Original research article

Understanding the missing middlemen of domestic heating: Installers as a community of professional practice in the United Kingdom

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ARTICLE INFO

ABSTRACT

Despite indications that they could play an important part in shaping how people heat their homes, central heating installers have been largely overlooked in energy research. As a means of addressing this oversight, this paper draws on a British ethnographic study to explore the ways in which these 'missing middlemen' can be said to comprise a 'community of practice'. Two aspects of community membership are explored in detail: social learning processes and shared identities. This exercise shows how socially acquired understandings of their professional role and their relationship with homeowners can influence the selection and installation of heating products. The paper concludes with suggestions for how industry and policy makers might engage with this group. These suggestions focus on strategies aimed at reducing the energy used for home heating, and the installation of alternative heating technologies, both of which might benefit from an appreciation of the informal processes of community formation.

1. Introduction

In most of Europe, space heating is the largest single contributor to domestic energy consumption [15]. In the UK context, gas central heating systems[1] are the dominant form of space heating [40], and heating installers are tasked with the selection, installation and explanation of these systems in homes. They are therefore the bridge between those who design relevant technologies and those who use them. Heating installers enter properties on a daily basis, potentially influencing the technologies installed, how residents interact with them, and the subsequent energy consumed through domestic space heating.

In the UK, policy makers developing strategies to move towards alternative forms of space heating are increasingly aware of the importance of installers. For example the UK Department of Energy and Climate Change's (DECC)'s Heat Strategy recognises the need to "improve capability and competency within the low carbon heat sector" ([12], p .88), noting the provision of a voucher scheme for training along with "providing advice" ([12], p. 88) to installers.

However, they lack detail on how these schemes will progress, and have made these recommendations amidst a dearth of information on how best to engage with this group. As a response, this paper explores the ways in which heating installers operate as members of a 'community of practice'. In so doing we build on a growing interest in undertaking anthropological studies of the various social and professional groups involved in creating and meeting energy demand [21,61], as taken forward by this journal [57]. Whilst such research is necessarily *situated,* in our case with the UK gas heating installer community, the approach and findings we present here are of wider relevance to those interested in the many building professionals and intermediary groups whose actions shape energy consumption.

We first outline how building professionals have currently been investigated in energy research to argue that, in their middle position, these actors can shape the technologies installed in homes and how they come to be used. Following this, we look at existing strategies to understand and influence the energy consumed through domestic central heating, and consider why the installer has been largely overlooked by these strategies. Then, we detail the empirical work drawn on in this paper before outlining the 'communities of practice' [33] concept that has been applied to explore the ways in which UK installers have undergone certain social learning processes that support a collectively shared identity. The paper then ends with how these processes of community formation might be

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[1] In this context a 'gas central heating system' is one which uses a gas-fired boiler as the heat source, which distributes heat via a series of radiators situated throughout the property.

harnessed by policy makers and industry in pursuit of less energy consuming ways of heating homes.

1.1. Building professionals in energy research

A recent article in this journal, by Parag and Janda [46], highlighted how a persistent dichotomy between technologies and users in energy policy fails to account for the 'middle actors'. This is despite the fact that these actors are clearly "active participants in the system, capable of creating (and sometimes preventing) change above, below and across other actors" ([46], p. 103). Schweber and Leiringer [56] also point to their importance, noting that occupants do not act independently; their consumption practices are mediated by a range of stakeholders. Similarly Moss et al. [38] would agree in emphasising their role in "enabl[ing] the uptake of new technologies and changed social practices within the production/consumption nexus" (pp. 21-22). The key argument here is that these actors have the ability to influence others. As Guy et al. [22] note, they "do not occupy a neutral position in dealing with other actors. They may well mediate or facilitate, but are by no means benign in the work they perform" (p. 6).

This argument is particularly important in the context of the building professionals who have a hand in shaping domestic energy consumption [28]. These building professionals are, however, diverse; in defining them, Janda and Parag [28] include "any person or group whose work involves the construction, refurbishment, management, letting or valuation of buildings, as well as businesses that supply materials and technologies to support these services" (p.42). They include architects [27,16], energy efficiency advisors [44,45], property agents [55], builders [30], plumbers [6], low carbon technology installers [52], and heating installers[2] [4,5,13].

Owen et al. [44] argue that tradespeople including builders, heating installers, plumbers and electricians can apply their own ideas in shaping decisions about the technologies installed in homes. For example, instead of offering a range of options, professionals might choose those that are more familiar to them [54]. Installers and advisers retrofitting low carbon technologies have also been found operating "according to their own heuristics of risk and acceptability" ([44], p. 176). Similarly, small and medium construction enterprises (SMEs) perform an "informal but multifaceted risk assessment" when considering new technologies, that includes cost, potential for malfunction, and personal familiarity ([31], p. 526). Furthermore, the reluctance of construction professionals to amend successful strategies and their skepticism of unfamiliar products has been attributed to their concern for call backs, reliability [27] and reputation [6,31]. Beyond the selection of products, these actors can act as crucial 'conduits for information' advising and facilitating the choices of others [55].

Yet, these building professionals and practitioners remain under-investigated in energy and buildings research, where, aside from the studies cited above, the vast majority of research has, to date, focused on end users and technical factors [56]. This is particularly true in the case of domestic central heating. This paper forms part of an attempt to address this issue by presenting an ethno-

graphic analysis of a group whose routine practices have significant domestic energy use implications: heating installers.

2. The missing middlemen of heat energy consumption in the home

To date, attempts to understand or influence the energy consumed through domestic central heating have focused on either technological strategies or on behaviour change amongst end users. These provide a limited understanding of space heating practices, in particular neglecting to account for the wider cultural context in which these practices take shape [37,35]. In the following section, these two existing strategies to reduce the energy consumed through space heating are considered in more detail before identifying the potentially important role of heating installers.

2.1. Strategies for energy saving through space heating

1. *The technical perspective*. Here we find the assumption that reducing energy consumption is achieved by improving the energy efficiency of technologies and buildings. For gas central heating systems, a notable technological strategy in the UK was the mandating of condensing boilers in the 2005 Building Regulations [39]. These operate with improved efficiency by extracting heat from the exhaust gases of a boiler, which was not captured with traditional boilers. However, the efficiency gains produced by this can be uncertain, for example, in-situ condensing boilers have been found to have operating efficiencies lower than the factory tested efficiencies they are purported to have [42]. Instead, the in-situ operating efficiency of a condensing boiler is dependent on system design, including the radiators, pipework and controls, which are all influenced by the system installer, but also effective operation, which is often regarded as the domain of the end user.

2. *Understanding users*. Attempts to influence the users of central heating systems have generally involved information campaigns, emphasising the potential for financial savings through reducing thermostat settings [10,11]. This strategy is common internationally, with campaigns for the addition of heating controls and use of particular settings being documented in American [47,49] and Australian [25] contexts, for example. However, although it would seem that these campaigns can increase users' knowledge, there is little evidence that they affect actual energy use [2]. Furthermore, they also fail to account for how end user interactions with these devices might be shaped by other influences.

Because both policy and research on this topic continues to be dominated by a focus on either central heating technologies, or on end user interactions with them [56], we lack a comprehensive picture of how space heating practices come to be. As a consequence, the contention of this paper is that both could benefit from a fuller engagement with relevant building professionals, in particular, heating installers. In this paper, heating installers are characterised as the 'missing' middlemen[3] of domestic heating research in the sense that, despite their potential for influencing heat energy use at home the dual focus of previous research has left them under-examined. The following section substantiates this argument, showing how heating installers may contribute to determining, configuring, and influencing this use of central heating systems, all of which are likely to influence the energy consumed through central heating systems.

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[2] Within this paper, the term 'heating installer' is used to identify the individuals tasked with the design, selection, installation and commissioning of gas central heating systems. The specific skill set and qualifications that these individuals possess is also recognised by the term 'heating engineer' by those in the UK heating industry, and indeed, many of the participants of this research identified as such. The terms 'heating installer' or 'heating engineer' may also be used to identify those involved in the installation of other types of central heating, for example those using oil-fired boilers and heat pumps; however, the focus of this paper is those involved in the installation of gas central heating systems.

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[3] We use this gendered term because of the dominance of men in the UK heating industry; all of the participants of this research were male. Indeed, the 2011 census revealed that 98% of people employed in the skilled construction and building trades are male [41].

2.1.1. The under-examined role of heating installers

In 2000, a piece of research by [4] on the network of actors implicated in the specification of domestic heating systems in the UK found that:

> "For replacement of heating systems in existing housing, it is clear that decisions about the appropriate system type and make or model are generally left to the installer. . .[who is]. . .usually able to suggest more or less what he sees fit." (p. 8.10)

What happens when things are 'left to the installer' provides the core focus of this paper. Banks' [4] research constitutes one of the only efforts to engage with those tasked with central heating installation; however this was limited to a small number of installers and conducted over 15 years ago. More recently, the Department of Energy and Climate Change [13] identified heating installers as suitable messengers, who could relay information about the most energy efficient use of heating controls to end users, when provided with guidance on this. Furthermore, beyond making decisions about the technologies to fit, heating installers have also been recognised for their potential role in shaping the subsequent use of central heating systems. Rathouse and Young [50] conducted a series of focus groups, which sought to understand end users' experiences with central heating controls. Although their participants noted asking installers about how to use their controls, installers were not the core focus of this work, and the authors do not elaborate further on how exactly these interactions would proceed.

Yet arguably, understanding the ways in which heating installers operate is essential, not only for establishing exactly how this influences the installation of gas central heating systems, but also for discovering how these practices might effectively be influenced in moving towards sustainability agendas. Given the limited information available about heating installers, the research on which this paper draws argued that a grounded, open-ended approach to investigating this group was required. With its relatively unstructured approached to data collection, which does not follow a strategy fixed prior to fieldwork [23], ethnography was deemed most appropriate for this investigation. This approach also led to the identification of communities of practice as a valuable concept for understanding how heating installers operate; these are both detailed in the following section.

3. Method: investigating heating installers as a potential community

In the UK, heating installers primarily work alone or in small teams in private properties, changing location on a regular basis. Indeed, this industry is dominated by micro and small enterprises, with over 70% of those registered to install domestic gas appliances operating as sole traders ([20], p. 22). As a result, this dispersed group can be difficult to monitor and hard to access.

The present study consequently adopted a snowball sampling approach, where key informants were identified through different routes, and they would recommend additional participants. The primary limitation in applying this approach is that it results in a certain degree of self-selection, yielding participants who regarded themselves, or were regarded by others, as performing a high quality of work, for example. In keeping with this, these participants might be those that are most engaged with maintaining and updating their skills. This strategy led to a varied sample, which included self-employed heating installers, working primarily in private homes, along with staff from several medium-sized organisations, who performed installation and maintenance work with Registered Social Landlords (RSLs). The majority of shadowing and observation took place within Greater London; however, through

training sessions and interviews, the sample also includes heating installers working in Somerset and the Midlands. The participants were all male, and aged between 25 and 65 years old. They had a variety of backgrounds, qualifications and routes into the industry, but the majority had been working as heating installers for over 10 years. Whilst not statistically representative of the approximate 135,000 (Gas Safe, pers. comm., 2013[4]) heating installers operating in the UK, this sample does reflect the diversity of this group.

The ethnographic approach used involved a range of data collection strategies that were used according to what seemed fruitful and feasible in the field. These included 20 semi-structured interviews with different heating installers, shadowing them approximately 30 times as they fitted systems in homes, and observing installers in more social settings including 9 training sessions hosted by boiler and controls manufacturers, spending time in the plumbers' merchants where installers sourced their parts and materials, and attending relevant trade exhibitions. Attending these events led to the collection of data from other actors working in this sector, including plumbers' merchants and representatives of manufacturers. The shadowing and observation were conducted overtly between September 2012 and December 2013, and resulted in interactions with approximately 100 heating installers and the collection of photographs along with detailed fieldnotes, ranging from 4000 to 10,000 words in length. Meanwhile the interviews were conducted in a location of the installer's choosing, they were between 45 min and 3 h in length, and were audio recorded and transcribed verbatim.[5] The data collected was analysed using qualitative analysis software (MaxQDA), and coded through an iterative process of moving back and forth between emergent themes and relevant social theory [36]. This paper, with its focus on understanding the practices of this spatially dispersed workforce, and how they emerge and might be informed, draws on one of these themes, using the 'communities of practice' concept to interpret the data produced by these various activities.

3.1. Theory: communities of practice and co-presence

The concept of a 'community of practice' comes from an established body of sociological work in which learning is understood as a process of social participation. In this, learning occurs through being an active participant "in the *practices* of social communities and constructing *identities* in relation to these communities" ([59], p. 4, emphasis original). Emphasis is placed on how it is participation within communities that "shapes not only what we do, but also who we are and how we interpret what we do" ([59], p. 4). The term 'community of practice' is thus intended to imply:

> "Participation in an activity system about which participants share understandings concerning what they are doing and what that means in their lives and for their communities" ([33], p. 98)

As such, a community of practice does not form on the basis of formally defined structures, such as allocated teams of co-workers [17]. Although formal training, qualification and registration struc-

tures do exist in the case of heating installers, these do not define the community of practice. In the UK, heating installers are legally required to be registered with Gas Safe Register, an organisation that manages a database of those qualified to work on gas in domestic properties [20]. In order to register with Gas Safe, a heating installer must complete the Nationally Accredited Certification Scheme for Individual Gas Fitting Operatives (ACS), which must be renewed every 5 years. Prior to ACS assessment heating installers must undertake training and achieve relevant qualifications (for example, through short-course training or a modern apprenticeship) [20]. Whilst these formal modes of training are no doubt essential in shaping the practices of heating installers, these were not the focus of this investigation. Instead, the approach used here captured their informal, day-to-day activities and interactions.

Community membership is an "intuitive notion" ([33], p. 42) with a fluid, emergent and informal structure [8,59]. It is worth noting here how, in selecting the term 'community', Lave and Wenger [33] also intend to capture the heterogeneity of these groups:

> "We assume that members have different interests, make diverse contributions to activity, and hold varied viewpoints [. . .] Nor does the term community imply necessarily co-presence, a well-defined, identifiable group, or socially visible boundaries." (p. 98)

Despite this emphasis that a community of practice is more nuanced than a co-located, well-defined group, Duguid [14] argues that users of this theory tend to focus on the 'community', rather than the practice. For example, studies that have empirically investigated communities of practice amongst building practitioners have maintained this focus on co-location, where the individuals under scrutiny are in the same place (see Refs. [17,58]).

Heating installers, by contrast, seldom work together. Instead, this varied and dispersed workforce often practice alone in private properties, making them a particularly interesting case. In this vein, the concept of communities of practice is drawn on by Axon et al. [3] in conceptualizing the different groups involved in shaping energy use in tenanted commercial properties. Meanwhile, Hitchings [24] has applied this idea to understand variations in thermal comfort practices amongst geographically dispersed groups, noting that 'community' centres on participation rather than proximity. Indeed, communities of practice are identifiable by their common traits. In particular, members share a collective understanding of what the community is about, a sense of being mutually engaged in the practices of that community, and they have a shared repertoire of communal resources, such as language, routines, tools and stories, developed within that community [59,60]. The question thus becomes one of whether these actors, who do a similar job but do not do their work together, do indeed share such understandings and repertoires and can therefore be understood as a community of practice. Further, if this community does exist, what does this mean for the installation of domestic central heating systems, and how might this community be successfully engaged with in strategies for moving towards lower energy consumption through domestic heating (such as DECC's Heat Strategy)? In order to answer these, the empirical material presented in Section 4 focuses on two particular aspects, in turn:

1. Processes of social learning in which potential members learn from one another;
2. The implications of this in terms of whether a shared identity can be said to exist.

3.1.1. Community learning

For Lave and Wenger [33] community membership is achieved through a process of 'legitimate peripheral participation'. In this composite term, legitimacy relates to accepted ways of belonging, whilst peripherality suggests that there are multiple, more or less engaged, ways of being in the community ([33], pp. 35–36). This concept has been used to understand the process of becoming a practitioner within a community (see for example, Refs. [33,17]), as well as the on-going learning work of community members (see for example, Refs. [8,53,32]). Brown and Duguid ([8], p. 41) note the particular importance of 'learning-in-working', suggesting that work practice, and the learning inherent in it, is very different to work as outlined in formal descriptions (for example, the guidance provided in manuals that heating installers might use). It is this type of learning that provides the focus of the current paper. In a similar vein, Orr [43], in his study of photocopier repair technicians noted the significance of 'war stories' in their work, namely anecdotal re-tellings of problem machines and successful solutions. By being situated in the practices of the community (i.e. the lived realities of repairing photocopiers), these war stories could become embedded in the 'community memory' and used as a diagnostic tool for future work ([43], p. 67). All this is consistent with Lave and Wenger's ([33], p. 109) argument that the ability to talk both within (i.e. exchanging information) and about (through stories, lore) the community as important elements of membership. These ideas are applied in the first section of empirical analysis, which explores learning amongst heating installers.

3.1.2. Community identity

As an inherently social undertaking, learning and operating within a community is more than participating in a certain set of activities; it implies becoming 'a kind of person' ([33], p. 53). As Duguid [14] notes, it is membership within the community of practice that:

> "Offers form and context as well as content to aspiring practitioners, who need not just acquire the explicit knowledge of the community but also the identity of a community member." (p. 113)

Thus, the community of practice provides a context for an individual to develop not only their practice, but also their identity. Wenger notes that identity is "not merely a category, a personality trait, a role, or a label" ([59] p. 163); instead, its construction is an ongoing, complex process, only achieved through engaging with community practices. Further, Brown and Duguid [8] highlight that those who develop noncanonical practices (i.e. diverging from those stipulated in official guidance) are continuously reconceptualising both "their own and their community's identity in their own terms so that they can break out of the restrictive hold of the formal descriptions of practice" (p.52). This idea of identity construction is applied in the second section of the following empirical analysis.

4. Results: how heating installers practice as a community

Despite heating installers being a spatially dispersed group, one research participant suggested that the heating industry is one 'where everyone knows everyone'[6]; (fieldnotes, PHEX). People may remain in this industry for many years, sharing stories, and reinforcing similar practices and accepted ways of working. In November 2013, during the Plumbing and Heating Exhibition (PHEX), an industry event at which manufacturers display their latest products, Mark, a plumbers' merchant, pointed to a group of installers stood at the bar, noting:

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[6] The quotations used in this paper are presented verbatim, apart from where colloquialisms were used by participants, these have been replaced by full words in square parentheses.

'That group of guys have all been doing this since they were fifteen – they all know each other. It's an industry where people stick around, it's not as fluid as some other industries where people move around and move on'

Indeed, the individuals that Mark was talking about appeared to be at ease socially, and share the familiarity of people that had known each other for a long time. This industry has enduring memberships, with people treading a similar course and developing shared understandings and stories. During three consecutive days of fieldwork, an interview, observation at a manufacturer training session and a second interview were all conducted, having been accessed through seemingly unconnected routes. However, without prompting, the participant of the first interview mentioned that he had been considering the exact training session that would be attended as part of this fieldwork the following day. It was during this training session that Burt, the course instructor, told a story where he likened connecting a new boiler to an existing central heating system to putting dirty oil into a new car engine (fieldnotes, manufacturer training). This story was then repeated almost verbatim the following day during an interview with a sales representative who had previously worked with Burt. Although each of these individuals had been accessed through independent routes, their paths had clearly crossed through industry events, previous work and shared stories. This familiarity and overlap seems to suggest the existence of an installer community. However, how this relates to issues of learning and identities, and what this means for how central heating systems are installed required further exploration; this provides the focus of the remaining empirical material.

4.1. Processes of social learning

The guidelines, regulations and products that heating installers work with are subject to change as they are updated and modified in line with shifting policy and industry expectations (an example of this is the modified flue gas analysis procedure discussed in the following section). Beyond formal examination and training (see Section 3.1), learning is inherent in the heating installer's work. In fact, the learning work of the installer is seemingly never done:

"If anyone says 'I don't need to learn anything else, I've learnt all I need', that's bullshit, you'll always learn, [until] the day you die, if you're not learning then you're doin[g] something wrong. . ."

Given the changing nature of heating installers' work, it is perhaps unsurprising that Carl saw learning as a fundamental and on-going aspect of his job. Carl is a self-confessed 'gadget freak' who, at the time of our interview, had imported some computer controlled thermostatic radiator valves from Germany, and installed them in his own home to "see what happens" before recommending them to his customers (Carl, self employed, interview). And Carl was not alone in this. Several participants would 'keep an eye on' new products by attending industry events (fieldnotes, manufacturer training), and reading trade journals and magazines. These can be useful for information about "new products and changes in the industry, new directorships, movers and shifters, details of illegal installations, changes in the law" (Amir, independent merchant, interview). In particular, *Registered Gas Engineer*, a supplement published by Gas Safe Register, was often valued because it detailed changes in the regulations and guidance surrounding the installation of central heating systems. With new information constantly flowing through these channels, learning was evidently an inescapable and ongoing part of their work. However, examinations and industry literature were not the only means through which these heating installers learnt.

4.1.1. Sharing stories

According to Wenger, "local lore, shared stories, inside jokes, knowing laughter", indicate that a community of practice has formed ([59], p. 125). As Seb, the manager at a plumbers' merchant, explained, 'that's what you get in the plumbing industry – a lot of banter, friendly people' (fieldnotes, merchant- national chain). When heating installers come together (for example, during passing interactions at the plumbers' merchant or manufacturer training sessions), such exchanges prevail; discussions, coffee breaks and lunchtimes are filled with the sharing of anecdotes and stories. These might be personal tales, accounts of recent work, problem solving successes, and customer anecdotes. This study revealed them to be important learning occasions.

During one manufacturer training day, Burt, the course instructor, emphasised the importance of ensuring that existing central heating systems are clean before adding a new boiler. He elaborated by telling a story of problem solving when he was called out to look at a problem with a newly installed boiler. This included identifying a blocked heat exchanger in the boiler, and looking at the condition of the radiators which revealed that the blockage was likely to be caused by debris from the rusting system (fieldnotes, manufacturer training). These problem solving stories featured regularly in heating installers' conversations. As with Orr's [43] photocopier repair technicians, through story repetition, a problem solving method became embedded into the heating installers' community memory. In this way, installers and industry representatives create a stock of stories for future reference, should similar scenarios arise.

These interactions can also be valuable means of learning about new professional requirements. During this fieldwork, heating installers were keen to discuss how they would accommodate a recent change to the flue gas analysis procedure announced via a 'Technical Bulletin' in *Registered Gas Engineer*:

Dan had talked about taking a reading and getting a print off to provide evidence for the commissioning sheet. One of the installers commented 'that's all well and good, but I don't have a printer on mine because it doesn't prove anything', you could be holding the probe anywhere and taking a print out. . . .Carl said that he thought that the printer was a good way to provide evidence that you've done the testing.

Flue gas analysis involves measuring combustion emissions with an analyser, which can dispense a print out of the reading; this provides evidence that the testing procedure has been completed according to requirement. Through discussing this particular piece of equipment installers could share their understandings of this new requirement, and how they may accommodate it into their practices. Indeed, heating installers were repeatedly seen to use their discussions of this topic as a means of collectively situating the abstract information provided in the Technical Bulletin within the intricacies of their actual practice [8].

4.1.2. Banter and bad practice

Another 'insider conversation' indicative of a community of practice amongst heating installers was the 'bad practice' story, as an informal detailing of substandard work that served to remind community members of what they should be doing themselves. Industry magazines regularly featured these in what one participant called their 'naughty pages' (Gerry, self employed, interview). These are examples of poor workmanship of varying severity, from messy pipes, poor finishes and incorrect locations to unsafe, illegal installations that readers have sent in. The focus here does not rest on energy; instead, these articles are primarily concerned with installers' workmanship and safe installation.

A Gas Safe representative explained that the organisation were trying to change the 'dobbing in' culture, and make it more acceptable to report unsafe gas works (fieldnotes, Gas Safe

meeting). However, the exchange of bad practice stories was found to be an important part of heating installers' culture, one which extended beyond magazine articles into their conversations with one another. On the occasions when they managed to come together, for example at manufacturer training sessions and plumbers' merchants, installers would use these exchanges as an opportunity to relay what they have read, but also their own experiences of bad practice. Here, example mistakes reinforced shared beliefs about the correct course of action, for example, where room thermostats should be located:

> "Don't put it on the radiator, you'll be surprised how many calls we get where the room thermostat's been turning off at room temperature. Not behind curtains, not behind clothes, we've had an engineer who's been asked by a tenant if they can put it in the cupboard because it didn't match the wallpaper. Not in the loft, not in the garage and not in the shed. Ok? All places that we've found room thermostats situated, and then the tenants complaining that the system doesn't work as they expected."

Phil was not alone in using stories of incorrectly located thermostats to demonstrate where heating installers should not put them. This information is particularly important because the location of a thermostat can affect the temperature it reads in the room, the subsequent functioning of the central heating system, and thus the energy it consumes. Indeed, instructors often noted this when discussing the role of thermostats during the manufacturer training sessions attended in this research. Brown and Duguid [8] highlight that such stories can act as repositories of 'accumulated wisdom', which might be quite different to those embedded in documents that privilege "the decontextualized over the situated [and] sweep away the clutter of practice" (p. 45). In this case, the British Standard guidance to install heating controls in a "position readily accessible to the user" ([9], p. 46), fails to account for the curtains, cupboards, wallpaper and diverse occupants that heating installers encounter in their everyday practice. Instead, they feature in Phil's descriptions of bad practice acting as a learning tool for installers. The study also found these anecdotes being used "as a claim to status as a member of the community" ([43], p. 68), which forms an important aspect of the installer's identity. These shared identifiers are a second indication that a community of practice exists, which is examined in the following section.

4.2. The identity of heating installers

In operating as community members, it might be assumed that heating installers share a particular professional identity. However, this requires investigation, and is probed in the remainder of this section. The participants of this research have been intentionally labelled as heating installers. This vocabulary (or 'heating engineers' – see Endnote 2) is used within the industry for 'positive reinforcement', and to distinguish those doing the job legally from those that are not, although the installer's identity runs much deeper than a label. In *Registered Gas Engineer* magazine, this term denotes a competent, registered member, whilst an 'illegal gas fitter' indicates someone who has installed an appliance without being registered with Gas Safe (fieldnotes, Gas Safe meeting). Gas Safe Register is an organisation central to the existence and development of this community of practice:

> "Gas Safe is like the erm, all you've got if you've got the, the premier league, you, you pass the exam, but, then you've got to apply to join the governing body, basically the club, all, all Gas Safe is, is a club, once you've applied to the club, you, then you get this card come through and that, that gives you the right to work on gas."

Becoming a legitimate member of the Gas Safe club is verified through examination, followed by certification and the receipt of a photo license card [20]. However, during this fieldwork, heating installers and surveyors were rarely asked by customers to produce these cards, with one of the participants noting: "I bet I do not take my ID and show it to someone more than about three times a year" (Jack, self employed, interview). This echoes Wenger's [59] suggestion that community membership is about much more than tokens like membership cards. A heating installer may be recognisable to those outside of the community through their 'uniform', usually comprised of combat-style trousers, a polo shirt, and a fleece jacket in the winter, along with the badges, labels and logos on their clothing, their vans, and the documentation they carry. However, these are relatively facile representations of legitimate community membership. Instead, it is installers' characteristics, ways of working and talking to non-members that most effectively cement an idea of a shared identity. One way of doing so was by drawing a distinction with comparable trades:

> "There's still that boundary, or the band where the heating engineers can become plumbers, but plumbers can't be heating engineers, they're quite the borderline, they haven't got that technical, bit more technical, erm and I'm not knocking any of [th]em because I know people that will be proud, I'd be proud to be called a plumber, the old boys that I've worked with, they've got more knowledge on their little finger than I'll [h]ave when I die..."

Here, Carl highlights the technical skills of the heating installer. Whilst both heating installers and plumbers have particular skill sets, the installer's may encompass those of a plumber whilst the reverse is not necessarily true.[7] Beyond that, James also suggested that he performs the work of an "electrician [...] a carpenter, [...] a plasterer, or bricklayer, or anythin[g] like that" (organisation B, interview). In fact, the perceived range and complexity of the installer's skills are such that these research participants compared themselves with some quite different professions:

> "It's like, it's a bit like being a doctor, [because] when you go to parties you can imagine being a doctor, tell you what doc, I get this really long [h]ere ... but when I go to parties, they go 'what do you do?', I go 'oh, I'm a heating engineer, I do plumbing and heating', they go 'why does my boiler always bang in the morning and why do I get all this tapping noise in the morning and the evening?'"

For Jack, it is the diagnostic element of the heating installer's work that makes it comparable to that of a doctor. Thus, the installer's identity is established by more than formal training and qualifications; rather, it is only through engaging in the practices of the community, including such diagnosis, that an installer can be identified as a community member. Further, this identity was often defined in relation to technical skills, high quality workmanship and diagnostic ability, rather than 'softer' skills like interacting with customers and discussing the energy consumed through central heating systems. With this complex skill-set, and contrast against other professions, heating installers define their identity and derive professional pride.

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[7] This aspect of community membership also relates to Abbott's 'System of Professions' approach, which examines how different professions define and maintain the tasks that fall within their remit (or 'jurisdiction') [1]. This approach has also recently been applied to understand the middle actors in housing retrofit supply chains [29]; however, beyond the comments included in this paper, it was the community amongst heating installers that was most strongly identified within this data, rather than their interaction with other professions.

Identity was also defined by these participants in their ways of differentiating themselves from, and presenting themselves to, outsiders, particularly customers. For example, although members readily discuss bad practice within the community (as detailed in the previous section), they are particularly wary of revealing this to customers for fear of a detrimental impact on the overall community reputation. Tom noted that he would "never slag off someone else's work" in front of a customer, no matter how bad it was (self employed, interview). Similarly, Doug pointed out that to "name a few cowboys" did not do the industry "any favours whatsoever" (self employed, interview). In this respect, the very existence of the idea of 'cowboys' was instructive. 'Cowboys' is the term used by heating installers to denote illegal gas fitters, who perform the lowest quality of work and may leave installations in an unsafe condition. The poor workmanship of these cowboys has been exposed in UK television programmes with titles such as 'Rogue Traders' and 'Watchdog'. These programmes, expose fraudulent, dishonest and illegally operating tradespeople. The negative impact that these have had on the industry's reputation was a frequent refrain in this research. These programmes were also noted for exposing the secrets of the community to outsiders. It is not desirable for customers to know too much about heating installers' practices, Giovanni noted, because then "the customer thinks he knows everything, [but] he knows nothing" (self employed, installation, fieldnotes). This is largely owing to heating installers' need to protect their reputation and skills, but also about how a collective identity was partly tied to being perceived as experts by customers. Identity is thus defined according to the formal requirements of being an installer, but also in comparison to other professions and with reference to desirable outsider perceptions. This influenced their interactions with customers, which is now discussed.

4.2.1. Demonstrating expertise

There are various ways in which a heating installer demonstrates expertise to outsiders: being able to solve customers' problems; recommend particular products; and complete the installation, documentation and registration effectively and efficiently. It was also suggested that an expert is someone for whom the task becomes unthinking, being able to "do it off the top of their [heads], without even thinkin[g] about it" is a sign of an experienced installer (James, organisation B, interview). Duguid [14] highlights that much of the art of practice, or knowing *how*, lies tacit in a community of practice. The installer's work becomes tacit through experience, but also familiarity with the tools and products they manipulate. During one training session, the course instructor demonstrated how to remove the boiler casing, suggesting that it was 'one of the main things to get right because the customer doesn't want you to turn up and not know how to take the front cover off' (fieldnotes, manufacturer training). There are variations in the case and boiler design from each manufacturer; thus, in order to demonstrate expertise, installers may limit their choice of technologies, ensuring that they are able to manipulate these devices without thought. For Rodney, "there's nothing worse than turning up at a customer's house and having to get the manual out to look at how to install it because then it looks like you do not know what you are doing" (fieldnotes, PHEX). It is for this reason that he exclusively installs the brand of boiler that he learnt to use as an apprentice. This tendency to stick to certain products could be significant for attempts to encourage the installation of alternative central heating products and is elaborated in the discussion.

Moreover, there was a general expectation amongst the research participants that expert installers should be able to "talk the talk"; that is, provide details about the products being installed and be "persuasive" about the right choices (Jack, self employed, interview). During one manufacturer training day, an installer queried whether, when replacing individual system components, he would

have to modify the central heating system controls by adding zoning. This best practice requirement, detailed in Part L of the Building Regulations for England and Wales [19], encourages the provision of independent control of different heating zones in a property, which is intended to minimise the energy consumed through space heating. The course instructor, Harry, suggested that it was best to provide two quotes, one with zoning and the other without, but then went on to explain to the installers that it was ultimately their decision. He elaborated:

> "I pretty much guarantee most people would say 'well actually, that's fair, you as a plumbing and heating engineer have come in as an expert and explained it all to them, but you've left it in their court to make that decision. . .At the end of the day guys, you are the industry experts, you're the installers [. . .] so they're relying on you to get this information to them."

Here, a manufacturer representative positions heating installers as the experts on whom customers rely when choosing between control strategies. This was also a positioning that installers staged themselves. In one instance, a surveyor (who performs surveys to determine the central heating systems that will be installed in social housing properties), Sam, had been highly personable and talkative as we travelled to a particular job. However:

> [There was] a change in Sam's persona when we entered the property – he was more business-like, he went straight to the corner with the boiler in it and started listing what would be removed – quickly reeling off the changes that would be made, 'we'll take this, this and this out' whilst pointing at different parts of the system. Then he said 'we'll put the new boiler in the kitchen'.

In front of the customer, Sam quickly asserted an expert position. He focused on boiler location, and briefly mentioned that a hall thermostat would be fitted, but did not elaborate further. In this case, the heating controls were not described to the customer. Whilst these may have been omitted in relation to time constraints, or lack of choice, Sam's brief exchange resulted in the customer receiving no information about the central heating controls they would receive. Beyond these limited interactions, heating installers' demonstration of expertise may also lead to householders' limited involvement in decision making.

A lack of customer consent was seen to lead some heating installers to reject jobs. Carl highlighted that he will not fit a particular product if he knows "it's not gonna do the job" despite the customer's wishes, instead he might turn down the work, telling them "you're not listening to what I'm sayin[g] to you, you won't be happy at the end result" (self employed, interview). Indeed he argued, "they don't choose me, I choose them" it is the installer that has the final say in whether the work goes ahead (Carl, self employed, interview). Brian's dislike of a particular brand leads him to 'try to change' his customers' minds, and if this is unsuccessful, he will decline work where the customer specifies that product (Brian, self employed, interview). Whilst Dale noted that "installers are tradesmen at the end of the day and some are really good at putting their point across and some are not so much" (sales representative, interview), other installers talked of how they may attempt to gently 'educate' the customer to accept their recommendations. Amir owns a medium sized installing organisation, whose strategy is to 'fact blast' the customer in order to 'educate them to how [they] would suggest' (Amir, organisation D, interview). Other building professionals have been found to similarly influence the selection of the technologies installed; this is one of the factors leading them to be described as 'middle actors' rather than intermediaries [29]. Indeed, in demonstrating and maintaining their expert identity, heating installers can assert their own preferences for certain cen-

tral heating products; the implications of this are discussed in the following section.

5. Discussion and policy implications

This paper set out to explore the ways in which UK heating installers might be understood to belong to a 'community of practice'. The data presented has demonstrated that heating installers share informal social learning processes, as particular forms of seemingly casual conversation establish what successful community membership entails. Further, the demonstration of an expert identity was also seen as essential in both managing their relationship with customers and maintaining community identity. Exploring these informal aspects of community functioning offers much needed evidence on the way that these actors share information and come to develop a particular identity. In relation to DECC's Heat Strategy this leads to the suggestion that, in addition to the more formal strategies of voucher provision and training, there may be other effective ways of engaging heating installers in the promotion of less energy consuming home heating practices.

5.1. Working with installers as experts

Importantly, as a significant part of community membership, identities are:

"Key to deciding what matters and what does not, with whom we identify and whom we trust, and with whom we must share what we understand" ([60], p. 239)

For heating installers, their identity as a member of this community leads them to present themselves as experts to outsiders, particularly customers. Whilst the desire to demonstrate expertise is understandable from the perspectives of both the individual installer and the wider community, it may restrict the products installed. Indeed, this demonstration of expertise might contribute to heating installers fitting the products most familiar to them. Whilst this limited selection of devices can also be linked to brand loyalties (as identified in Ref. [5], with familiarity, heating installers no longer need to consult manuals and user guides. Thus, this preservation of an expert identity can contribute to heating installers being reluctant to accept new technologies (as identified by Refs. [5,30]). This is important for the UK's heat strategy, which calls for alternative sources of heat in homes including heat pumps[8] and biomass systems [12]. One recommendation is therefore that it would be beneficial to explore the types of support that will allow heating engineers to retain a hard earned expert identity whilst also fitting the most desirable products in energy use terms.

5.2. Learning through talking

Furthermore, this expertise can be demonstrated by being able to 'talk-the-talk', for example through being an assertive decision maker, and providing brief explanations to customers. Janda and Parag [28] highlight that whilst middle actors in the construction industry may be in a position to contribute to aims to reduce energy consumption, it is not always within their remit to do so. Thus, in moving towards the more sustainable construction and use of buildings, the energy community might consider the best strategies for heating installers to 'reorient' themselves ([51], p. 138), so that their professional goals include energy considerations [28], or determine who else might be best positioned to play this

role. In the UK, this is again relevant for the Heat Strategy, which notes the importance of training installers in promoting less energy intensive ways of heating homes [12]. However, if, as this analysis has demonstrated, installers learn through multifaceted, informal routes, it is an over-simplification to assume the practices of this community can be modified by decree [59]. Changes in the requirements stipulated in the Building Regulations, or in the information formalised in training schemes, are not linearly transposed into installers' practices. Instead they undergo a process of dissemination and discussion, exposing them to multiple interpretations that may potentially lead to some very different results (for example, the different interpretations of the flue gas analysis procedure detailed in Section 4.1). If heating installers both learn, and establish their identity through these informal routes, it might be effective to use them. To this end, it could be especially valuable to engage with Gas Safe Register, which, as an organisation that is central to the heating industry, is already actively involved in the creation of heating installers' expert identity. As it stands, the primary concern of Gas Safe Register is the safety of gas installations, and it is this that they promote through their publication of 'bad practice stories', for example. A suggestion would be to investigate the possibility of adding energy messaging to this remit.

6. Conclusion

Although established research traditions and policy strategies have focused on domestic technologies and the building occupants using them, this paper has explored the role of the missing middlemen of central heating. The approaches that heating installers in the UK adopt, when selecting and explaining central heating technologies, can be shaped by the social learning processes and maintenance of an expert identity inherent within their community of practice. Against this information, it is naïve to assume that technologies and end users are the only aspects worthy of our attention if we wish to alter domestic central heating practices towards lower energy consumption, as has been the predominant thinking amongst policy makers. Whilst it is difficult to ascertain the exact extent to which these actors then influence domestic energy use, the evidence presented here suggests that understanding how heating installers operate as a community of practice might help in strategies which seek to engage them in promoting alternative heating usage patterns, or the fitting of alternative heating technologies. In particular, these might benefit from employing informal strategies better aligned with the processes of community formation detailed here.

Heating installers present an interesting case in that they are rarely co-located, and they are primarily self-employed and working alone in domestic properties. However, studying this group has demonstrated that a community of practice can exist amongst individuals that come together relatively infrequently. We have no reason to expect that UK heating installers are the only building professionals who display the informal traits of communities of practice. Indeed, this approach could be used to examine whether informal structures exist amongst other building professionals, both in the UK and internationally (for example, general builders, plumbers and electricians). Further research could explore what these community dynamics tell us about how and when these building professionals might engage with sustainability agendas to enable the effective diffusion of practices that support lower energy agendas. This could lead to new ideas about how sustainability could be promoted in ways that are sensitive to how building professionals actually work.

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[8] The role of vocational education and training for the installation of heat pumps has recently been subject to inquiry by Gleeson [18]. We see this paper, with its focus on informal learning, as a complement to this work.

Acknowledgements

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