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RESEARCH ARTICLE

Selling and installing heat pumps: influencing household practices

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ABSTRACT

When installing energy-efficient technologies in housing, such as heat pumps, the energy savings predicted by technical analyses are often not realized, resulting in a performance gap. This study focuses on air-to-air heat pumps in residential settings. Interviews with actors in Scandinavia who are involved in selling and installing heat pumps are analysed to understand what role these actors have in relation to the performance gap. Previous studies have focused on households and their everyday practices with heat pumps. This study focuses on the process of integrating the heat-pump technologies into homes, and analyses the role of professional practices from supply-side actors (*e.g.* advice, provision and installation) in relation to questions of residential comfort, know-how and use, as well as the material (physical) integration of heat pumps into homes. In analysing these questions, the study's contribution is a focus on how to understand material elements within practice–theoretical approaches. From a policy perspective, the analysis shows that a sole focus on the efficiency of technologies is too limited in terms of achieving reduced energy consumption. There is potential for different actors on the provision side to be assigned new roles in order to realize more energy savings.

KEYWORDS

comfort; heat pump; household energy; performance gap; practice theory; professional practices; space heating

Introduction

From a technical point of view, there is energy-saving potential in substituting direct electric heating with air-to-air source heat pumps, and therefore heat pumps are seen as part of the future energy systems in several countries with colder climates. However, as is apparent with many other energy-efficient technologies, in real life the expected energy savings from heat pumps are not being fully realized. There are a variety of explanations, and several relate to how the heat pumps are integrated into the everyday life of householders.

Different studies have looked for understandings of this performance gap. A Danish study following electricity consumption before and after installation of an air-to-air heat pump concludes that about 20% of the theoretical savings are transformed into higher indoor temperatures (Gram-Hanssen, Christensen, & Petersen, 2012), thereby confirming other studies on the rebound effect in domestic heating (Galvin, 2015; Sorrell, Dimitropoulos, & Sommerville, 2009). This study concludes that, to different degrees, people change their heating practices and start to heat more rooms, increase their indoor temperature, extend the heating season and some also occasionally start to use the heat pump for air-conditioning (Gram-Hanssen et al., 2012). A Norwegian study distinguishes between a temporal rebound (heating for a longer time) and a spatial rebound (heating more space) and shows that this relates to three different types of agency: people's own practical knowledge, expert knowledge – mainly introduced through contact with sales and installation actors – and the embedded script of the heat pump (Winther & Wilhite, 2014). A UK study using qualitative methods to understand the uptake of air-source heat pumps among low-income families concludes that none of those interviewed realized any energy savings, though the majority increased their comfort level (Owen, Mitchell, & Unsworth, 2013). The study proposes that the perceived complexity of the heat pump is a barrier to the use of it, especially for elderly low-income households (Owen et al., 2013). Following this line, another study has worked with improving the delivery service to enable heat pumps to be accepted and used more efficiently by

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using a user-centred design process to improve delivery services (Moore, Haines, & Lilley, 2015).

Together, these studies highlight how the context of the introduction of the heat pump influences how it is integrated into everyday life, and thus to what degree technology adoption is followed by energy savings. They also point at three main aspects relevant for understanding why the heat pump often fails to deliver the expected savings: (1) physical location and integration of the technology into the home; (2) changes in heating practices and comfort expectations; and (3) users' knowledge and competences related to operating the new technology. Furthermore, some of these studies suggest that the role of the installation technician is important for understanding the integration of the heat pump into households' everyday life (Moore et al., 2015; Owen et al., 2013; Winther & Wilhite, 2014).

This interest in the installation of the heat pump, and more broadly the interest in the full supply side of heat pumps, is in line with ideas from earlier consumer studies viewing practices as the meeting point between the provision side and the lifestyles of consumers (Spaargaren & Van Vliet, 2000). More recently, studies within practice theoretical analysis and sustainability have further considered how professional practices contribute to the making of material arrangements, which are then subsequently part of structuring energy consuming everyday practices (Shove & Walker, 2014; Shove, Watson, & Spurling, 2015).

This paper takes a closer look at the supply side of heat pumps, and on how this provision side (*e.g.* the subset of the supply side that is specifically involved with the advice, sale and installation to the customer) influences the integration of heat pumps into residential settings, and thus supplements the existing knowledge on heat pumps, which has mainly focused on the household (everyday life) perspective. The study seeks to contribute to both academic and policy debates. The academic perspective is to contribute to discussions within theories of practice, especially with regard to how to understand different types of materiality and the role of professional practices in establishing this materiality. The policy contribution addresses how to go beyond the promotion of ever more efficient technologies, as this creates issues such as the performance gap. Instead, new ways of dealing with rebound effects can be found by asking what possible roles different actors on the provision side play, or could play, in reducing these effects.

The paper proceeds with an introduction to the theoretical framework of our study, as well as a description of the methods and data collection. Then, building on qualitative interviews and field studies with actors from the heat-pump sector in two Scandinavian countries, Denmark and Norway, the analysis forms the main contribution of the paper. The discussion and conclusion highlight the potential learnings in relation to theory and policy, respectively.

Practice theory, materiality and the provision side

Social science studies of households' energy consumption within the last decade have to a rather high degree relied on a practice–theoretical perspective. The advantage of this perspective is that it focuses on the technology-bound, routinized and collectively shared aspect of households' energy-consuming activities. Rather than viewing consumers as actors deciding individually what to do on the basis of their individual values and attitudes, or focusing on consumers belonging to certain lifestyle groups showing their identity through their consumption, the practice–theory perspective focuses on the collective practices carried by practitioners.[1] There is thus a quite extensive body of research focusing on everyday life and energy-consuming practices (*e.g.* Bartiaux, 2008; Gram-Hanssen, 2011; Hand & Shove, 2007; Hargreaves, 2011; Røpke, Christensen, & Jensen, 2010; Shove & Walker, 2010; Shove, Watson, Hand, & Ingram, 2007; Strengers, 2010) and, common to all these energy-related studies, is that they draw on an approach to practice theory as described by Schatzki (1996).

This paper is interested in how those selling and installing heat pumps in households take part in constructing the practice in the households related to these heat pumps. In a practice–theoretical perspective, a practice is something which is meaningful for the practitioners (Røpke, 2009), which in this case would be the practice of keeping your house warm and comfortable. This practice is constituted by different doings and sayings, such as regulating thermostats and discussing temperatures. Within practice–theoretical energy studies, the prevalent approach has been the framework developed by Shove and co-authors, in which the three elements of materials, competences and meanings hold practices together (Shove, Pantzar, & Watson, 2012). With regard to practices related to heat pumps, these are thus held together by collectively shared meanings of what thermal comfort is, by the technologies (the heat pump), as well as by competences, including instructions about using the heat pump, as provided in manuals or explained by those selling and installing the technologies.

Technologies, or in broader terms the material elements, are especially relevant when it comes to energy consuming practices, and there is thus ongoing debate about how to conceptualize materiality and technology

within practice theory. This debate on the material in practice theory was first initiated by Reckwitz (2002), who proposed integrating Latour's actor–network theories (ANT) into the framework of Schatzki. Schatzki opposes this, explaining that, although what he sees as material arrangements might be similar to the actor–network of Latour, these material arrangements or networks are only one of the two phenomena that make up the social, the other being practices (Schatzki, 2010). Schatzki instead works with materiality as a consequence of practices and part of the context for these practices, and he distinguishes between humans, artefacts, organisms and things of nature, which can all be combined in different types of material arrangements (Schatzki, 2010). Relations between materiality and practices in this approach include that materiality can prefigure practices in certain ways, by making something easier or more obvious. Going from studying practices primarily focusing on single technologies, towards studies that include material arrangements, where the individual technology is seen as part of a larger integration with other types of materiality, such as infrastructures and sources of energy etc., Shove and Walker recently proposed following Schatzki more closely in his understanding of material arrangements and thus make an analytic distinction between material arrangements and practices (Shove & Walker, 2014). The advantages of this are that it becomes possible to see that practices happen, whereas material arrangements exist. This implies that material arrangements can be the context for numerous different practices at the same time, and that the timing of material arrangements, being the results of previous practices and contexts for present and future practices, can better be understood (Shove & Walker, 2014). This view of material arrangements as a result of practices also emphasizes professional practice, that is the provision side, and how this takes part in forming the context of household practices.

When it comes to the notion of competences holding practices together, Shove and co-authors present the interesting idea that competences can be shared between products and practitioners (Shove et al., 2012). For example, some products need skills at a higher level than other products, as shown with do-it-yourself (DIY) practices, where new types of paints and fitting systems for pipes make it easier for householders to do DIY projects (Shove et al., 2007). Similarly, questions of competences in practices related to heat pumps should include understandings of how these competences might vary with different material arrangements of the heat pump.

Practice theory has been used in the study of comfort related to heating and cooling, *i.e.* controlling indoor climate (*e.g.* Hitchings, 2011; Hitchings & Day, 2013; Winther & Wilhite, 2014), and in different ways it has been shown how practices related to indoor comfort are shared among practitioners according to certain expectations, know-how, rules and meanings, but also that the actual performance of the practice might vary among practitioners along the same elements (Gram-Hanssen, 2010). More generally, socio-technical studies have shown that ways of keeping comfortable, and ideas of what residential comfort is, vary with culture (Wilhite, Nakagami, Masuda, Yamaga, & Haneda, 1996), and that norms of comfort have escalated together with the introduction of technical standards for indoor environment and new building types (Shove, 2003). The 'meaning-element' related to the practice of keeping your house warm and comfortable thus relates to social norms of comfort, which can vary over culture and time and that can change together with the introduction of new technologies for heating.

The theoretical interest in this study primarily relates to questions on how the provision-side actors of heat pump technologies take part in establishing the material arrangements of the households' energy consuming practices. In addition, questions on how these provision-side actors may take part in constructing meanings and circulating rules and knowledges among householders are of interest.

Method: qualitative interviews

The present study is part of a broader study on air-to-air heat pumps, which included interviews with both households and the supply side, as well as document readings from newspapers, advertisements etc. mainly in Norway, but also including interviews with the provision side in Denmark (Strandbakken, Heidenstrøm, & Vittersø, 2015). It only deals with the role of the provision side, and analyses the Danish and Norwegian market for heat pumps as a single Scandinavian market, with some differences between the two countries, *e.g.* in climate and infrastructure.

Air-to-air heat pumps are regulated, sold and marketed in quite similar ways in Denmark and Norway. Sales channels include DIY stores, companies specializing in these products, heating, ventilation and air-conditioning (HVAC) dealers, and to some extent electricity companies working together with other dealers. It is a requirement that those installing heat pumps are certified, in both electrical installation and HVAC technologies, and this is part of a policy to ensure quality in the installation of the technologies. DIY stores selling heat pumps thus often cooperate with installation companies. The Danish Energy Authority estimates there are about 50,000 air-to-air heat pumps in Danish

houses,[2] though this figure is debated within the sector itself. Furthermore, the sector estimates that the majority of Danish air-to-air heat pumps are in summerhouses, though there are also some in detached houses previously heated by direct electric heating and situated outside of the district heating grid. In Norway, there are about 1 million heat pumps installed; over 90% are air-to-air pumps. In 2012, 27% of Norwegian households had installed a heat pump.[3] A governmental support scheme from 2003 to 2006 led to rapid market growth and it has continued to grow.

Based on insights into the sales channels of heat pumps, a number of different types of actors were contacted for interviews as well as for field studies during installation. The selection of actors was based on contact with various types of provision-side actors, including companies specialized in selling and installing heat pumps and companies having this as only a minor part of their business. DIY stores and energy companies were also included as they were thought to have another type of contact with households, each in their own way. Importers of heat pumps (especially those with big market shares) were included as they have an important role for decisions on marketing and distribution channels. The trade organization and representatives from the authorities in both countries were interviewed, as they were thought to have relevant insights into how the market works and is regulated. The idea with this selection was thus not to have a representative sample of interviews covering all types of actors in the market, but to obtain as varied information as possible, including many different types of relevant actors, based on an approach of maximum variation in case studies (Flyvbjerg, 2006). All actors approached for interview accepted the invitation, so there is no bias from self-selection. After interviewing, the informants were asked if there were other relevant actors that should be included in the study, and a snowballing approach was thus used to reach a satisfactory number of informants. A summary of the empirical work is provided in Table 1. Altogether, 17 interviews were completed with selected actors, as well as three field studies following an installer during one working day.

Most interviews were done face to face, recorded and transcribed, and afterwards the interviews were coded using NVivo. Two interviews were carried out by phone and one interview with a dealer was very short and not recorded and transcribed, but is included through written notes, as it contained relevant information. All interviews were semi-structured (Kvale, 1996) with a questionnaire guide, which was adjusted to the different types of actors, but was similar across the sample. Interview questions addressed the sales process for the heat pumps and the extent of contact with the households. Questions also covered questions of comfort, knowledge transfer, etc. as well as the market and market regulation. Field studies were reported with field notes and photographs.

Table 1. Overview of the interviews and fieldwork.

Type of actor	Form	Comment	Country
Dealer	Interview with a chief executive officer (CEO) of a company		Denmark
	Interview with a day-to-day manager at a company		Norway
	Interview with a seller at a company		Denmark
	Interview with a department manager at a company	Not recorded and transcribed, only filed notes	Denmark
	Interview with a seller at a company		Denmark
	Interview with a seller at a company		Denmark
Installer	Fieldwork following an installer	Following one service and one installation. Field notes and pictures but no recording	Norway
	Fieldwork following an installer	Following installation	Denmark
	Fieldwork and interview with an installer	Following one service and one installation. Field notes and pictures, but no recording	Norway
Importer	Interview with a CEO of a company		Denmark
	Interview with a CEO of a company and an employee	Two interviewees	Norway
	Interview with a marketing manager		Norway
Producer/supplier	Interview with a product manager	Same person as the one for the trade organization	Denmark
Trade organizations	Interview with a representative of the organization	Same person as the product manager for a company	Denmark
	Interview with representatives of the organization	Two interviewees	Norway
Energy company	Interview with an energy advisor		Denmark
	Interview with an energy advisor	Telephone interview	Norway
	Interview with an energy advisor	Telephone interview	Norway
Authorities	Interview with a project manager		Denmark
	Interview with a department head and an employee	Two interviewees	Norway

Analysis: the provision side's role in integrating heat pumps into homes

The following analysis builds on the theoretical concept of practice theory as developed in the theory section, highlighting the importance of understanding respectively materiality, meaning and competences related to the heat pumps, where the meaning element specifically relates to comfort expectations.

Material integration of the heat pump into the home

As described in the theory, the material arrangement is decisive for the practice and the following will investigate how the provision-side actors and their professional practices take part in establishing the material arrangement in private homes.

According to the different informants, the sales process can be initiated in various ways. Consumers might contact a dealer for a suggestion on what pump to install, and where, or perhaps the consumers themselves have found the heat pump they want on the internet and are looking for someone to install it. Some installers only install products they sell themselves; others cooperate with different dealers, so that whenever a heat pump is sold the deal includes installation with the specific installer. In all cases, it is important that a professional is involved in deciding which pump fits the house best, and the best location for installation in the house.

As emphasized in this interview, the provision side has worked for some time on establishing a common understanding that the installation is important for the function of the product:

> […] I think we have come through with the message, also among the consumers, that it is not only a question of buying a quality product, you have to buy a quality installation as well, because the product will never be better than the installation.
>
> (trade organization representative, Denmark)

This quotation is interesting because it emphasizes that the technology cannot be viewed in isolation from the way it is fitted into the home. Within our sample, the trade organizations are the strongest exponents of this view, together with the authorities. This is also why the authorities and trade organizations in both countries have worked on regulating the market for installation, including different types of certification schemes for installers. Where most other energy-consuming appliances are primarily regulated through a product-oriented policy such as the energy label, in the case of heat pumps this is not sufficient, as the product will perform very differently depending on how it is installed. However, laboratory testing of heat pumps to see whether they perform as their label indicates has also been part of the policy approach. According to the Danish trade organization, the trade organizations and authorities have generally worked together to secure better products on the market because they believe that, as a sector, their reputation will be tarnished if there are too many examples of consumers dissatisfied with the products. In particular, many of the actors in both Norway and Denmark talked about how some years ago many cheap heat pumps were imported and sold with little guidance for customers. They consider that this problem has now largely been solved by regulation, as expressed by the representative from the Danish trade organization:

> I don't think I see anything on the market today that I would call rubbish. Today I would say there are almost only quality products on the market, at least for the 99 percent who dominate the market. Of course there will always be someone who buys a container full of cheap products and tries their luck.
>
> (trade organization representative, Denmark)

However, the technical performance of a heat pump, including energy efficiency, not only depends on technically correct installation. The physical location in the house is also important for how the heat pump performs. The heat pump takes energy from the outside air at a lower temperature and uses this to heat the inside air through a condenser. To perform efficiently, the heat pump needs free space in front of the outside unit and it needs open rooms and easy circulation of the air around the house for the inside cassette. Sale and installation are therefore also about advising the customer about where the heat pump can best be placed. A Danish installer answered the question on whether they always visit the home of the customer to look at the house during the sales process:

> Most often we do. Unless the customer says, 'I want it installed there.' Then we do not need to visit the home to discuss it. We just take it with us in the van […] then, if they want it in a completely unsuitable location, we say to the customer: 'This is not going to work well […] why not place it there […]' simply advising the customer if they have made a wrong decision.
>
> (chief executive officer (CEO) of a sales company, Denmark)

This quotation, and many similar quotations from other interviews, shows how the provision side view themselves as taking an active part in deciding where the heat pump is placed physically, because they are aware of the importance of this for the performance of the technology. In one of the field trips with a Norwegian

installer, however, there was an example of a heat pump placed quite wrongly according to the installer who did the installation. The customer wanted the heat pump installed in a small room used as a children's playroom, and from there the heat was also to circulate to the living room. The installer explained to the interviewer that he thought this would mean that it would get much too hot in the small room and that the heat pump would not be able to heat the living room sufficiently, meaning it would also perform ineffectively. However, the location of the heat pump had already been decided during the sales talk with the manager, so the installer did not want to question this decision and he did not say anything to the customer. The power dynamics between the installer and the sales manager are thus also part of understanding how heat pumps are integrated into homes. This is thus an example of how, for various reasons, an agreement on where to place the heat pump sometimes ends up being a less technically optimal option.

Deciding where to place the heat pump most often includes questions of aesthetics and noise, and, according to the interviews, especially women are not keen on having either the inside or the outside part of the pump visible. In reply to the question of whether they discuss with customers about the visibility of the product and where to place the heat pumps, a seller said:

> Well, they generally want it hidden away as much as possible. But that again can limit the efficiency of the products. But when it comes to the noise, then we are, or at least I am, quite particular on this. We try to get it away from where people are sitting the most […].
> (day-to-day manager at a dealer company, Norway)

It is thus interesting that the efficiency (in the form of the right location) of this technology, which is supposed to provide heating comfort, has to be negotiated against what can be understood as other aspects of comfort, such as visual and acoustic comfort. These ideas of comfort, together with the functioning of the heat pump, also highly relate to how the home is used: where the family usually sit, what doors are open or closed, what activities are going on and where, etc. Questions of what comfort is, and how the home is used, are thus important for where and how the heat pump is physically integrated into the home, and this physical location is important for how efficient the heat pump works.

A discussion of how to understand the materiality of the heat pump in the practice of heating the home therefore has to include the physical integration of the heat pump into the home. The materiality of the heat pump and of the home interact with each other, and in the end it is the combined materiality of home and heat pump that constitutes the material element of the heating practice. The technical design of the heat pump implies that, in a technical perspective, the heat pump is better integrated into the home in certain ways than in others. To some degree, the provision-side actors take part in translating, and thus explaining, this technical design to consumers, and advising them on integrating the heat pump into their homes in certain specific ways. These are negotiated against the householders' ideas of different types of comfort and their everyday lives, including many other different practices going on in the home.

Changes in comfort expectations and norms

Studies of rebound effects highlight how the introduction of efficient technologies is most often followed by higher levels of consumption. For heating technologies specifically, they are followed by higher norms of thermal comfort (Gram-Hanssen et al., 2012). From a practice–theoretical perspective, one would also always expect that changes in the technological element or context of a practice include a change in the practice as such. The following analysis focuses on what role the provision-side actors have in this process of households changing norms of comfort when getting a new heat pump.

From the heat pump trade organization in the two countries, and from several of the sellers, importers and installers, there is focus on the question of whether the heat pumps actually deliver savings and on how they, as providers of the technology, should act in relation to this question. The representative from the Danish Trade organization explains that:

> […] I put an effort into saying that you should always inform the customers that we talk about the *now*-situation. If you change habits, and people often do that. […] It could be an old couple living in a house with direct electric heating, and believe me they can keep the temperature down. […] but then they say, 'now I save 60 percent so I can turn up the heating and don't have to suffer anymore', and that eats into the savings.
> (trade organization representative, Denmark)

What is expressed here is that the trade organization advises its members not to promise customers too high financial savings, as they know that such savings are not always realized, because the customers might decide to have a more comfortable heating level. It is like the trade organization advising its members to make a disclaimer by not promising any savings and thereby making sure that customers are not dissatisfied. The question is, however, whether, by taking this stand, the provision side can also be seen as taking part in normalizing the use of heat pumps to gain higher comfort rather than energy savings.

Other quotations from the actors who sell heat pumps support this picture of sales people formulating what they think is normally happening in the homes, and thus, without necessarily being aware of it, they may also be taking part in constructing this norm. For example, the authors consider that the following quotations by two different sellers in Norway indicate that the respondents believe that it is almost a matter of course that consumers will realize higher comfort, rather than energy savings:

> We are always quite careful not to promise the customer savings which can be significant to their family economy. Because often they compensate […] if they had 18 degrees before, then they have 21 degrees after they get the pump.
>
> (energy advisor in an energy company, Norway)

> They [the customers] may think that they will save lots of money, however, I try to be informative. I tell them: 'you will most likely experience better comfort in your home. Whether you also save money – that is not for sure'.
>
> (daily leader in a dealer company, Norway)

This is not necessarily implying that consumers actually act as the provision side expect, although it illustrates how these actors circulate norms of what to do with this technology and thus, possibly, to some degree reflect and influence what happens in the homes.

This analysis points towards the provision side and the technology as taking part in establishing user practices and comfort norms in daily life. This is not necessarily in accordance with how the provision side sees itself. A Norwegian importer indirectly deals with this question when he is asked whether there are any myths about heat pumps:

> Yes there is this myth about the heat pumps not saving energy. Many say, 'Hey, I have got this heat pump and now my electricity bill has actually gone up.' I reply, 'Yes, that is a claim you have, but let's talk about it. How did you heat before, did you use a wood stove? […] have you got a higher temperature now? […] do you heat up more rooms now? […] do you heat up all the time or only as before when you used the woodstove? […].' Then I say, 'There's your answer. You have changed your behaviour. The product delivers exactly as we promised, and I can come and check this for you. However, you have decided to change this saving into increased comfort, and I cannot do anything about it. That is your choice.' So it might be about informing more about this, so they do not blame it on the heat pump. The heat pump technology is great for the environment; however, consumer attitudes around this might be discussed.
>
> (marketing manager in an import company, Norway)

In this quotation, and in several of the other interviews, there is a tendency to claim that the technology is efficient in itself and that the problem is the way the technology is used. Thus, indirectly, the use is claimed not to be related to the technology. Following the ideas of how technologies contribute to establishing practices, and that meanings and know-how are shared among actors, this idea of distinguishing between the technology and the use of it is inappropriate. As described above, most of the interviewed actors also express that most households actually do use the heat pump in identical ways, which includes getting more comfort rather than savings, thus they indirectly acknowledge how the technology prescribes certain uses rather than other uses.

The concept of comfort seems to be very important when discussing whether heat pumps deliver savings. The meaning of the concept might, however, vary and also relate to questions of convenience. In Norway, the heat pump often substitutes for a wood stove, so comfort can be about having a high temperature in the house when the household wakes up in the morning and when they come home from work, which is difficult to achieve with wood stoves. In Denmark, many heat pumps are installed in summer houses, where comfort can be about keeping a higher temperature in the house all year round to prevent mould and smell in the house and furniture, and being able to control the heating at a distance to make the house nice and warm upon arrival. Some aspects of changed heating practices are thus dependent on the different material and infrastructural settings in the two countries and how the heat pumps are brought into this, whereas other aspects are the same: keeping a higher temperature, heating more rooms and heating for longer periods of time etc. Furthermore, the heat pump also delivers some other aspects related to comfort, like cleaning the indoor air and cooling in summertime. Whether this is perceived as additional for the consumer when buying the product, or whether it is seen as a main driver, varies among the perceptions of the interviewees. Furthermore, most of the sellers say that they experience that customers, most often women, who were sceptical about the acoustics and aesthetics of the heat pump during the sales situation often become very satisfied with the pumps in time because of the indoor air quality and the distribution of heat in the rooms. That customers are usually very satisfied with their heat pumps is also confirmed in various interviews with householders (Gram-Hanssen et al., 2012; Strandbakken et al., 2015). The drawbacks of aesthetics and noise are thus most often not considered as persistent problems compared with the gains in thermal comfort related to the heated and circulated air. Ideas of what aspects of comfort are the most important can thus change when a new technology is integrated into everyday life.

Competences related to operating the new technology

Integration of the heat pump into the everyday life of households includes controlling the heat pump, whether this is done by leaving it on an automatic setting or changing the settings. This may relate to the comfort norms and expectations as described above, but it may also be about technical knowledge and understanding among the consumers. It is thus relevant to know more about the role of the provision side in how this knowledge and understanding is established, as well as how the different types of actors view their role in this.

As emphasized by the Norwegian trade organization, it can be in the interest of the sector to ensure that people know how to use their new heat pump, but this does not imply that it always happens:

> I do not think there is anything wrong about those who sell the heat pumps, it is just that they do not reflect upon that they have to invest a little time with their customers. [Name of one of the importers of heat pumps] are better I think […] but they have many sales courses, where they try to teach the installers that they have to think about selling more. They also have an 'Instructions for Installers' where they write very clearly that they should use time during installation to make sure the customers understand the heat pump, and ideally they should come back a few days later to see if everything is fine. And this is about selling more. So you can sell to their neighbours and you have satisfied customers.
>
> (trade organization representative, Norway)

Allowing the installer time to introduce the heat pump to the customer might be seen as an ideal, but, as seen in our data, it does not always actually happen. Maybe this reflects that sales people and organizations are aware of the importance of satisfied customers, whereas the installers are more focused on technically correct installation, or they do not have time for long explanations in a busy working life. Most of the interviewed actors acknowledge that they need to provide the customer with some type of guidance, though some of them leave it more to the customer to try things out:

> Interviewer: What type of use do you recommend then?
> Dealer: Well it varies from house to house, so the customer must try it out themselves. We put up a standard setting, and tell them that they have to see how it works and try to change it themselves afterwards. […] we have this quick-start leaflet from the distributer, so we give this to them. (daily leader in a dealer company, Norway)

In one of the Norwegian installations studied, there is an example of what might happen when the information for the customer should have been provided. In this case, the householders were not at home during the last part of the installation, and the installer had to leave the house without giving any information to the customer. This also raises the question of whether it is actually the responsibility of the provision side to provide customers with guidance:

> We know that the product we provide can do the job, so it is up to the customers to familiarize themselves with the product. If you choose not to do that, or if you do not have the capacity to do that, well that is a pity […] but if you are not willing to do that, to learn how it works, then I do not feel […] in a way it is not our […] and we know they are happy anyway. Well that is what we hear, they are happy with the way they use it, and even though it is not the most optimal, that they could get more out of it, but then they have to show some interest. I don't think we are to be blamed.
>
> (CEO of an import company, Norway)

Questions about responsibility and necessity to guide the customer on the use of the heat pump relate to how complicated or easy the pump is to use. Following the theoretical discussion on competences and know-how as shared between user and technology, the situation can be seen as a combination of the heat pump and the user together performing the practice of heating the house. Thus, competences may be part of the practice of heating, and not something the customer alone has to a higher or a lower degree. Following previous discussions, the technology, or the material element, should be viewed as the heat pump and the home in integration. This means that the question of how easy or complicated it is to use the heat pump varies with this material integration. In most cases, it is recommended that the heat pump supplements other heating sources such as direct electric heating and wood stoves and, as illustrated in the following quotation, this also influences questions of how complicated it is to regulate the heat pump:

> […] you have a heat pump and you have direct electric heating, and maybe you have a wood stove. And you have to control these things so that the direct electric heating has a lower setting than the heat pump. The heat pump should be utilized to a maximum before the electric heating is turned on. Because, if both the heat pump and the electric heating are set on 22 degrees then they are competing all the time. And maybe the direct electric heating is on too much of the time and does the job which the heat pump could have done. And this also makes it difficult to answer the question of whether it is efficient to lower temperatures at night or not.
>
> (trade organization representative, Norway)

Material integration of the heat pump thus not only depends on the structure of the house but also on other heating sources that are part of it. Furthermore,

as seen in the following quotations, the material integration of the heat pump also includes the outdoor temperature and thus the climatic conditions at the location of the house. The following quotations deal with whether the heat pump should be turned off when it is below –10°C outside, and the interviewed professionals do not actually agree on this:

> Many people say, 'Heat pumps are good, but they do not work with lower temperatures. If it is a bit colder than –10[°C], then you should turn them off, and it is better with direct electric heating.' And many of these kinds of myths […] that we have tried to go against, and we say, 'Yes they work even if it is cold. It is much better to use the heat pump, even if it is –20[°C] outside.'
> (marketing manager in an importing company, Norway)

> What is needed is information and retailers who inform. And who are honest. I know that they want them to work down to –25[°C], and they are very happy to advertise about this, but if they were just more honest and said that below, let's say –10[°C], but this varies, then the de-icing starts to use electricity, and it has to be calculated into the electricity that the heat pump uses […] so below this it is more economical to use the direct electric heating.
> (authorities' representative, Norway)

Heat pumps can be easy or complicated to use, and to a high degree this depends on the material integration of the heat pump, including the house, other heating sources and the outdoors. Following the ideas of competences being distributed between products and practitioners, it can be said that the argument on to what degree the customer has the capacity to understand the technology, as expressed by the CEO of a Norwegian import company above, is a too simple way to frame things. Competences should rather be seen as shared between the households and the material arrangements of the heat pump, including the house and its other heating sources, as well as the outdoor climate. As emphasized by many actors, householders are happy with their heat pumps, but maybe the pump is not running most efficiently, and, depending on the material integration of the heat pump, the practice related to running the heat pump can also be a more or less complicated practice.

Discussion of theoretical implications

As shown through this analysis, to understand the rebound effect or performance gap related to installation and use of heat pumps, it is important to focus not just on the heat pump itself but also on the integration of the heat pump into the broader material arrangement, including the layout of the house, other heating sources in the house and related infrastructures, as well as outdoor climate related to the geographical location of the house. This study is thus in line with other recent studies within practice theory and energy consumption emphasizing material arrangements, rather than single technologies, when understanding the performance of energy-consuming practices (Shove & Walker, 2014), and also including, for example, climate as part of this arrangement (Schatzki, 2010).

Furthermore the analysis shows how the provision side has an active part in constructing this material integration, and thus confirms that the study of professional practices may bring important knowledge into understanding how the material arrangements come to be as they are (Shove et al., 2015). It is thus 'vital to remember that material arrangements are themselves made, reproduced and transformed through, and as part of, happening practices' (Shove & Walker, 2014, p. 51). Further studies on heat pumps could thus also look deeper into understanding these professional practices and, for example, the relations between different types of provision actors in performing practices of establishing material arrangements, as this has not been investigated in depth in this study.

In the case of the heat pump, it is especially interesting how the material integration is negotiated between, on the one hand, households, with their understandings of home and ideas of comfort related to indoor temperature, aesthetics and noise, and, on the other hand, the provision side, with their understanding of the technical requirements of the heat pump. Following these negotiations, the study also points at how the provision-side actors actively take part in circulating ideas of what comfort might mean in relation to the heat pump. Where other studies of comfort have focused on cultural differences in comfort (Wilhite et al., 1996), or shared conventions of comfort (Hitchings & Day, 2013), and how technical standards take part in shaping expectations of comfort (Shove, 2003), this study adds further knowledge about how provision-side actors contribute towards normalizing the heat pump as an element in the escalation of comfort norms related to heating. Furthermore, the study suggests that the introduction of the heat pump also takes part in constructing the perception among householders that heating comfort is more relevant compared with aesthetics and noise.

Seeing the heat pump as part of a material arrangement rather than as a single device also has implications in relation to competences and complexity related to the heat pump. Where the provision-side actors primarily talk about competences as something which the customer has to a higher or a lower degree, a theoretical contribution suggests that competences in the performance

of practices are shared between materials and practitioners (Shove et al., 2007). In the case of the heat pump, this also helps one to understand that the complexity of a heat pump can vary, depending on the specific material integration, in which, perhaps, the heat pump is to work with other heating devices, and depending on the actual use of the home and the outdoor climate. Depending on the competences and meanings associated with the practice of heating with a heat pump, households can either leave the heat pump on an automatic setting or try to regulate it to make it perform with lower energy use. If the heat pump is left to run on automatic after installation, the question of how to view materials in practice also becomes more pressing: Should the material arrangement then be viewed as a context for the practices performed by humans, even if the humans do not actually perform the practice? This case thus points towards an approach where material arrangements are rather seen as co-performers of practices.

Conclusions and policy implications

This paper has addressed how the provision side takes part in constructing the material integration of air-to-air heat pumps in homes, and how it contributes to circulating norms and competences related to the use of this heating technology. The practice–theoretical perspective in the analysis has thus contributed to raise new types of questions related to performance gaps and rebound effects related to the use of heat pumps by emphasizing the collectively shared aspects of household practices and the role of professional practices in constructing household practices. The theoretical discussion emphasizes that the heat pump should not be seen in isolation, but rather as part of a material arrangement including the location in the house and its relation to other heating sources etc. Following this, competences related to the use of the heat pump should not only be viewed as something the individual consumers can possess, or acquire, through different types of communication, rather these competences should be seen as something shared between the material arrangements of the heat pumps and households more generally.

The interviews reveal how authorities, together with, for example, trade organizations, have worked to secure higher quality in products and installation to secure energy efficiency. Within the sector, it is also widely agreed that the actual location of the heat pump in the house, as well as how the customer uses it, is important for how the heat pump performs, although so far there have not been any attempts to influence this through regulation or policy. Those involved in sales and installation for the most part express that they advise their customers about where to place the heat pump and also, to some extent, on how to use it, although they also express generally that in the end it is the customers' responsibility. The provision side cannot be seen as having any moral or social responsibility other than providing heat pumps and earning a living, and in a competitive market, discussion on location and providing detailed handover advice potentially detracts from immediate earnings. However, seen from a policy perspective, it might be relevant to include the provision side, and enhance their possible role.

In both Denmark and Norway there are some forms of financial support schemes for households installing energy-efficient technologies like heat pumps, therefore it might also be relevant to address location and use of the technologies in these schemes. Here, the sales and installation situations seem to be the obvious meeting points at which professional knowledge and household practices can be exchanged and combined to decide where to place the pump and to circulate knowledge on how to regulate it. This already happens to some degree, but it is not systematic, and it highly depends on the individual installer and seller. These professionals share an interest in ensuring satisfied customers and thus partly regard it as part of their job to advise and inform the customers, although they decide themselves how much to focus on it, rather than it being part of a regulatory framework. In this regard, potential policy suggestions could be that the authorities and the heat pump sector together focus more on how energy efficient use of heat pumps can be introduced to households by the provision side, and how communication and dialogue with customers can be included in the certification courses for installers. Furthermore, different forms of written and digital communication, co-produced by the sector and the authorities, could help influence practices related to the use of heat pumps, although it is acknowledged that information cannot stand alone.

Another policy perspective, in which there are fewer common interests with the commercial sector, deals with the question of how norms of comfort develop towards still higher expectations. As shown in this paper, the provision side of heat pumps can actually be seen as contributing to constructing consumers' increasing expectations of comfort, and furthermore it is shown that they also have an interest in this, as comfort can be a better sales argument than energy savings. Thus, it is important to start debating how policy can deal with the issue of ever-higher expectations of comfort, and part of this debate is probably also to realize that the provision side does not share an interest in this regard.

Notes

1. For further explication of the difference between practice theory, behaviour and lifestyle approaches to energy consumption, see Gram-Hanssen (2014).
2. See http://www.ens.dk/undergrund-forsyning/vedvarende-energi/varmepumper/.
3. See http://ssb.no/husenergi/.

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