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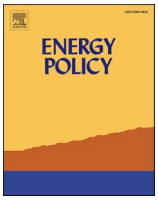

Don't extinguish my fire – Understanding public resistance to a Swedish policy aimed at reducing particle emissions by phasing out old wood stoves

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ABSTRACT

Wood stoves emit particulate matter when used for domestic heating. Consequently, the National Board of Housing, Building and Planning in Sweden enforced a prohibition of new installations of old wood stoves in 2017 to protect the public health. The prohibition caused a public backlash that organized itself as a "wood stove rising", eventually leading to a cancellation of the new legislation in 2019. We performed comprehensive interviews with 11 signatories of the original appeal to analyze the underlying motives for combating the implementation of this pro-environmental energy policy. We find that domestic heating through fire-making is an age-old human behavior that is deeply connected to several social and emotional human needs, but also to survival in remote areas with cold climate. The likelihood of policy observance and acceptance is higher if the policy is not perceived as being in direct conflict with these needs: basic emotion regulation, sensations of tradition and connection to other people, and means of crisis management for the individual. We also find that the protesters acted out of a sustainability perspective, albeit one where the continued use of functional devices was valued more than the perceived wear-and-tear of replacing outdated technology.

1. Introduction

Why, when, how, and how much should an old energy technology be phased out in favor of a new technology regarded as better for the environment and human health? This important question is relevant for decision makers, product developers and policy development globally, nationally and locally, in several different areas (e.g., transportation and domestic heating). Here, we shall attempt to shine light on this question via analysis of a failed attempt at introducing tighter emission regulations to phase out old wood stoves in Sweden, where the more stringent rules introduced in 2017 were eventually discarded in 2019 due to public resistance (Boverket, 2019; SVT Nyheter, 2019).

The challenges involved in designing policies for technology transitions are complex and multifaceted (Toman and Withagen, 2000; Kemp and Pontoglio, 2011), as energy use is part of a larger system on a societal level (e.g., Johnstone and Hielscher, 2017). Furthermore, technologies such as wood stoves and other domestic heating devices are also a part of a lifestyle including human behaviors, beliefs, and emotions in people's private domain. Emotional motives have previously been identified as an influential driver in domestic fireplace use (Hine et al., 2007; Bhullar et al., 2014; Boso et al., 2018; Karlsson et al., 2020), and a need for more in-depth understanding of the roles played by conflicts of interest and impeding conditions in large-scale diffusion of clean technological innovations has been identified (Bossink, 2015, 2017; Frishammar et al., 2015).

1.1. Psychological strive for balance

The strive for psychological and bodily balance is a crucial common human motivator all over the world (Montgomery and Ritchey, 2010), acting both helpful for survival, and contributing to unhealthy habits, resistance, and prejudice (Craig, 2003; Neuberg et al., 2011). It is known that people may form affective bonds to objects, e.g., devices for domestic heating such as wood stoves. These affective bonds can include positive emotions such as joy and harmony and usefulness in daily life (e.g., Karlsson et al., 2020). Objects can also bring joy by helping people to recall memories and be crucial to preserve a sense of identity (Stevens et al., 2019; Yapy and Grisham, 2019). A product such as the wood stove can, in addition, be part of a setting that includes cultural traditions and social habits that makes people feel good and connected to other people

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(Petersen, 2008) and to nature (Karlsson et al., 2020). However, people can also form affective bonds to objects to compensate for loneliness and the perceived unreliability of others (Keefer et al., 2012). In addition, traumatic events can also cause people to cling on to things in an extreme way, and this reaction may often be associated with feelings of anger and hostility (Mathes et al., 2018).

1.2. Circularity versus cleantech

A technology shift, suggesting that old but functioning technology should be less used or even recycled or put to waste, may clash with lifestyles aiming to reduce and reuse products and the perception of being a caring, informed and moral consumer (Bohlin, 2019). The three R:s used within the so-called waste hierarchy (to *reduce*, *reuse* and *recycle* instead of wasting), are also frequently communicated as means to reduce emissions and save the environment. If the reused product is less expensive than the successor, environmental values may also be associated with economic underpinnings. People may prefer an old technology because it is less costly for them, or they simply cannot afford a new one, and prohibiting the old one may make it impossible for some groups to achieve the main function of the product. In addition, the psychological concept of *sunk cost* (Arkes and Blumer, 1985) refers to that people are less willing to let go of objects they have invested much effort in. Investments in old wood stoves may be associated with effort in many ways; it is a product that takes a lot of resources to manufacture in terms of handicraft and raw material, and it is quite big and takes a lot of effort to get into place. In addition, the product itself is also intimately related to actions associated with effort, e.g., carrying wood to the stove, tending a fire, regular cleaning etc. Thus, the sunk cost for disposing or recycling a functioning old wood stove may be considered high and the perception of waste large. From a psychological perspective it can be relevant to talk about *perceived waste*.

1.3. Particle reducing policies in Europe

The idea that waste is a variable term, that must be understood and defined in its context, is supported by the long and detailed description separating waste from non-waste in the European Waste Framework Directive (Directive 2008/98/EC, 2008). Common sense also indicates that the perception of waste is a matter of degree and proportion in its context (cf. e.g., OECD, 2008; Thürer et al., 2017; GA Circular, 2019). In Northern Europe and many other temperate regions, the use of domestic fireplaces is popular (Karlsson et al., 2020). It is nowadays, however, established that combustion of wood fuels emits particles that are problematic for both human health (Danielsen et al., 2009; Johnston et al., 2013; Stern, 2014; Nielsen et al., 2017) and the environment (Nielsen et al., 2017; Blanchette and Richards, 2010; Bond et al., 2013). Actions have therefore been taken to reduce the particulate emissions from domestic wood combustion. More specifically, old wood stoves are generally emitting more particulates than modern stoves (Tissari, 2008; Bäfver et al., 2011; Olsen et al., 2020), which indicates potential health benefits from a phasing out of older stoves.

1.4. The Swedish "wood stove rising"

In Sweden, in 2017, the National Board of Housing, Building and Planning in Sweden (*Boverket* in Swedish) enforced an effective prohibition of new installations of old wood stoves, to protect the public health by decreasing particulate emissions from old stoves (Boverket, 2019). The new legislation was also intended to harmonize national Swedish regulations with current regulations on the EU level. The prohibition meant that CO emission and efficiency performance limits were sharpened for fireplace heating stoves, kitchen boilers, inset stoves and pellet-fueled stoves, and that such limits were for the first time also enforced for kitchen stoves (cf. Table 1). There were no regulations for particulate matter or organic gaseous carbon (OGC), as the existing standards under the European CPR directive only contained assessment methods for CO (EU, 2011). Nevertheless, the new regulations implied in effect that older wood stoves could not be installed in new or modified buildings. The regulations had no effect whatsoever for already installed wood stoves in existing houses. Additional details on the 2017 regulations are provided in Appendix A.

Table 1
Swedish emission regulations before and after the 2017 update (Boverket, 2017).

Device type	CO emissions, before [vol-% (max) in dry gas at 13% O_2]	CO emissions, after [vol-% (max) in dry gas at 13% O_2]	Efficiency at nominal load, before [% (min)]	Efficiency at nominal load, after [% (min)]
Fireplace heating stove	0,3	0,12	60 (recommendation)	65 (requirement)
Pellet stove	0,04	0,024	70 (recommendation)	79 (requirement)
Kitchen boiler	0,3	0,12	–	65 (requirement)
Kitchen stove	–	0,12	–	65 (requirement)
Inset stove	0,3	0,12	50 (recommendation)	65 (requirement)

The prohibition soon resulted in massive protests (Vedspisupproret, 2019), especially from people living in remote rural areas, and resulted in the so-called Swedish "wood stove rising" (cf. Appendix B). The outrage made the Swedish parliament commission the government to investigate the effects of the new regulations on several issues, such as the cultural-historical values and the state of crisis preparedness (Boverket, 2019). This investigation eventually led to the cancellation of the new regulations in 2019, because "the number of wood stoves concerned is not that high" and thus the administrative costs incurred would outweigh the relatively miniscule positive health effects attained (Boverket, 2019). The cancellation was largely portrayed as a victory for the wood stove rising in Swedish media (SVT Nyheter, 2019; Vedspisupproret, 2021). Nevertheless, the implementation of more stringent emission performance limits for *new* wood stoves starting in 2022 (in accordance with the EU Eco Design directive) remains unaffected by this cancellation, and the wood stove rising community has therefore continued to exist until this day (Vedspisupproret, 2021).

In this context, it should be pointed out that there is awareness about the health issues associated with particulate matter from wood combustion in the Swedish population, although the toxic effects of wood smoke have been somewhat downplayed previously (Kjällstrand and Petersson, 2001; Kjällstrand et al., 2003). In a study from 1997, the local prevalence of annoyance related to air pollution in 55 Swedish towns and cities did not correlate significantly with black smoke (Forsberg et al., 1997). Since then, the general population exposure in urban populations have been reduced for PM_{10} (Olstrup et al., 2018). Typical local contributions of $PM_{2.5}$ from wood burning are one or a few μg/m3 during wintertime in Sweden, but despite these moderate levels, self-reported annoyance due to wood smoke was more pronounced and common among residents in wood-burning areas compared to the general Swedish population (Almerud et al., 2013).

1.5. Why is a Swedish wood stove rising interesting for energy policy?

A policy-induced energy-technology shift may, as it did in the Swedish wood stove rising, trigger at least part of the previously discussed common human emotional responses, especially if it is understood to concern the private zone. Knowledge and understanding of the psychological driving forces behind such resistance may facilitate observance and can therefore contribute to more efficient policy

development. When researching the wood stove rising, we found that the driving forces may be described in universal terms, that should apply to a wide range of other situations as well.

The term *change resistance* has traditionally been used, in the meaning that people often are reluctant to change and prefer what is old and known. Cognitive psychology suggesting that people choose familiar things before unknown products are in line with that reasoning (Gigerenzer and Goldstein, 2011), and so are our findings. However, our approach goes a bit further by researching the psychology behind *why* people may prefer the old solutions.

1.6. The present study

The driving forces we found behind the Swedish wood stove rising where multifaceted and, apart from emotional and bodily balance, also other factors common to humanity all over the world were mentioned: social cohesion, ancestors, affordability, and survival in times of short- or long-term crisis. The overall aim of this study was to better understand the emotional underpinnings of the Swedish wood stove rising in particular and domestic fire-making in general. We will report and discuss the wood stove case and its implications for policy development, with a particular focus on resistance towards technology shifts.

2. Methodology

2.1. Participants

The result presented below is based on 11 participants, 7 women and 4 men, with a mean age of 47 years (range: 26–69). Participants were recruited from the official name-list of signatories of the Swedish wood stove rising appeal (Vedspisupproret, 2019). Randomly chosen names on the list were contacted via phone. In total 20 participants answered yes to participation and were interviewed. Out of these 20, eleven participants were selected for further analysis based on that they had 1) a wood stove of their own, 2) a rural lifestyle, and 3) they were able to talk to the interviewer on the phone for more than 20 min. All participants lived in Sweden and interviews were performed in Swedish. When cited, participants are henceforth referred to as participant A1 … A11 (Table 2).

2.2. Ethics

The present study follows ethical guidelines in Sweden for survey data. Before participating in the study, the participants were informed about the purpose of the study, their rights to end at any time and that participation was voluntary. Participants gave their consent by answering yes to participation before the telephone recording.

2.3. Procedure

Data collection was made by semi-structured interviews based on an interview guide (Appendix C). The interview guide was divided in three sections: 1) introduction, 2) core questions, and 3) ending.

Table 2
Overview of participants.

Participant ID	Gender	Age	Occupation
A1	Woman	40	Teacher
A2	Woman	53	Administrator
A3	Woman	50	Person on disability pension/Farmer
A4	Man	29	Electrician
A5	Man	31	Construction engineer
A6	Woman	44	Goat farmer/Economist
A7	Woman	69	Retired
A8	Man	56	Farmer
A9	Woman	43	Receptionist/Farmer
A10	Woman	45	Horse-farmer
A11	Man	62	Social worker

2.4. Analysis

A thematic analysis was made based on Braun and Clarke (2006) using the software Nvivo. The coding was inductive, which means that the material should speak for itself with no pre-understanding and without any specific theory. In line with Braun and Clarke (2006) the analysis was made in six phases. In the first phase, the material was read several times and notes were made of suitable quotes in the function "memos" in the Nvivo software. A subset of these quotes is reported below to illustrate the themes. The second phase consisted of coding where the least meaning-carrying segment of the text was coded (e.g., "A fire provides a calming feeling" was coded as "calm"). The third phase consisted of a grouping of the codes with similar content. This phase implied the formation of clusters and notes from step one were merged into themes. In the fourth phase, themes where named and sub-themes created (cf. Table 3). The fifth phase was devoted to fine-tuning identifying overlaps and borders between themes to achieve more accentuated themes. The sixth phase consisted of writing the results in text.

3. Results

The main purpose of the study was to illustrate motives for and emotions associated with fire-making in a domestic wood stove, to enable linking of such motives to the engagement against the new emission legislation for wood stoves. Quotes from the interviews to provide more depth are provided in Appendix D.

A general result was that all participants, except participant A9, were positive towards fire-making and perceived the fire to provide positive health effects and a natural feeling. When asked about this feeling, some participants had a hard time expressing exactly what they felt, but feelings like harmony and togetherness were reported. The fire was also seen as an everyday practicality and security when global support and security is lacking.

3.1. Feelings associated with fire

Mainly positive emotions were expressed in association with fire. A few persons answered the stomach or the chest when trying to locate the feeling in their own body.

The fire creates togetherness when people gather around it, and it can be seen as a hub for unpretentious social gatherings. The fairytale of Hensel and Gretchen was used as an example of a horrible picture of the drawbacks of fire. To be thrown in fire like the children in the story were, according to participant A9, a way to describe her own fear of fire. Even nightmares of being chased by fire were mentioned. Another perspective was having respect for the power of fire. Participant A8 meant that firing was not romantic but an everyday occupation that is taken for granted.

3.1.1. Harmony

In general, the view of positive emotion and fire eliciting meditative, calming, and harmonic feelings was present for all participants except A9 who described fear of fire. Through viewing the fire, it was possible to let go of other thoughts, and a stabilizing peaceful and grounding

Table 3
Description of the four themes that were elicited from the interviews.

Main theme	Sub-theme
Feelings in association with fire	Harmony, warmth, soothing security
Origin	Tradition, quality, natural
Survival	Crisis management
Environmental impact	Environmental engagement

state could be reached. Often peaceful thoughts appeared as if the brain rests for a while when viewing fire. Participant A2 had similar experiences from flowing water: the movements of fire that appear were associated to symbols and pieces of art. The fire was soothing and calming and associated with a special kind of harmony that may best be described as a kind of peaceful presence (cf., Kabat-Zinn, 2005). Gazing into a fire can be hypnotic both in the stove at home or in the woods. The fire spreads a calming feeling of relief from stress. A fascination for fire is described; being able to stir around in fire and ember, being able to make fire was a process that created harmony.

3.1.2. The soothing feeling of security

Wellbeing and a soothing feeling of security is mentioned several times. *"I guess it is not more than that, or it can be just everything"* (A6) is one way to describe it, like a part of the soul. It was accentuated, in a life-giving active way, that fire is homely. For other participants, the fire created a secure environment. The feeling associated with fire was explained with words like calmness, security, and peacefulness, and these explanations were made with a tone of reverence, providing the fire with a state of honor. Security is the feeling that emerges when viewing into a fire. Participant A3 associated this with that we have used fire for protection from predators, and to provide warmth and the possibility to cook. The meaning of fire was incorporated into people like a collective consciousness. That "fire is cozy" was also frequently stated when trying to explain feelings associated with fire.

3.1.3. The warmth of a fire

Participants also mention the warmth spreading by the fireside. They describe the warmth from different perspectives, how nice it is to heat up a cold cottage with a fire in the stove. To feel the warmth in the body is another important factor, a feeling of coming in from the cold and to be enfolded in the warming fire enclosure. The warmth from the fire is described as another type of heat than coming from e.g., electricity. Heat from fire is perceived as more comfortable and deeper, a "warmer heat" says A4 and A3: *"You get warm inside"*. A saying that was used was "wood warms many times", that is: also the process of taking care of firewood, from the forest to the firewood basket, is associated with positive, warming experiences (A3). The word warmth was frequently used to describe fire. Here, participants use the word warmth to describe physical heat but also a spiritual warmth.

3.2. Origin

Firing wood was associated with being connected to one's origins. Historically, taming fire is part of all cultures. A continent-crossing perspective on the perception of fire was formulated by Participant A2. Fire, being a part of the national parks in Tanzania, was a gathering place for people providing an enhanced perception of the surroundings. Fire is also described as a focal point for socialization within the family. Participant A8 meant that it is nice to light a fire in the tiled stove on a Friday or Saturday night while enjoying a whisky. The open fireplace was an alternative to the TV (A8) and the firing gave association to concepts like "closer". The fire is also described to be a part of the house. Older rural houses are built with a fireplace as primary heat source, and one participant told that in her kitchen there used to be an integrated device for smoking meat and fish in the wall (A3). When rebuilding the house, this wall was removed due to risk of fire. Fire behavior is described like a part of life itself, like a tapestry where the element of fire is a natural part of something bigger.

Memories from childhood are also associated with the wood stove. Traces of solemn nostalgia shine through stories formulated by participants: e.g., in ice-cold winters, putting frozen feet in front of the fire, description of a nice warmth spreading through the body. Sitting and warming fingers by the fireside, and the sounds and smells from the crackling fire providing an emotional warmth. The firewood handling is also described in terms of how nice it is to collect firewood from the woodshed in a classical wooden basket. The firewood handling also has to do with a larger context including drying, chopping, and stapling (A4). Making a fire in the wood stove is however not limited only to cozy occasions. In contrast to the feeling of coziness, Participant A9 spoke about fire-making for heating as handling large pieces of wood in a boiler. This accentuates that it can also be an unpleasant experience based on the respect of fire.

3.2.1. Tradition

The feelings associated with fire also seem to be ones of tradition, a sense of time travel or a taste of our ancestors' lives. The fire and the wood stoves are described as a legacy from ancestors that should be preserved. The fire itself has provided possibilities for a good life during a long period in history. Comments suggest that there is a kind of belonging to the history. Fire has a strong tradition, not only in our culture but in all human civilizations around earth. Participant A6 meant that making a fire is something that has been always there and that will continue to exist, therefore being intimately connected to "the wings of time". There is a craze for the old traditions, such as to cook on a wood stove, because it is tradition and because it is a cultural expression worthy of preservation.

3.2.2. Quality

The solid material in older stoves was highlighted and perceived to be of good quality. The mere construction material in the wood stove was considered an important advantage with the older stoves. They are made to last for long, to sustain. Older houses are aesthetically compatible with older stoves and fireplaces, contributing to charm with the older stoves in buildings typical for their time and it is suggested that the modern stoves are "inscrutably ugly". The classical old stoves are described as cultural monuments not always represented primarily as a heat source. There can also be other applications for an older wood stove, e.g., the possibility to cook and boil water. Some participants would choose a modern variant of wood stoves while others on the contrary don't want to replace the old ones and see no gain with that.

Economic motives were involved in the decision of buying a wood stove. Limited resources contributed to why some participants thought it was not possible to buy a modern stove. Participants also suggested that fire-making is an economical alternative for people having access to firewood of their own forest.

3.2.3. Natural

Sweden is, especially at wintertime, a cold country and it is considered natural to have the fire as a source of heating. Naturalness is referred to, something that is like mere life, like breathing, a basis that has always been there. Fire-making is a way of living.

3.3. Survival

"Human survival" is a term that shows the meaning that fire and wood stoves has for the participants in the current context. Based on a brochure from the Swedish Civil Contingencies Agency (*Myndigheten för samhällsskydd och beredskap* in Swedish) (Myndigheten för samhällsskydd och beredskap, 2019), participants show ambivalence around what they experience as double messages: prepare for a crisis, at the same time as they should not be able to install an old wood stove (A8). The equation is considered strange. Participants living the north of Sweden are clear that wood stoves are a basis for survival there.

The thought that large cities are prioritized before rural areas in times of crisis is also present in the participants' stories. Since there are more people living in cities than on the countryside, rural areas are not prioritized according to one participant (A8). At the same time, there is a polarizing situation between city and rural areas that causes tension and lack of trust. Participants in rural areas expect to suit themselves in the countryside if a crisis would appear (A8). Fire was associated with having protection against wild animals in a historical perspective. Some

participants reasoned about economy as a limiting factor (A1) that seemed to be associated with feelings of lower degree of control over the own situation.

Electricity outage was an important dimension in the discussion about firewood, and wood burning is seen as a means of providing warmth and be able to cook during both short and long outages. Participant A2 meant that outages of electricity had become less prevalent now as compared to before electricity was underground. Electricity consumption is bothering the participants: "how are we going to provide electricity to all?" (A2).

3.3.1. Crisis management

Survival and crisis management was frequently mentioned and raised as a motive for using fire and owning a wood stove. This motive was based on an insecurity about how society would cope in crisis, which means that the individual can be left on his/her own, to take care of him/herself and the family. Somebody meant it would be chaos in Sweden if a crisis happens and somebody else that wood stoves should be in everybody's home and not be regulated because of crisis management.

There were associations between crisis preparedness and the Swedish forest fires during summer 2018, linked to a feeling that the authorities were not prepared and could not help in a desired way (A6). Participants mirrored clear lack of trust based on insecurity if society should be there for them when they needed help but there were also some that expressed trust spontaneously.

Furthermore, the participants pointed towards a wish for more clear and understandable dialogue from the expertise concerned with changes introduced through new regulations. The participants that expressed trust in society functions also supported democracy and clarified that the alternative to democracy was not an option. There were voices that argued that trust in politicians was low as politicians often think in short term as associated with election periods. At the same time, trust was higher in clerks and universities based on perceived competence and better approach from these instances (A8). Fending off to even having an opinion was another approach, and yet another was to prefer own local solutions to relate constructively to crisis in everyday life, like neighbors cooperating in water shortage.

3.4. Environmental impact

Environmental commitment in several areas is mentioned, also related to particle emissions as was the focus of the new regulations. At the same time, there are many nuances in the stories told by the participants, illustrating a range of different perspectives. Being forced to throw away an old wood stove, even though it works, is a contentious issue that the informants are grappling with, which consequently raises the question of its environmental impact (A1). There is criticism against regulations based on environmental impact. There are different views on environmental impact and particle emissions, and a feeling that authorities only take one perspective into account (A3). Participants illustrate alternative theories as a reply to the ban on older wood stoves, e.g., A8 means that the prohibition is a way for the state to obtain more taxes on wood handling or that it is lobbyism to sell more of the modern stoves (A8). The logic is missing, suggests A5, when it is hard to see why it should be beneficial for the environment in the long run to toss away old wood stoves that are constructed to last for long (A5). The lifecycles of the old wood stoves are much longer than those of stoves recently produced, according to Participant A9.

3.4.1. Environmental engagement

There was reasoning around what was perceived to be the destructive and prevailing throwaway-society. Things that have already been produced with care and that are intended to last for long, should last for long and not be discarded until their lifetime is over. Participant A1 argued that old wood stoves were built for sustainability in the sense that they would last for long. According to A7, the wear-and-tear culture was a source of irritation, as this culture did not match with this participant's ideals.

Political short-termism was mentioned as a reason for lack of sustainability, because decisions are made during the tenure, and it can be hard to find ways to combine diverse environmentally sustainable directions in such a short time. Politicians' horizons are therefore too short to make visible changes during their tenure time (A8). Another more practical aspect is that knowledge about properly making a fire is important to make combustion efficient. One example of a bad habit is to limit oxygen inflow by throttling, which makes the fire glow longer by making the combustion less efficient and increasing the risk of chimney fire, according to A7 (well in line with the current scientific understanding, see e.g. Karlsson et al., 2020). For many informants (A1, A3-9), the perceived contemporary culture was a source of irritation as they carried different ideals. Those informants rather hold views and ideals based on sustainability. An important position for many of the informants proved to be the importance of stoves but also other products being built with a clear sustainability aspect (A1).

4. Discussion

Below we discuss the results from the present study researching motives for domestic fire-making and being part of the so-called "wood stove rising" with public protests against the prohibition to reuse old wood stoves in new installations. The driving forces we found behind the Swedish wood stove rising were multifaceted. We grouped the analysis into four themes that had to do with feelings in association with firing, survival, origin, and environmental impact. However, these themes were interconnected.

4.1. Emotional and bodily balance and basic survival

The two themes *emotional association to fire-making* and *survival* concerned the worry of losing the possibility to emotional and bodily balance (since the wood stove contributed to nice warmth and a meditative harmonizing feeling when viewing fire), social cohesion (when sitting in front of the fireside), and survival in short and long-term crisis (the wood stoves were used in crisis too cook and to heat). These reasons should be seen in the light of affordability, since it was easier to find old wood stoves to a more affordable price than new ones, and it may not be possible to afford new versions that would provide the same functions. These findings were in line with Petersen (2008) describing "personal strategies that may be rooted in economic considerations or in the desire for homeliness and sensuous pleasure" from a study on wood stove usage in Denmark.

The economic motives for continued use of old wood stoves and use of own wood for household heating and cooking deserve some further attention. In a Chilean study, it was found that homes with higher household income level were more likely to support air quality improvement policies (Boso et al., 2018). Interestingly, a Swedish study indicated a higher sensitivity to particulate matter air pollution in higher socioeconomic classes, possibly due to that the added risk of cardiovascular disease from exposure to particulate matter is more pronounced in a healthier population (Stockfelt et al., 2017). It would thus seem as if sociodemographic factors may provide citizens with very different starting points for their decision-making on the wood stove issue, where households of lower income may experience economic lock-in effects in combination with lower perceived health threats.

The fact that the participants in this study host overall positive feelings towards fire-making is well in line with previous research on the role of affect in maintaining wood burning behavior (Hine et al., 2007). Bhullar et al. (2014) also showed that citizens of Armidale, Australia, with stronger positive affective associations with wood heating expressed less support for wood smoke mitigation policies involving regulation, which is also in agreement with the present observations.

4.2. Environmental values, zero-waste and perceived quality

The two themes of *survival* and *origin* covered big-picture values and thoughts of the solitary human as part of something bigger in time and space. This observation is in line with research finding self-transcendence and universalism to be values associated with more responsible post-consumption behavior (Dursun et al., 2017). The idea of being part of a circle of life, larger than the own personal life and the own personal context, sharing and using means to survive together with other people, all being part of the same nature and world (e.g., fire is as natural as breathing) fits well with what Bohlin (2019) describes as *serial care* of things in second hand. The wear-and-tear society was questioned, and quality was not necessarily associated with new products, rather with care for what you have and reuse, as discussed by Stahel (2016). Material, durability and craftmanship were quality indicators associated with old wood stoves, but not new ones. This is also reminiscent of Bohlin (2019), noting a passion for second-hand products involving a "certain kind of affection for objects and serial care for things in motion" (Bohlin, 2019). Whereas in other areas, health concerns may be raised in association to reuse and recycling (e.g., Van Heek et al., 2017), the reuse of wood stoves was considered sound and health-promoting by the participants. This soundness had to do with several things. It was associated with personal wellbeing elicited by the fire itself, as well as the active lifestyle around the classical firewood handling (carrying wood, making a fire, viewing the fire). In addition, the old stoves could build a spiritual and emotional bridge to ancestors and traditions and efforts, and this link may also have strengthened the sense of the self as being part of a line of ancestors that used the same wood stove, in line with what is called identity fusion in psychology (Swann et al., 2012). The reasoning about survival and soundness was also expanded from the own personal survival to being connected to other people and to nature and a larger part of humanity and humanity surviving on earth. In a similar fashion, the positive feelings related to forging a strong national identity and a coherent sense of history have been proposed as a main driver for problems with air pollution from household wood burning in New Zealand (Cupples et al., 2007). Research from Australia has furthermore identified justifications for wood burning that are centered around the identification of wood combustion as a "natural and traditional activity promoting comfort and cohesion" (Reeve et al., 2013).

4.3. Fire-making may contribute to big-picture thinking

We consider it plausible that big-picture thinking may have been catalyzed by the regular use of fire itself. Wiessner (2014) found that thoughts and conversations around the big picture of life (e.g., stories about ancestors and myths) were elicited in the fire-light talk around bonfires among bushmen, suggesting that the setting with a fire may trigger these big-picture thoughts. There is also research suggesting that viewing a fire may stimulate alpha waves in the brain (Lynn, 2014), which are associated with a calming transcendent feeling, like when falling asleep by dusk (Kato et al., 2004). Thus, viewing fire may facilitate another kind of mental focus than in everyday business.

4.4. City and countryside – society and electricity failure

The interviews also revealed differences in approach in people living in rural and urban areas. The fact that the wood stove rising was common in remote areas not always connected to the big city areas may also have contributed to its intensity there (Land, 2019). The lack of cohesion with the rest of society may also be one contributing factor. In case of crisis, an opinion that the remote areas were neglected may have contributed. This observation is also in line with the psychological theory that objects may serve a more important role when reliance on other people is absent, and anger and hostility may be elicited if threatened to get rid of these objects (Mathes et al., 2018). Within psychology literature, the maladaptive part in terms of hoarding is documented. However, in this case it may be more adaptive since the wood stoves are not actually hoarded, even though hoarding tendencies cannot be completely ruled out. Participants also raised issues that were not much discussed in the public debate at the time but is so now, e.g., possible shortage of electricity. This group had experience of what happens when electricity is out and had developed strategies and the wood stove is then important. The use of wood stoves to prepare for electricity blackouts has also been observed elsewhere (Silvast, 2017), and it has also been established that experiences of real-life difficulties in which wood stoves have proven themselves useful may spur the emergence of narratives of resistance to change that can have long and profound impact on energy policy reception (Boso et al., 2020a). Furthermore, the need for consideration of *local* normative contexts, such as linking of wood fires with rural identity, has previously been identified in policy opposition (Shove, 2003; Reeve et al., 2013). It should be emphasized here that the Swedish population is very unevenly distributed over the country, with Northern Sweden – characterized by its cold climate – being much more sparsely populated than the southern part: large areas have fewer than 3.53 people per square kilometer (the average population density is 25 people per square kilometer) (Jenelius et al., 2006; SCB, 2019). The perceived necessity to prepare for crisis may thus be well-founded in these parts of the country. Crisis preparedness is also a fundamentally different motivation to owning a wood stove as opposed to secondary heating for aesthetic appeal or primary heating of poorly insulated homes (Cupples et al., 2007; Petersen, 2008; Reeve et al., 2013).

4.5. Lack of concern about indoor pollutants

It is interesting to note that most participants associated fire-making with positive health effects due to relaxation, and that no participant raised the issue of unhealthy levels of indoor pollution from particulate matter that is known to be associated with domestic fire-making (Semmens et al., 2015; De Gennaro et al., 2015; Wyss et al., 2016). The Swedish Environmental Protection Agency warns about pollution from domestic fire-making, but emphasizes problems due to outdoor pollution levels in densely populated areas rather than elevated indoor pollution levels from own fire-making (Naturvårdsverket, 2018). Previous research from Chile has also indicated the existence of a *home halo effect*, by which people living in areas of high exposure to air pollution from wood stoves perceive the air quality in their home to be better than that of their city, even when such perceptions are objectively in error (Hofflinger et al., 2019; Boso et al., 2020b). Interestingly, research on perceived nuisances from industrial pollutants in regions with a high concentration of petrochemical industries in Sweden show no correlation to the comfort of the own home (Nielsen and Barregård, 2008). One may therefore speculate that the psychological tolerance to indoor pollutants is higher when they originate from one's own behavior inside the own home, in comparison to when it originates from outside by activities outside one's own control. In addition, perception of the beautiful light and warmth of a fire (Karlsson et al., 2020) may contribute to an overall pleasant bodily feeling and a halo effect in the home, but not outside where the smoke can be perceived but not its source, the fire. Moreover, research suggesting that wood smoke particles from small-scale wood burning are significantly less toxic than particles from other sources due to antioxidant effects from methoxyphenols received considerable media attention in the beginning of the 2000s in Sweden (Kjällstrand and Petersson, 2001; Kjällstrand et al., 2003). These communications may also have contributed to a lower level of concern for indoor particulate matter from wood stoves in the Swedish population. Research from Australia has shown that users of wood heaters perceive fewer health risks from wood smoke (Hine et al., 2007) and that opposition to regulatory restrictions on wood burning are linked to beliefs that wood smoke does not pose a serious threat (Bhullar et al., 2014). In conclusion, the combination of these three mechanisms (home halo effect, sense of control over the

pollutant-creating process, and lack of worry over health effects from wood smoke in particular) can possibly explain the absence of concern over negative health effects from wood combustion among the signatories of the "wood stove rising".

4.6. Alternative particle reduction technologies

An alternative to replacing entire wood stoves to reduce particulate emissions would be to retrofit such stoves with electrostatic precipitators (Brunner et al., 2018) or particulate filters or catalysts (Ropp et al., 2015). Also, reduction of indoor particulate emissions through high-efficiency air filtration has been proposed to counteract the negative health effects from residential wood combustion (McNamara et al., 2017). Adoption of such strategies would have focused more on the health effects and the net emissions, rather than on the technology producing the raw emissions. It can be speculated whether such an "evolution rather than revolution"-strategy would have been perceived as less conflictive than a complete technology shift imposed via legislation.

4.7. General conclusions about phasing out old technologies

As we have seen, a policy phasing out an old energy technology may threaten several psychologically and bodily balance issues: 1) emotional and bodily balance in daily life, 2) daily routines and sense of self, 3) sense of the past and local traditions, 4) sense of connection to other people, 5) the ability to live comfortably during small crises, 6) the ability to survive during longer crises, 7) the value not to toss anything functional away, but to use it as long as it serves and only thereafter let something else take over.

We argue that the likelihood of policy observance and acceptance is higher if these seven points are met in a good way, since they relate to basic psychological and bodily needs that people all over the world may express and strive to achieve. We also believe these needs can serve as creative inspiration to develop more innovative technological solutions.

4.8. Limitations

This study has several limitations. Deep interviews were conducted with a limited number of participants, implying that the data collected provides a qualitative overview rather than a quantitative characterization or an exhaustive enumeration of individual motifs. Furthermore, the study has by design focused on signatories of the Swedish "wood stove rising" petition, and it thus provides a picture of this movement without directly contrasting it with other groups, such as people who feel an affection for wood burning but nonetheless sympathize with stricter emission legislation or people who host neutral or negative feelings towards wood burning. This approach was chosen as the focus was to provide rich and detailed descriptions of the reasoning and behavior of a particular group in a particular real-world context in which it occurred, for which qualitative research of this kind can be considered appropriate (Price et al., 2015). Finally, the interviews were conducted over telephone rather than in face-to-face meetings, due to the overwhelmingly long distances involved. This methodological choice was deemed acceptable, as previous research indicates that qualitative telephone interviews produce data of comparable quality to face-to-face meetings (Carr and Worth, 2001; Sturges and Hanrahan, 2004).

4.9. Further research

The finding that participants expressed that fire warmed their bodies deeply and differently as compared to electric energy sources is in line with previous research. Karlsson et al. (2020) found that wood fuel may be a preferred complementary energy source for some because it provides more comfortable heat and beautiful light (Karlsson et al., 2020). Moreover, other research suggests that viewing a domestic fire may affect blood pressure (Tamakoshi et al., 2011) and brain processes (Lynn, 2014). If heat and light are considered vital for human wellbeing and survival, just like food is considered vital for human wellbeing and survival; is it then perhaps possible to identify a policy providing something like a "diet circle" also for heat and light to identify an adequate mix of energy sources that promotes mental and bodily health for all, and sustainability for society and earth in line with Agenda 2030?

Further research within energy policy could benefit from a deeper understanding of the emotional ties between humans and energy conversion technologies, since such ties may facilitate or hinder policy acceptance. In addition, a better understanding of people's emotions in relation to energy sources may highlight contextually important factors when developing energy policies, not only regarding wood stoves but for any energy technology.

5. Conclusions and policy implications

Wood stoves remains popular throughout Sweden despite their link to particulate emissions, which has caused authorities to try to enforce stricter emission legislation to phase out old wood stoves. We have performed comprehensive interviews with eleven signatories from the Swedish "wood stove rising" that protested a prohibition of new installations of old wood stoves launched by The National Board of Housing, Building and Planning in 2017. The protest movement was successful in that the new regulations were cancelled after a politically motivated reevaluation in 2019. Our goal was to identify the sociocultural and emotional underpinnings of the protest, to elucidate how to better formulate and implement pro-environmental energy policies with lower risks of similar public backlash.

We have found that domestic heating through fire-making is an age-old human behavior that is deeply connected to a range of social and emotional human needs. The likelihood of policy observance and acceptance in this area is higher if the policy is not perceived as being in direct conflict with these needs, such as: basic emotion regulation needs, sensations of tradition and connection to other people, and means of crisis management for the individual. Furthermore, the protesters were found to act out of a sustainability perspective, albeit one where the continued use of fully functional devices was valued more than the perceived wear-and-tear of modern society. This point-of-view was used as a justification for the cherishing of an outdated technology, despite its unfavorable particulate emission performance. We also identified a polarized situation where the signatories, living in rural areas, signaled that the wood stoves were a basic means of survival, threatened to be taken away by unreliable politicians while society at large was still unable to guarantee uninterrupted services in e.g., electricity supply.

It is important for policy makers to achieve a deep understanding of the emotional ties between humans and domestic energy conversion technologies, since such ties may facilitate or hinder policy acceptance. Deep understanding of this kind should also be valuable in the development of new technological solutions to replace outdates ones.

CRediT authorship contribution statement

Anna Sahlberg: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft. **Bodil S.A. Karlsson:** Conceptualization, Methodology, Writing – review & editing, Supervision. **Jonas Sjöblom:** Conceptualization, Writing – review & editing. **Henrik Ström:** Conceptualization, Writing – review & editing, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendices. Supplementary data

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