the singular technically or practically competent PV owner—female or male—able to unlock the potential of the technology for the benefit of the entire household and for the common goals of society. The obvious characteristics of technical superiority, a winner mentality and event-oriented activities echo an (ideal) masculine identity. However, the power dimensions and hierarchy of the ideal PV man are not only determined by the ability to exercise power through technology but also intersect with the roles of father, partner and caregiver. Eric respects that his son needs to have the router turned on before he goes to bed, even though Eric would prefer it to be switched off. And Frank repeatedly emphasised that smart technology on appliances, heaters and other devices allows household members to carry on with their activities as they like, even though adjustments to practices and flexibility would lead to a better consumption–production match.

The act of caring played a prominent role in many interviews with PV owners, male and female alike, indicating that being a parent, a partner and a household member also provides an insight into how everyday practices are conducted and scheduled. According to Johnson’s (2020) concept of cognitive labour, caring leads to knowledge of household members’ personal interests and habits. The crucial point is the power to change. Knud has neither the authority nor the motivation to change household practices. Eric and Frank have both the motivation and the power to change theirs. They were both able to legitimise why certain measures were taken or not taken to maximise their PVs’ potential, not only through technical or economic explanations but also due

to their consideration of household members' comfort or personal needs. These decisions were made *by* them (in collaboration with their families), not *for* them (by a partner or other family member). This suggests that masculine domesticities and PVs also intersect with the perception of being a modern family man, which can be both productive and counterproductive in terms of energy consumption.

5. CONCLUSIONS

This study has shown how PV technologies emerge within inherited masculine domains and spaces but have also added new perspectives on how gendered practices, roles and understandings are undertaken within the private sphere of the home.

Although limited in its number of interviews, geographical locality and inclusion of only heterosexual couples, this study points toward several conclusions that can be instructive for both further research and policy recommendations.

The analysis describes how domestic PV systems reinforce previous configurations of masculinities through status demonstration and identity development. In addition, PVs introduce new types of practices. However, they can also contribute to changing domestic masculinities, for instance when the production of energy from the PV raises questions of how better to link production with consumption, through either new smart technology or innovative adjustment to everyday practices.

PVs can be seen as spatially peripheral to the home, but also masculine symbols of status. The physical placement of PVs adds to a masculine ideation of the house with its invisible wires and pipes, with the inverter and monitor often placed outside in the shed, garage or facade, or locked in the attic. This peripheral status of the PVs' materiality is also underscored by their technical design and masculine aesthetic, especially the solar panels on the roof of the house, which to many PV owners represent a 'front stage', symbolising their identity, social status and technological skills. In this way, PV owners contribute to a modern history of masculine domesticity that includes them in the private sphere but avoids compromising their masculinity through the construction of their own space detached from the everyday spaces of the household. Thus, the location and design of PVs add to the reproduction of spatial gender divisions and aesthetics.

PV systems reproduce a conventional symbolic and embodied connection between masculinity and technology, a connection both male and female PV owners deal with differently according to gender, specific model and skills. Living with a PV requires owners to develop new technical competencies in terms of linking together energy consumption, energy production and PV technology. This discourse was embedded in the way most male participants talked about, understood and performed their roles as PV owners. In contrast, female PV owners were more reluctant to use specific terms and technical figures to explain their point of view. This can be interpreted as a way to avoid a masculinisation of their identity.

Male participants were likely to combine a common wish for sustainable energy consumption/reduction with an explicit awareness of their own personal gains and self-expression, while female informants mostly detached their personal identity from the performance of their PVs, even among those who conducted highly competent technological practices. This indicates that PVs are already inscribed in a masculine practice, and that the competencies built reinforce a masculine identity and serve as a way for men to perform their masculinity within the sphere of the home. However, the strong demarcation of a (masculine) technical domestic domain, in which masculine autonomy and enjoyment is being conducted, makes it difficult for female PV owners to feel included, not to mention the numerous men and women who do not have technical skills or feel it is a hobby or part of their identity.

The question of power and masculinity related to PV is ambiguous. Strengers's (2013) resource man is an ideologically masculine figure able to unlock the potential of smart technology. In this study, however, technology is also an object able to unlock (hidden) masculinity and allow PV owners to exercise and perform masculine roles within the home. Following Lohan & Faulkner

(2004: 319), it can be said that the PV system and its owner are mutually co-constructed in a dynamic process of social interaction, practice and discourse. The masculine power of PVs is defined by the power to select and buy technology (the biggest, best and most expensive) and to master it (like an expert). However, this study shows that masculinity is also embedded in how and to what degree households manage to change their consumption patterns according to their PV production, and for what reason. A comprehensive understanding of the links between these two aspects of mastering PVs (technical mastery of production and management of consumption) requires a more focused investigation than the present study. However, it seems that masculinity among PV owners relates to whether the change in household consumption is implemented through smart technology or by more subordinate or alternative initiatives. The latter allude to the concept of flexibility mother, according to Johnson's (2020) definition of an innovation and energy savings that are deeply embedded in the complex set of everyday practices. While masculinity may emphasise the social demarcation of and opposition to femininity, in this case it also contributes to unlocking the potential of PVs through more practical-innovative initiatives and adjustments to activities. From this perspective, this study shows that while adding to the historical gender division, this kind of competitive masculine approach also transcends its own masculine domain and locks into the female core of everyday life practices.

The perceptions surrounding domestic energy monitoring, management and practices play a significant role in the adoption and use of this technology. Monitoring and management need to be (re)linked to the female domain of everyday practice. The technology and associated practices could offer a new way of bridging house and home, infrastructure and household practice, and masculine and feminine domesticities—but this depends on: (1) perceptions of gender identities by both men and women; (2) the intersection of factors such as age, social class, location and context; and (3) the design, usability and ease of interfacing with the information and feedback from the technology.

All the interviewed households strongly indicated that awareness of the links between energy production and consumption is fundamental for changing a household's consumption. However, the responsibility for monitoring and managing the PV was generally seen, by both men and women, as a male task.

Coordinating domestic practices involving energy production and consumption is a key issue that can be hindered or helped by gender roles. While the adjustment and flexibility of household practices have rightfully been identified as a female domain overall (Damingler 2019; Johnson 2020; Morosanu 2016), the present study suggests that masculinity is also needed to unlock the hidden potential of co-producing one's own electricity and contributing to more sustainable residential energy consumption, at least in modern Western households. The crucial element is whether these masculine practices, roles and spatial domesticities are solely conducted as a demarcation of masculine domesticity, e.g. detached from the feminine domain of the home or if both male and female household members are able to bridge house and home, infrastructure and everyday practices, and masculine and feminine domains. Thus, masculine practices and cognitive technical skills and understandings concerning the PV system can be either productive and counterproductive, according to the specific male identity and the binary dynamic within the two-gendered home.

Households that do not link (female) everyday practices and energy management to (male) technical competence are more likely to have difficulty benefitting fully from co-producing their own electricity. This may include households not possessing sufficient technical competence or households which, for various gender-related reasons, are not able to bridge the masculine and feminine sides of this issue. By contrast, households with overlapping gender practices, perspectives and competencies (i.e. a fluid gender hierarchy) have the potential to use their PV system more efficiently and to achieve a more holistic approach to how and why they should adjust to their own production of energy. In short, both feminine and masculine understandings of technology, practices and energy consumption are necessary for a more effective transition to a low carbon future, and with a more equal distribution of these competencies and practices

between the sexes in households with opposite sex-partners, this may happen without further adding to gender inequality.

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AUTHOR CONTRIBUTIONS

The authors developed the idea for the paper together, and both took part in developing the interview guide. M.M. performed the interviews and the analysis for this paper and drafted the main parts. K.G.H. contributed to all parts of the paper by discussing, revising and editing.

COMPETING INTERESTS

The authors have no competing interests to declare.

DATA AVAILABILITY

The qualitative data behind this study are not available because interviews cannot be made public due to the anonymity of informants.

ETHICAL CONSENT

Informed consent was given by all participants following the Declaration of Helsinki. Following Aalborg University's rules, this study did not require approval by an ethics committee, but is registered according to General Data Protection Regulation (GDPR) rules.

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