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SPECIAL COLLECTION: ENERGY, EMERGING TECHNOLOGIES AND GENDER IN HOMES

RESEARCH

Emerging technologies' impacts on 'man caves' and their energy demand

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ABSTRACT

Colloquially termed the 'man cave', the shed provides a conceptual lens for thinking about the home's 'edges rather than its centres'. This paper explores the implications for energy demand arising from the extension of existing and emerging technologies into these gendered 'edges' of the home. As well as considering sheds as physical sites, the paper draws on relational geographies of social practice to understand the peripheries of the property as important 'doing-places' for expanding activities. Three themes are discussed, drawn from an ethnographic study of 72 Australian households. First, the paper examines shed-doing-places for handiwork, home maintenance, hobbies and home charging, with opportunities to entrench and disrupt masculine associations with electric-powered technologies. Second, the paper identifies how the shed is becoming a masculine proving ground for smart and automated technologies, both outside and inside the main dwelling. Finally, the paper explores the shed as a secondary home centre for an expanded range of activities, infrastructures and technologies, which potentially challenge the shed's traditional masculinity by making it accessible to others. The paper concludes by discussing the building, policy and research implications of these gendered edges' changing role in relation to the centre of the home.

POLICY RELEVANCE

Traditionally considered 'non-habitable structures', sheds and other peripheral structures on residential properties lack the energy and housing policy attention of dwellings, houses, consumers and households. This research demonstrates the increasing importance of these peripheral spaces as sites of consumption, gendered proving grounds for emerging (energy) technologies, home-based electric charging and secondary living spaces. Further, through a relational understanding of the shed, the paper identifies how the places traditionally provided by physical sheds may be shifting inside the home.

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Policy opportunities include efficiency renovation incentives and demand management programmes targeting peripheral sites of consumption, which may be more or less flexible than other sites and activities. Additionally, the gendered dynamics associated with sheds and the technologies reveals important insights about how to engage with households as they embed or reject smart, automated and energy technologies into their everyday lives.

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1. INTRODUCTION

Building and energy research on housing and household consumption has typically focused on 'the "four walls" of home', and neglected other physical spaces such as verandas, decks, backyards, out-buildings, garages and sheds (Middha *et al.* 2022: 1). In mainstream housing policy, the primary dwelling has been the focus for energy efficiency standards such as low-carbon housing retrofits (Middha *et al.* 2022). Emerging energy technologies, *e.g.* home battery storage systems and electric vehicles, are increasingly located in sheds, garages and on the edges of the property. Likewise, the home improvement and consumer electronics sectors are promoting new property-wide sites and opportunities for consumption (Dahlgren *et al.* 2021). For instance, smart home industry visions promise to deliver electrified convenience or 'pleasance' across the whole property (Nicholls *et al.* 2017; Strengers & Nicholls 2017; Strengers *et al.* 2020). Available devices include (automated) outdoor lighting, water features and irrigation systems, whole-of-property security cameras, outdoor kitchens, outdoor heating and cooling systems (including patio heaters; Hitchings 2007), outdoor entertainment systems, and pool maintenance devices. While some of these technologies are more significant for energy demand than others, all are contributing to the broader trend of expanding electrification and internet connection of the whole property (Strengers *et al.* 2020).

Alongside this, the Covid pandemic, housing affordability problems, and broader demographic and social changes are resulting in increasingly distributed energy demand that extends beyond the primary dwelling (Middha *et al.* 2022). For instance, shed producers in Australia (Williams 2021), the US (Brown 2020) and the UK (*The Economist* 2021) report that interest for sheds grew by 450% since the pandemic, with demand for larger and more habitable versions (*e.g.* with plastered walls). Insurance companies are also responding to a rapid rise in conversion of garages and sheds into office, exercise, entertainment and cooking spaces (Marsh 2021).

Within this context, this paper responds to an emerging body of research calling for a more intense focus on the meaning of home (Blunt & Dowling 2006; Ellsworth-Krebs *et al.* 2015; Gram-Hanssen & Darby 2018). In particular, it focuses on how the practices performed on the peripheries of the property are changing in relation to what people expect from their homes. The route into this exploration is inspired by Bell and Dourish's analysis of the shed, which this paper adopts as a conceptual and methodological window into the home's 'edges rather than its centres' (Bell & Dourish 2007). The present paper's interest in and understanding of the shed is both physical and relational. Physically, spaces such as sheds and garages, are fixed building structures that have historically been located outside or adjacent to the main dwelling. Relationally, sheds are spaces that are defined and made through the activities that take place within them (Hui & Walker 2018). Traditionally, these activities have involved small projects and manual labour, tinkering, drinking, brewing beer, making and playing music, socialising with 'mates', or 'watching the game' (Bell & Dourish 2007, Williams 2021). These historically masculine activities have led to sheds being understood as the 'precept of men' (Bell & Dourish 2007: 374). Colloquially, they are often referred to as 'man caves', to indicate their role as a refuge for men amidst the broader feminine domestic sphere (Browitt 2017). Masculine associations between men, emerging technologies and sheds (or more broadly with the peripheries of the property) follow a longer historical association between '"boys and their [technological] toys", hidden in attics, basements, barns and backyards' (Oldenziel 1997: 62).

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Sheds are interesting and important because they have historically provided a place for tinkering with or fixing gadgets and devices. They are often considered the 'proving ground' for emerging technologies before they are welcomed inside the home (Bell & Dourish 2007: 375), and a 'staging point for technologies coming into or out of the home' (Bell & Dourish 2007: 374). Sheds also provide space for the 'overflow' of stuff or 'junk' from inside the home, being an important site for storage, for second or third fridges (Taylor 2020), or for things which are 'out of order' and in need of fixing (Graham & Thrift 2007). Both in physical and relational terms, sheds are increasingly interesting and important sites for 'digital housekeeping' (Tolmie *et al.* 2007), new practices of consumption, and as the control hubs for automated, smart, digital and electrified technologies anticipated to realise energy futures (Strengers *et al.* 2019).

Despite all this, sheds are remarkably absent from smart home imaginaries, policy responses aimed at decarbonisation and peak demand management, and even from social research. It is therefore timely to look more closely at these edges of the home and ask questions about their role in realising energy and building policy ambitions. For this task, this paper discusses insights from six Australian households which illustrate themes identified in a larger ethnographic project. The Australian context provides a rich fieldsite for researching the edges of the home, given this country's long cultural and masculine associations with the shed, and its ongoing importance in daily life as both a private and a community space (Bell & Dourish 2007; Golding *et al.* 2008). The paper analyses how the meanings of sheds (and homes) are changing for Australian households in relation to the technologies and gendered practices within them, and what this means more broadly for energy and housing policy. The paper continues by further outlining the shed's physical and relational positioning on the edge of the property, which provides a conceptual framework for the analysis that follows.

2. SHEDS AS RELATIONAL EDGES: A CONCEPTUAL APPROACH

Thinking about the edges of the home provides a novel conceptual approach as well as an emerging research agenda for realising energy and housing policy ambitions. As outlined in this section, this approach brings together a physical and relational understanding of sheds as socio-temporal sites for social practices and technologies, and draws attention to the traditionally masculine physical peripheries of the home.

The edge is a curious place, sometimes devoid of a particular space at all; positioned more as a site of flux, change and future plans, and therefore often 'under the radar'. In common vernacular, being on the 'cutting edge' is testament to something that is pioneering new paths or practices within a particular field or site. Being 'on the edge' can be risky and dangerous, evoking precarity and uncertainty. In this regard, the term has masculine associations, through its connotations with danger, (technical) innovation and adventure, and its attachment to male-dominated fields such as 'edge investing' and 'edge computing'. This is also reflected in past ethnographic studies in the home, which have demonstrated how men have historically (and continually) been responsible for integrating 'cutting edge' technologies into the home (Kennedy *et al.* 2015; Strengers & Nicholls 2018; Strengers *et al.* 2019; Strengers & Kennedy 2020), and have simultaneously approached housework through heroic acts or with a sense of rugged adventurism (Pink 2004).

Likewise, the shed's physical association with danger and dirt makes this edge of the home a 'thoroughly and quintessentially masculine space' (Bell & Dourish 2007: 376). As Bell and Dourish (2007) explain, the shed is masculine precisely because domestic space is largely gendered feminine. Further, they contend that:

> The edgefulness of sheds might allow a very different understanding of the 'home' [... becoming] a stand in for a wide range of domestic but not 'home' locations—the verandah, porch, patio, stoop, mudroom, nature-strip, front yard, back yard, deck.
>
> (375)

Similarly, moving to the edges of the home provides an opportunity to think beyond the 'normal' routines of household life, and examine sites that are in rapid flux, subject to ongoing repair or undergoing significant transformation.

Turning to social practice theories of consumption (Shove *et al.* 2012; Schatzki 2002; Shove & Walker 2014; Warde 2005), and relational geographies of energy demand (Hui *et al.* 2018; Hui & Walker 2018), these edges can be further conceptualised and investigated as places for practice innovation and improvisation. Building on Schatzki's theory of practice and his concept of 'time–space' (Schatzki 2002, 2009), Hui & Walker (2018) outline conceptual resources for thinking about how places (such as sheds) can be relationally understood. Following these authors, the residential property can be conceptualised as a 'setting' that contains a range of 'doing-places', which are defined by the practices that take place with them, and by the technological and infrastructural 'objects' and services which 'anchor' them in space and time. Maintenance, charging, experimental or repair practices, for example, are more likely to occupy a doing-place on the edges of the property (such as a shed), where mess and uncertainty may be transformed from a problem to be cleaned away, to a hobby or task to be savoured or persisted with. More broadly, a relational understanding of home has led scholars to draw attention to the continual blurring of outdoor and indoor spaces, and the interpenetration between them (Beillan & Douzou 2018). Additionally, understanding the shed relationally provides an opportunity to think through how and where these doing-places might be located when there are no *physical* sheds or garages. This is particularly relevant for people living in apartments, or for those in flats, townhouses, share houses, caravans or alternative dwelling formats.

Practices performed in or designated to peripheral doing-places such as sheds may also exist at the edges of time, occurring at night, at the weekend or outside the 'normal' household routines that occupy the centre. These dynamics are particularly worthy of further attention given the increasing emphasis on energy 'flexibility', *i.e.* on energy demand management programmes and technologies designed to shift household practices in both time and space (in response to the availability of solar generation and consumption-based peaks; Blue *et al.* 2020; Powells *et al.* 2014; Strengers 2012). Exploring the lines of enquiry posed by a research agenda and conceptual commitment to the peripheries of the property is beyond the scope of a single paper. However, the following section outlines the project methodology that underpins the analysis, and provides an opportunity to peer into the home's edges and the gendered practices and relations within them.

3. METHODS

The analysis for this article was conducted as part of a project exploring how people envisage their lives unfolding and changing into the future. The ethnographic stage of this research, which informs this article, involved 72 Australian households (81 individual participants) living across the states of Victoria and New South Wales in the south-east of the country. Households were invited to participate through an online survey sent by their electricity distributor (who are partners in the project). People were recruited to represent a broad range of socio-demographic, housing and household characteristics, including gender and cultural diversity, home ownership, age, income, and households with and without solar and/or battery storage. Only heterosexual couples, families and single people participated in the research. Therefore, the gendered analysis that follows is limited in focus to cohabiting women and men.

The ethnographic methodology engaged participants in creative activities that invited them to reflect on their present and possible future lives. The ethnography took place over two 'visits' (conducted virtually due to the pandemic using established visual ethnography methods) (Pink 2013; Pink *et al.* 2017), with optional interim activities. One or two researchers (from a team of five) undertook the ethnography with specific households. The first visit involved an informal interview, discussion about the household's electricity load profile and discussion about industry visions for the future (which were synthesised and visually depicted into accessible comic-strips during the previous stage of research; Dahlgren *et al.* 2020; Strengers *et al.* 2021, 2022). In between visits (approximately three to six weeks apart), households were invited to video record their routines,

prepare a video-recorded home tour, prepare a photo or written diary, or produce their own comic strip. In the second virtual visit, households were invited to discuss their interim activities and/or lead a live tour of their entire property.

Due to pandemic research restrictions and the shift to virtual, video-conferenced visits, the majority of research involved one person describing the broader household relations and practices. This allowed participants to speak freely about their experiences of the household, but limited access to other perspectives. Other members of the household were encountered and involved in discussion where possible, including during home tours. Final in-person visits conducted with five households included more household members in a follow-up interview and video-recorded tour for a documentary film.

The research and analysis focused on household practices across seven key domains: charging and mobility; cooking and eating; healthy indoor air and thermal comfort; living and play; working and studying at home; caring for the home and its occupants; and saving, shifting and storing energy. Additional themes such as the impact of the Covid pandemic, interest in automation, and trust and privacy also guided the research. Verbal conversations were video and/or audio-recorded through the Zoom virtual meeting platform, and later transcribed for analysis. Transcripts were coded into themes (based on the above) into NVivo qualitative software. Additionally, case notes and ethnographic case studies were also produced from the materials to inform the analysis.

For this paper, the research team's interest in the peripheries of the property was spurred via an 'ethnographic hunch' (Pink 2021) about the importance of the home's edges. While sheds and other edge doing-spaces were not an explicit focus of the ethnography, they came into view during conversations about the impact of the pandemic on home life; the location and practices of charging, mobility and energy storage; interest in automation; household hobbies and home maintenance; and comfort considerations. Additionally, sheds and other property edges were discussed and visited during home tours, when participants took their laptops or phones outside. These encounters tested the limits of the virtual methods, when the Wi-Fi signal faltered or failed as participants moved further away from the main dwelling. This, though, also highlighted the potential limits of the home's edges as emerging sites for connected and smart technologies, if digital connectivity cannot be enabled or adequately maintained.

The ethnographic research revealed three key themes relevant to shed-doing-spaces. The themes reveal tensions in how the meaning and purpose of sheds is both intensifying as a masculine site for consumption and energy management, whilst simultaneously being repositioned as more inclusive spaces for whole-of-household activities. For each theme, this paper contrasts one household in which traditional gendered doing-spaces are maintained and intensified and another where they are challenged or disrupted by the introduction or absence of emerging technologies and associated infrastructures.

4. THREE THEMES ABOUT SHEDS IN AUSTRALIAN HOUSEHOLDS

4.1 HANDIWORK, HOME MAINTENANCE, HOBBIES AND HOME CHARGING

Jessica (32) lives with her husband and two young children in an inner-Melbourne suburb. When the research team visited her household, the family was in the middle of a significant home renovation, for which Jessica's husband was contributing much of the manual labour. Like other households, Jessica's was transitioning towards electric battery-operated power tools and yard maintenance technologies. This was described by Jessica as a cascading process which began with the electric mower:

> We had a petrol mower at our previous house but that died. So, he [Jessica's husband] wanted to invest in a battery-operated mower which he got the higher voltage and he loves it.

The electric charging trend had since extended to battery-operated tools. This, however, had generated some issues for the 'centre' of the home, where most of these devices needed to be

charged in the absence of a shed with power. This was particularly problematic because of a lack of power points inside:

> At our old house, they were plugged in all the time in the garage. Here, we don't have enough power points. There's only one power point in each room, so he's found that really frustrating because obviously you have to take out other things to plug the charging batteries in and they don't last as long.

The current solution to this problem was to buy more batteries, as Jessica explained: 'So, for his birthday, he just got two new batteries.' The main issue Jessica identified with indoor power tool charging was the lack of suitable space, as well as the risk of these practices disrupting or potentially harming others (such as their small children who roamed around). The solution that the couple were envisioning was to run power to the shed:

> He'll have power run down to that which they'll be able to charge all the time down there and that will solve that problem.

Told through Jessica's perspective, but with continual reference to her husband and his practices, indoor charging was clearly frustrating and only temporarily tolerated while it was located in the centre of the home, and anchored there through the electric infrastructures required to carry it out. Having power in the shed, and having her husband manage this doing-space, was central to providing an amicable solution and longer term resolution to the expanding range of electric tools needed to renovate, repair and maintain the home. For Jessica's household the need for space to charge batteries was likely to result in the electrification of the shed and the resulting potential for other electric appliances to furnish that new edge of the home, including the potential for high energy-use practices such as heating and cooling as described by the example of Marj and Peter below. However, physically moving charging activities to the shed could also facilitate greater flexibility when charging happens, since while the doing-spaces associated with sheds and domestic life are co-located, practices remain in competition for the available electrical infrastructure, which limits opportunities for demand shifting.

For Dianne (60) and her husband Gary living in regional New South Wales with their two adult children, their garage and another small electrified garden shed were important doing-places for charging property maintenance technologies. The convenience and ease of battery-operated tools and garden equipment had enabled Dianne to take on more of this 'edge' labour in recent years. As she explained:

> He [Gary] once did all the mowing, but when he became unwell, we got rid of the petrol mower because I couldn't start the wretched thing, and I've used the battery powered mower for the last two years and it works a charm for me.

Like Jessica and her husband, the electric mower began a cascade of purchases for compatible electric gardening equipment and home maintenance power tools.

> The mower was the first thing we bought and I suppose there was a lot of scepticism about whether it would actually work properly [...] it just worked brilliantly. Then, from there, I bought the blower, and after that, I bought other things.

Although Gary's illness was the initial impetus for Dianne taking on more of the shed's practices, the electrification of the lawn mower and other gardening equipment intensified Dianne's involvement in these activities and her ongoing interest in electrified property maintenance.

Dianne showed the researchers their garden shed full of battery-charged gardening equipment, and an impressive selection of power tools which filled a large shelf in their garage, and included two drills, a circular saw 'for small jobs around the home', an air compressor, a sander, a reciprocating saw that she viewed as 'essential for maintaining tree roots', and a multitool that had a small sanding and saw attachment that she used 'for all sorts of fiddly little things'. The family also had an angle grinder, and jigsaw, which Dianne found dangerous and that Gary would

primarily use. Gary also had the back section of the garage set up as a workshop for his own hobbies. He enjoyed making fly fishing lures—including using an electric airbrush to spray them—and associated fishing activities. Dianne explained that it:

> also forms a lot of social activity too, so his mates come around once a week and they talk fishing lures, they all make fishing lures.

Additionally, Dianne and Gary's garage contained their solar photovoltaic (PV) inverter and battery, which Dianne regularly checked to make sure it was working correctly (via an energy monitor on her tablet). Their battery was relatively small (1.5 kW), but Dianne explained that it 'helps us through the expensive period of time' (higher electricity tariff period). Physical space constraints were a consideration regarding battery size, as were the high prices of bigger batteries that the family had considered.

> This one we've got is a tiny little thing that's in the garage, and you could buy another one and just plug it in and it would work. [...] But there are, of course, bigger batteries that are much more expensive.

Dianne and Gary's home illustrates the increasing electrification of the edges as they become doing-places for charging (to support home maintenance practices and for battery storage), and as they continue to be embedded in masculine hobbies and social activities. The electrification of the shed and the objects within it (which were less dirty and heavy than other power tools) offered new opportunities for Dianne to participate in traditional masculine practices. However, the increasing space required for these technologies has its limits and may prevent further opportunities for the household to expand into larger home battery technologies or purchase and charge electric vehicles at home. Notably, Dianne and Gary's children were still largely absent from the sheds. However, their son was a 'keen gamer', and his room was a technological proving ground of sorts, set up 'with the umpteen screens and all that sort of stuff'. This relational extension of the shed from the edges into the centre of the home is discussed further in the cases of Fred and Artem below.

4.2 AN EXPANDING PROVING GROUND FOR EMERGING TECHNOLOGIES

Fred (33) lives with his wife and dog in the outer suburbs of Melbourne. He is a keen enthusiast of many emerging technologies and enjoys experimenting and building his own prototypes. Aside from a few smart modifications, Fred described his shed as 'a stock standard garage'. Like Dianne and Gary, Fred's garage was the primary site for charging, which in his case included an electric motorbike, bicycle and skateboard, as well as a range of electric power tools and an electric mower, which he had set up on a charging station to maximise the best energy rates. As he explained:

> Yeah, lawnmowers, drills, flashlights, bicycle lights, anything that just we have batteries in the house that's rechargeable will just be on a row in the garage on one of the shelves and it just sets that on a timer to charge at that time, because it's sunny on Saturdays and if it's not you're getting off-peak rates.

While Fred explained that his charging was not 'smart of anything' but rather 'automated in the most basic way' using a 'regular timer', he managed this system in concert with his available solar generation and a time-based tariff. Thus, charging was a form of digital housekeeping for Fred that he managed on the edges of the home, and in a way that supported demand management objectives.

Fred's garage was also the site for larger projects (*e.g.* restoring and converting a Jaguar car to an electric vehicle), and for servicing his wife's car, for which he used other appliances such as a wet–dry vacuum (for cleaning up any spills) and an air compressor. Additionally, Fred was experimenting with emerging smart technologies in his garage, to control the lights, a few speakers and the operation of the garage door with an Apple iPhone Siri voice assistant. Some of these smart technology projects were starting to expand into the home. In a spare room, Fred showed the research team several old and unused laptops which he was planning to convert into

smart mirrors. Fred was experimenting with automated sensor technology for his air-conditioning system in one of the (spare) bedrooms, had modified their security system to display footage on a monitor in his home office, and several rooms also contained technology in various stages of development or storage (waiting for future smart tech projects).

A key consideration for Fred was whether or not these technologies would be welcomed by his wife. Until he was sure they would be, his experiments and projects were relegated to fringe doing-spaces, which were physically located in the garage and unused spaces such as spare or storage rooms. He explained that the smart controls he had set up for the lights and garage:

> had to be something that we use quite easily on our phones already. I knew if it was something where she had to have another device or had to use something that she wasn't used to, she wouldn't use it.

More broadly, Fred acknowledged differences when:

> guys and girls generally have projects. [...] When I speak to my wife, if I can prove to her that something has worked and it makes her happy [...] she's fine with it.

With this knowledge about his wife, and through the technology proving grounds Fred had set up in the garage and other parts of the home, he was exploring opportunities to engage his partner in emerging technologies (such as electric vehicles). Hence his own experimentation was not just a personal hobby, but a method of introducing his more tech-septic partner to technologies she otherwise would not consider.

Artem (37) and his partner, both immigrants, rent an apartment in a western suburb of Sydney. Artem's hobby of experimenting with smart tech was supported by his profession as a user experience designer for an information technology (IT) firm. 'I'm a geek,' he explained. 'I like to play with the technologies before they become really common.' In contrast to Fred, Artem was constrained by the lack of a physical shed or garage in which to innovate and experiment with emerging technologies, so his 'proving ground' and shed-doing-space was the home itself.

Artem told the research team how he had set up several smart technologies inside the apartment, including automated blinds, around 15 smart lights, smart plugs to control appliances, a morning routine involving Google Home, and an infrared blaster retrofitted to voice control a split system air-conditioner.

> I have also automation for my air cons, so they are driven by IR blaster so I can say 'okay, switch on the air cons' and it switches it on, or I can ask for a specific temperature, and I have a morning routine when Google Home tells me about the current weather and turns on my amplifier and puts music into it. [...] When I leave home, I say 'I'm leaving' and it shuts off everything in the house.

Artem was interested in automation to create routines or 'schedules' for the home, as he explained:

> I try to make schedules but I actually only use the scheduled opening of the window blinds, so they open halfway at 10 minutes before the sunrise and 15 minutes after the sunrise they open completely so it just helps to wake up naturally.

Like Fred, Artem was the smart home tech leader, who 'usually set up everything'. He explained that while his partner:

> can do it herself she is not keen much. I'm crazy about this kind of stuff. I have this automation in my car as well.

Artem reflected on how he needed to modify his original (more complicated) smart home set-up because his partner struggled with it. The switch to voice commands was what enabled his partner's interest and use of the system, supported by the couple giving their devices cute and clever names that she could easily remember, as he explained:

> The only thing my partner needed to know are the names of the devices, we give them funny names. Turn on the breeze, or turn on the wind, or to turn on the sleepy light.

Fred and Artem's cases both demonstrate how the doing-spaces associated with technological tinkering and experimenting can shift from the edges to the centre of the home, which involves complex gendered negotiations. In Artem's case this was partly due to the absence of a physical shed, but in both cases, it reflects the growing normalisation of smart technologies and their integration into household practices more suited to the central doing-spaces of the home. While Fred and Artem also maintained private and masculinised doing-spaces, such as Artem's car and Fred's garage, their female partners played key roles as the gatekeepers for technologies entering the centre of the home, and made important judgements about the value, usability and viability of new technologies. This reflects prior research highlighting the 'wife acceptance factor' for smart home technologies (as one Australian industry professional has labelled it) (Strengers & Kennedy 2020: 184). These gendered dynamics are therefore important for thinking through how emerging technologies move between the peripheries and centre of the home, and therefore help or hinder energy and smart technology policy and industry ambitions.

4.3 A SECOND DWELLING OR LIVING SPACE

A third theme identified in the analysis was how sheds are increasingly positioned as 'second centres' in their own right through the increasing normalisation of the domestic activities taking place within them—and through the extension of electrical and internet infrastructures and technologies across the property. In this regard sheds were sometimes considered separate physical dwellings or living spaces either for one person (commonly a man) or for multiple members of the household. Marj (71) explained the changing use of her partner Peter's shed, where he pursues his passion for restoring and building cars. However, with Peter in retirement and spending most of his day in the shed, it was becoming an additional living space:

> He would be up in the shed during the morning and the afternoon; just come down for snacks and lunch and whatever. Then he'll go back up to the shed.

Peter also had numerous other amenities in his shed, earning it the designation of a 'man cave' from Marj:

> He's got this little man cave inside the shed. He's got a bar in there. He's got a TV. He's got a fridge. He's got a stereo system. And it's littered with signs and God knows what else.

In the winter, Peter used an oil heater in the shed, which Marj believed had increased their power bill:

> I think he finds, in the winter, it's too cold to go up there [...] so he's had to have the oil, so that's probably when the power bill went up that month. [...] But hey-ho, you've got to do something. You can't sit in the house all the time.

In response to some age-related health issues, Peter was considering installing a reverse cycle system in the shed to manage the summer heat:

> I would say it will [happen], because it keeps popping its little head up more and more often. It was just a dream in the beginning. Then in the summer, on the hot days, it's too hot to go up there.

Unlike Peter, Marj was concerned about energy bill impacts, but considered the installation of cooling via a reverse cycle system to be 'the best way of controlling the temperature for the lowest amount'.

Haruki (49) had a more holistic vision for his shed as a second living space for the whole household, and as an expanding doing-place for a range of activities, especially as his three school-aged boys were starting to grow up. Haruki lives with his wife and children in the outer suburbs of Melbourne.

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He works in IT and his wife teaches violin part time. The family occasionally watched television together on the sole family television, but they also watched things on separate devices, although sometimes in the same room, each around their own screen. One of the motivations Haruki gave for wanting to renovate the family's shed into an additional living space was to provide an additional space in which to watch television. This was particularly important in the context of the Covid pandemic, where lockdown restrictions and working-from-home orders had generated physical space pressures inside the main dwelling.

Haruki's shed in the backyard had a spare refrigerator and lights installed, but was hardly used, as it was in poor shape with broken glass and rats living in it. Haruki explained:

> we don't do any work, or DIY stuff in there, but we are actually trying to rebuild it in the near future.

The aim was to create a liveable space for various family members' entertainment and hobbies:

> just be able to sleep in there and just have a potentially a TV installed for entertainment, because we've got a what do you call it, electric drum kit as well, which we have in our TV room at the moment, [...] and yeah potentially sleep and have kids friends come and sleep over, play drum, and have my wife teach violin, her lessons in there. Yeah, it's about probably two bedroom size.

While Haruki designated responsibility for renovating the shed to himself, he did not think of it as a 'man cave' for his own masculine pursuits, but as a space for different members of the family to carry out practices that would be more conveniently located away from the main dwelling. The future renovated shed would provide privacy, solace and reduce disruption to others by providing an extra space for his family in which to sleep, entertain themselves, socialise and work.

Even though Peter and Haruki had very different ideas in mind for their shed, both shared a common goal of transforming this site into a secondary living space and a second centre for the home, made possible through electricity and internet, and through a duplication of household appliances and devices (such as televisions). As identified in the introduction, the expansion of living spaces into sheds is becoming increasingly common internationally, and can generate new home energy demands from the emerging integration of well-established appliances (*e.g.* televisions, heaters, coolers, refrigerators) into peripheral home spaces, possibly leading to another round of household electrification (Røpke *et al*. 2010). Draughts, lack of insulation and ineffective window coverings (common in the physical structure of sheds) will increase the energy use of heating or cooling appliances compared with those used in the central, better insulated, dwelling. Further, many of these conversions are likely to be 'informal' and therefore do not invoke the insulation improvements that would be required under Australia's National Construction Code if they were recognised as no longer being a 'non-habitable' structure.

5. DISCUSSION AND CONCLUSIONS

The households discussed above illustrate three themes regarding the changing roles that sheds are playing in everyday life, and the gendered practices that both make and transform the doing-places that occupy physical sheds and homes:

- *How sheds are becoming increasingly electrified*

  As physical structures, sheds are used to store, charge and use emerging electric power tools, property maintenance technologies, electric vehicles and home batteries. These infrastructures and technologies are anchoring an expanding range of activities within the shed.

- *How sheds are important 'proving grounds' for emerging smart technologies*

  Smart technologies are moving from the edges into the centres of the home. This was particularly important for people such as Artem, who do not have access to a physical shed,

and instead rely on their main dwelling (and other sites such as the car) as doing-places for experimentation and innovation with emerging technologies.

- *How sheds are becoming important secondary living spaces in their own right*

  Here, sheds might remain physically located on the edges of properties whilst becoming more central to everyday life; positioned as a second centre for recreation, work or social activities—or a more flexible and expansive doing-place for multiple practices, enabled by duplicate appliances and technologies, and by the extension of electrical and internet infrastructures towards the edges of the property.

The cases discussed in this paper invite further attention to the gendered dynamics involved in the practices associated with sheds and other edges of the property, and with those involved in emerging smart and energy technologies. As Dianne and Gary illustrated, the change from petrol to electric maintenance devices, power tools and battery charging may reposition these technologies from being dangerous, heavy and dirty to more convenient and clean. This in turn is likely to destabilise the masculine associations with these technologies and the practices involving them, enabling broader participation from other genders. In contrast, other emerging technologies, such as those involving smart and automated devices, may further entrench masculine associations with the shed, and also see further proving grounds for emerging technologies embedded within the centres of the home, as seen with Fred and Artem. And finally, while the shed is likely to remain a 'man cave' for some like Peter, its increasingly important role as a secondary hub for household activities involving emerging uses of well-established technologies and infrastructures may break from these gendered associations, and lead to a much more diversified and inclusive set of practices taking place within these doing-places and physical sites, as was Haruki's aspiration.

These changes have important implications for realising energy efficiency and demand management policies, which have largely ignored gendered doing-spaces on the periphery of domestic life and the physical property (Middha *et al.* 2022). With the real estate industry highlighting demand for homes with additional living spaces (accelerated by the Covid pandemic) and significant increases in home value, homeowners are further incentivised to convert home edges to living space. However, the 'official' conversion process involves surveyors, local government and requires costly building work to meet standards for insulation, waterproofing, ventilation, *etc.* (City of Joondalup 2022; City of Mandurah 2022). Although these building codes are well-intentioned, the cost of complying is likely to encourage self-renovations without the required planning and building permits, and therefore keep the growing importance of sheds out of view of planning and building authorities.

Taking these insights and research agenda forward, it would be productive for policymakers and industry professionals seeking to achieve decarbonisation, demand management and wellbeing to start thinking about the home as a property—or co-located site of multiple doing-places—rather than a single dwelling or even a household. Following Maalsen (2020: 106, 109), who calls for geographers to account for shared living as:

> a long-term housing solution for a wide range of demographics—and an increasingly important site of homemaking,

conceptualising the shed and its relationship to the home needs a similar rethink. Like shared living, the changing physicality of the shed—and the doing-places sheds are associated with—reconfigures the home as a site of multiplicity and change, where household members can simultaneously occupy different spaces that consume the same (duplicate) or different appliances and technologies. Being left at the edge, and beyond the target (or under the radar) of policy and regulation, people are more likely to think of their sheds as rogue sites where 'anything goes'. Alternatively, if the shed is more clearly centred in energy and housing policy, renovation incentives and demand management programmes that specifically target the shed could be introduced (Nicholls *et al.* 2021). In this regard, following other scholarship on practices and flexibility (Blue *et al.* 2020; Powells *et al.* 2014; Strengers 2012), an important research priority is to consider how demand flexibility might be differently realised in the types of doing-spaces sheds afford, and

what this could mean when these spaces are co-located within the main dwelling, or in secondary living spaces on the same property.

Attuning to gender amidst these changing dynamics will become increasingly important as policymakers and energy companies seek to engage householders in taking up smart and automated technologies, or participating in the energy transition through further uptake of rooftop solar PVs, electric vehicles and home batteries. As illustrated by Fred and Artem, those most interested in these emerging technologies may not be the key people involved in realising their entrance into the home, or their transferral from the edges to the centre. Paying attention to those who are sceptical or disinterested in emerging technologies will therefore be crucial in realising smart energy ambitions, as will considering the historical and contemporary gendered associations with emerging technologies (such as whether they are considered dirty or clean; smart or dumb; or heavy or light). Conversely, the electrification of sheds and the objects within them, and the conversion of sheds to more expansive living spaces, may challenge 'man cave' stereotypes and result in more inclusive and fluid gendered participation (and possibly more expansive consumption) across the whole property. Broadening the focus from heterosexual relationships and families onto people who identify as LGBTIQA+ may also reveal other important gendered themes about how these peripheral doing-spaces are changing.

Finally, it is important to consider people who do not have access to physical sheds, or who cannot afford or access emerging technologies. As Artem's case demonstrated, people without sheds may increasingly maintain shed-doing-spaces within their homes or at other edges of their properties for tinkering and experimentation, and may also have extensive plans for 'sheds in their heads', which they aspire to realise in the future. It is clear that both the edges and centres of the property are critically important doing-places for everyday practices, gendered relations, technology and energy innovation, and homemaking—all of which deserve further attention from policymakers and social researchers alike.

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AUTHORS' CONTRIBUTIONS

YS is a chief investigator on the project. The authors (including YS) carried out ethnographic research for the project, analysed the materials for the paper and wrote the article. KD contributed to the analysis and writing of the ethnographic cases and was one of the researchers conducting the ethnographic study. LN carried out some of the ethnographic research, contributed policy insights and edited the manuscript.

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The research undertaken for this article was approved by the Monash University Human Research Ethics Committee (Project ID: 21876). Participant names are provided in accordance with participant preferences and consent (pseudonyms or real first names). All identifying details have been removed for publication.

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