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'That's when we started using the living room': Lessons from a local history of domestic heating in the United Kingdom

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ABSTRACT

Indoor climate control forms a major share of residential energy demand. Policy measures to curb this demand tend to focus on energy-efficient technologies. However, while the energy efficiency of domestic heat provision in the United Kingdom (UK) has increased considerably over the past century, demand for space heating has increased as well. This paper offers a distinctive explanation of increasing levels of domestic demand for space heating. It is grounded in a case study on changes in social housing design and use in the UK between 1920 and 1970. Based on detailed analysis of the co-evolution of housing circumstances, heating provision and patterns of everyday practice, the paper argues that increases in demand for space heating can be understood as a spreading of such demand over domestic space and time. In explaining this spread, it identifies three key contributing processes, comprising: 1) materialisations of ideals of separating domestic activities; 2) delegations of work and control to infrastructures and appliances; and 3) shifts towards more indoor, sedentary activities. It closes by considering how understanding these processes historically can inform contemporary energy policy to curb domestic energy demand for heating, and how the distinctive approach taken has implications for energy research.

1. Introduction

Worldwide, energy use in buildings comprises approximately one third of final energy consumption ([1], p. 294), of which indoor climate control has been estimated to be roughly fifty per cent [2]. Indoor climate control is therefore a focal target in energy policies. As Nobuo Tanaka, executive director of the International Energy Agency puts it:

> 'Energy-efficient and low/zero-carbon energy technologies for heating and cooling in buildings will play a crucial role in the energy revolution'
>
> '([2], p. 1).

However, the promises of energy-efficiency to lead to required reductions in energy demand have long been questioned, on two key fronts: first, because of rebound effects, where savings trigger new forms of consumption [3–5]; second, because of the inherently limited effects of aiming to maintain current, unsustainable standards in more efficient ways, without questioning those standards themselves [6,7]. To open up new avenues for energy policy to confront these shortcomings, this article examines relations between changing domestic heating provisions and escalating standards of domestic demand for space heating in the United Kingdom. In Section 4.4, we link this specific case back to the global issue of indoor climate control in buildings.

Over the past century, domestic heating systems in the UK have become far more energy efficient. Muthesius, in his seminal study of 'The English House', mentions that for the coal fired open hearth popular in the early 1900s, only fourteen per cent of the heat effect would benefit the room ([8], p. 182). Since then, heating systems have changed from open coal fires to predominantly gas central heating. While just 5% of UK households had central heating in 1960 [9], today this is over 90%, of which the great majority is fuelled by gas [10]. In gas central heating, the conversion of fuel into heat is more efficient than in open coal fires – current standards require new boilers to be at least 86% efficient [10]. In parallel, homes have become easier to heat due to better thermal insulation. However, while detailed data of domestic energy demand for heating from before 1970 are lacking, the level of domestic coal consumption first recorded in 1943 [11], and more precise records in the latest UK Housing Energy Fact File [10], covering the period from 1970 up to 2011, indicate that it has not gone down in line with increasing efficiency. What this means is that over the past century, *demand for heat* in homes has increased.

In the UK, space heating accounts for approximately two thirds of average total energy use in homes [10], and home heating systems are

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held responsible for about 20% of the total UK carbon emissions [12]. Given the UK government's legal commitment to reduce carbon emissions by 2050 by 80% compared to 1990 emissions [13], domestic heating is an explicit target area in national carbon policies [14]. However, while more efficient domestic heating systems feature prominently in envisioned futures – in the form of stimulating the uptake of heat pumps, district heating and thermal insulation [15,16], efforts to address levels of demand for heat remain limited to measures stimulating households to 'turn down the thermostat by one degree centigrade' ([16], p. 90; [15], p. 80). Although such measures have potential to render reductions in energy demand, we hold that a deeper understanding of the processes by which levels of domestic demand for heat have increased historically is necessary to inform policies with potential to achieve reductions on the scales required, because they engage with standards of home heating.

In pursuit of this agenda, the paper focuses on gaining a better understanding of the co-evolution of domestic heating provision and levels of demand for heat. The following section sets out existing understandings of increasing domestic demand for heating and outlines the theoretical and methodological starting points for the case study underlying this paper. After a description of the study's specific aims and methods, the paper moves on to introduce and work through three interrelated historic processes identified in the case, covering a time span between 1920 and 1970, which we argue to have played key roles in the spread of demand for space heating over domestic space and time. The case discussion closes by highlighting how insights into these historic, local processes shed new light on the dynamics of domestic demand for heating more broadly, and discusses some wider implications for energy policy.

2. Literature review: understanding the dynamics of domestic heating

While reports like the Housing Energy Fact File identify increases in demand for domestic heating over the past decades, explanations of this phenomenon remain speculative. Computational modelling of changes in the UK housing stock and levels of domestic energy demand for heating suggests an increase in average indoor temperatures from 13.7C in 1970 to 16.9C in 2008 [10]. The report mentions increasing home sizes, people heating their rooms to higher temperatures and heating more rooms for longer as possible explanations for this increase in heat demand ([10], p. 35). However, various housing surveys have found that the average size of newly built homes has gradually *decreased* since a peak in the 1950s [17,18]. Evans and Hartwich [19], for example, use EU housing statistics to show that, for 1996, the average size of newly built homes was around 10% smaller in comparison to the existing stock. Moreover, Shipworth [20] collected empirical data on changes in thermostat settings in owner occupied houses with central heating between 1984 and 2007, but found no evidence of higher temperature settings over time. This leaves the assumption that more rooms have become heated for longer.

A general explanation for this phenomenon, linking it to changes in heating provision, is that it was caused by the gradual transition from coal fires to gas central heating (notably, [21,22]). In these studies, which are grounded in theories of sociotechnical transitions [23,24], the emphasis is upon processes of technological and institutional change, with changes in the demand for energy services – such as demand for heated spaces – discussed in abstract terms, and featuring mainly as consumer choice influenced by prices of energy services. An attention to the sociotechnical relations at stake in changes like these means such approaches offer a more sophisticated understanding that do those such as thermal modelling. However, the assumption that the diffusion of new energy technologies happened because they provided 'useful services to end users' ([25], p. 84) passes over the fact that something must have changed in everyday life for these new technologies to *become of use* to large numbers of people.

Focusing more on changes in domestic demand for heating, a range of studies have engaged with indoor climate control from an end-user perspective. Shove et al. [7,26,27] focus on notions of comfort and how they have changed over time in interaction with professional standards and heating technologies. Other studies focus more on heating practices, and how they are configured [28–30], or reconfigured when encountering new heating technologies, such as heat pumps [31], or when moving home [32]. However, recent efforts in the area of understanding energy demand are arguing for an approach that views demand as an outcome of the full range of domestic activities, or practices [33]. Considering these practices as 'partly constituted by, and always embedded in material arrangements' ([34], p. 174), implies a move away from thermal comfort in itself, towards situating changing expectations of comfort, or levels of demand for heat in understandings of 'how complexes of social practices and infrastructures develop together' ([34], p. 175).

The account offered in this paper thus focuses on the intersections between material arrangements of the home and everyday domestic practices. Moreover, it builds on the idea that historical research can provide insights for contemporary energy challenges [35]. This facilitates a focus not on heating technologies themselves, or only on the practices involving direct engagement with them. Instead, of central concern are the ways demand for heat is implicated in the changing patterns of practices comprising daily life. Based on these starting points, energy demand for domestic heating is conceptualised as emergent from interactions between changes in material arrangements (infrastructures, heating systems, technologies, buildings) and temporal and spatial patterns of social practice in the home and beyond, such as cooking, shopping, bathing, eating, parenting, playing, doing homework, working, sleeping, getting around and more. In order to develop this account, the research underlying this paper aimed to gain an understanding of how changes in housing design, heating infrastructures and domestic practices interacted and shaped each other over time.

3. Methodology: capturing the co-evolution of practices and material arrangements

The account results from a research project the aim of which was to better understand how changes to the patterns of daily life, with consequence for energy demand, relate to changes in technologies, infrastructures and institutions of supply. The research was conducted between 2014 and 2016.[1] Exploring these relationships in line with the theoretical approach outlined above is empirically challenging, involving a level of detail which is only possible through focused qualitative research, enabled by a case study approach [36]. Our research aim led to an ambitious empirical strategy combining archival work with oral history interviewing, within a specific case study locale. Details of changes in housing design were obtained from archival material on municipally provided social housing – 'council houses', both on local and national scales. Related accounts of corresponding local changes in specific aspects of daily life were collected through oral history interviews.

Council housing was selected as a case study topic because of the accessibility of its detailed documentation over the extended period of fifty years, which also corresponds with the shift from coal fires to gas central heating. Council housing provision in the UK had its most active years from the 1920s to the 1970s and was responsible for a substantial portion of housing supply during this period so that by 1975, nearly one third of the UK housing stock consisted of council houses [37]. Council housing meant that local authorities commissioned the design and building of new estates, which were rented out, or in some cases sold to

[1] This project is part of the programme of research comprising the DEMAND (*Dynamics of Energy, Mobility and Demand*) centre – www.demand.ac.uk.

Table 1
Overview of social housing estates built in Stocksbridge included in the study.

Estate name	Years of construction	Number of houses	Interviewees (see Table 2 for details)
Shay Lane	1923–1931	68	Hilda
Wilson Road	1925–1928	20	
Royd	1929–1939	42s	Peter
Pre-war Spink Hall	1938–1940	180	Beryl, Tom, Edward
Post-war Spink Hall	1945–1948	80	Panel 3
Stubbin Farm	1946–1957	461	Peter, Panel 3
East Whitwell	1955–1968	434	Bethan

selected candidates – mostly households needing rehousing following local slum clearance efforts, and employees of local businesses needing housing in the area – at rates that 'many of the working classes could afford' ([38], p. 220). Local authorities had to comply with national requirements in order to be eligible for central government funding, on which they were dependent for financing the estates. This publicly funded nature assured relatively detailed and accessible archives of plans, specifications and rationales.

The locale selected for the case study was Stocksbridge. Stocksbridge is a medium sized town on the outskirts of Sheffield in Northern England that actively built new estates over the full five decades in which council housing provision was at its peak. Between the mid 19th and mid 20th century, the town expanded quickly around the success of its central steel industry: the population grew from 7 households in 1851, to about 4.700 households in 1971 [39,40]. With increasing numbers of steel workers requiring (better) housing, the town council commissioned the building of a series of council estates. Between 1923 and 1968, six estates were built (in seven main phases), together comprising about 1.285 houses (overview in Table 1).

An historian on the research team selected, collected and analysed archival material from the Stocksbridge Urban District Council (SUDC) concerning council housing provision preserved in the Sheffield Archives. This material contained a detailed account of changes in building layout and specifications, as well as tenant's perspectives on local housing provisions in the form of direct correspondences, and indirect references in council minutes. These local data on housing design were supplemented with national data on changing housing design guidelines as published by three subsequent Local Government Board (LGB) housing committees: Tudor Walters [41], Dudley [42] and Parker Morris [43]. In the words of historians Ravetz and Turkington, these housing committees functioned as 'social reformers as well as designers' (1995, 149) and held ambitions to significantly improve housing standards. The Tudor Walters committee for example, expresses an ambition to 'profoundly influence and raise the general standard of housing' ([41], Par 3). To guide the building of homes for future tenants that improved standards of living, the detailed design recommendations necessarily incorporated visions and ideas about future, 'better' living, which were in part derived from prospective and actual tenants through surveys and consultations. This sequence of reports thus provides a certain perspective on actual and envisioned patterns of living in council housing.

In addition, the case study data included transcripts of eleven individual oral history interviews and four panel interviews with residents about daily life in Stocksbridge conducted by the authors (Table 2). The interviews focused on capturing changes in daily life over time by asking people from different age groups to talk about the time in their life when they were between 20 and 35 years old. This set-up was chosen in order to capture accounts from the perspective of adult household members in similar life stages, but different periods in time. With interviewees in ages between 48 and 90 years old (see Table 2), primary coverage of the interviews ranged from the 1940s to the 1980s. Because childhood memories and contemporary situations tended to come up in the interviews as well, secondary coverage ranged from the 1930s to the present.

Interviewees were recruited with the help of the local history society, a local university project, a senior citizens support group, flyers in public spaces, door to doors, and snowballing. The individual interviews lasted between one and two and a half hours and covered the following topics in varying order: discussing a floor plan of the house occupied during the focal age range of 20–35; describing the household's main activities on a typical day and week, and a detailed discussion of laundering, getting around (to work, school and shops), and keeping warm in winter. The four panel interviews, conducted in the setting of an elderly citizen support group, were set up to complement the individual interviews by going deeper into the topics of laundering, keeping warm, getting around and electrification, with a focus on the 1950s. The panels justified the expectation that collective discussion between respondents from a similar age group would elicit greater depth of collective recollection [45]. References to interviewees in the text are indicated using the interviewee pseudonym followed by their year of birth in brackets, e.g. Harry [1966].

The historic case study as a method was most appropriate for pursuing the research aims because it enabled multi-method attention to the interaction of relations and processes as they converge in a locality over time. However, the choice for this method also has limitations. Because the research findings are based on a specific type of housing, with a specific demographic of occupants, and a specific geographic locale, they cannot be considered representative for other types of housing, different socio-economic groups and other cultural contexts. For example, the rise of ideals of open plan homes, the implementation of electric or district heating, or particular issues concerning domestic cooling were not addressed in our case study, but will be significant in other locales (see for example [46–48]). A comparative case study over a variety of housing types and geographic locales could have eased some of these limitations, but was not possible within the constraints of the project. Moreover, the case had to rely on indirect resources to gain insight into the specific setting and events studied, such as oral accounts based on memories, and a selection of documents from the archives of local and national authorities, which necessarily provides a partial account. Finally, with more time and resources, return interviews to discuss emerging key topics such as eating and cooking, interviews with former professionals involved in council housing, complemented with more diverse historic material could have provided a more nuanced view.

Data analysis set out to understand if, how and why more rooms had become heated for longer over the decades. It involved the coding of the fifteen interview transcripts in NVivo (a qualitative data analysis software), systematic comparisons of floor plans and specifications of the seven subsequent estates, and a detailed reading of local and national housing guidelines. During the process, data interpretations were regularly discussed within a multidisciplinary research team, and discussed with the local history society. Analysis first focused on identifying and explaining changes in spatial and temporal patterns of living, i.e., where and when did householders do what in the home and how did this change over the decades. This included a range of 29 different practices, identified through analysis of the material, such as television watching, receiving guests, cleaning and gardening. Next, it listed effects that these changes could have on levels of demand for heat in the home. Through this analysis, three key processes of change were identified. The processes described here are identifiable retrospectively as contributing to a particular result, namely that of increased levels of domestic demand for heating. They were, however, not orchestrated or deliberately directed towards producing this result, but happened to come together as such in the course of events. In making sense of how the use of heat in homes changed, these processes are helpful instruments because they tie together more or less related developments, trends and changes, in local and national governance ideals and

Table 2
Overview of interviewees.

Interviewee pseudonym	Age at interview [Y.O.B.][a]	Period(s) discussed	Estate/neighbourhood and tenure during the focal period or periods of the interview
Harry	48 [1966]	1970s–80s; 2000s	Stocksbridge, owner occupied; Stocksbridge[b], rented from council
Peter	Appr. 60 [~1955]	1950s–60s	Royd and Stubbin, rented from council
Barbara	65 [1954]	1950s; late 1970s–80s	Sheffield, rented from council; out of town cottage, owner occupied
Beryl	66 [1948]	1984–present	Pre-war Spink Hall, rented from council, later owner occupied
Tom	Appr. 70 [~1945]	1976–present	Pre-war Spink Hall, rented from council
John	71 [1943]	1940s; late 1960s–70s	Northeast Yorkshire town, council; Deepcar, owner occupied
Bethan	77 [1937]	1940s; 1960s–70s	Wales, council; East Whitwell, council, later owner occupied
Hilda	80 [1934]	1930s–40s; 1960s–present	Shay Lane, rented from council; Stocksbridge, owner occupied
Edward	83 [1932]	1982–present	Pre-war Spink Hall, rented from council, later owner occupied
Phyllis	88 [1926]	1950s; 1980s–present	Out of town terraced, private rent; Stocksbridge, steelworkers retirement home, private rent
Doreen	90 [1923]	1930s–40s	Deepcar, owner occupied
Panels 1–4	mainly in their 80s [~1930s]	1950s	Various estates and tenures in Stocksbridge and Deepcar

[a] Year of birth is used together with pseudonyms to refer to interview participants in the text.
[b] Council flat built after focal period of study.

structures, technologies, housing design, public opinion and patterns of tenant's everyday lives. Moreover, once identified, they form vehicles that give the historic analysis contemporary relevance. This latter point will be elaborated on in a separate section on implications of the work for contemporary energy policy.

4. Findings and discussion: explaining increases in domestic demand for heat

The data from the case study provide material with which to construct a detailed narrative of how, between 1920 and 1970, a set of interrelated changes took place that together produced a spreading of demand for space heating throughout domestic space and time. This spread is not simply a consequence of a spreading of heating provisions over the home. From the 1920s onwards, the vast majority of houses in the Stocksbridge estates had heating provisions – in the form of open fireplaces – for most rooms of the house. However, interviews and archival material consistently indicate that in the earlier years of the study period, most of these provisions were hardly used. Taking account of changes in provisions, the following sections focus on how and why the *use* of space heating spread from one living room throughout the home, and from predominantly evening time to morning, daytime and night time. The final part of this section develops from this historical analysis to draw out contemporary policy implications.

4.1. Materializations of ideals of separating domestic activities

The first key process is a materialization of ideals of separating domestic functions in the design of housing layouts and provisions. While certainly not the sole contributors, the local and national housing committees involved in council housing played important roles in this process. The analysis of changes in spatio-temporal patterns of domestic life between 1920 and 1970 indicates that the committees' progressive pursuit for *a spatial separation of domestic functions* – considered necessary to achieve improved standards of living in the form of more privacy, better hygiene and higher education – is clearly linked with increases in demand for space heating. Although the national recommendations were not directly instrumental in local design decisions [38], their changing ideals and related design recommendations are reflected in the changing local estate plans. Because of the returning ideals of separating functions, changes in housing design created material arrangements by which domestic activities were enabled and facilitated to spread over the home. The following sections describe this process in more detail.

In reference to the private sector terraces' '2-up and 2-down', with two upstairs bedrooms, and a living room and scullery[2] downstairs, a main objective in the Tudor Walters report was to 'eliminate from the living-room the dirty work, and particularly the cooking of meals' (1918, Par 87). This was to be achieved by replacing the living room cooking range – a coal fired cooker and stove – with a single purpose heating device, and providing gas cookers in sculleries. Plans for the series of Stocksbridge estates built between the early 1920s and early post-war years (Shay Lane, Wilson Road, Royd and Spink Hall), show a phased shift of cooking provisions from the living room to the scullery. In 1944, the Dudley report suggested that the moving of cooking to the scullery had been successful. However, it also stated that eating had in many cases followed. This move was in a way welcomed by the committees of the time, because it freed the living room from the 'constant bustle of meals' and allowed it to become 'a quiet place for study, social intercourse and recreation' ([42], Par 40). The need for which was expected to grow because of the rise of 'continued part-time education for all young people' ([42], Par 27). But it was also frowned upon; 'eating alongside the sink' ([9], p. 156), in 'the housewife's workshop' prone to be filled with cooking smells and steam [49] was felt inappropriate and undesirable by both local and national housing committees.

To address the issue of separating eating from cooking, a 1945 local housing committee in Stocksbridge recommends a ground floor plan with a working kitchen, dining room and living room layout, where a 'working kitchen' is an unheated space, deliberately made too small for a dining table. However, in spite of this attempt to force cooking and eating apart, 'the greater convenience of eating in the same room in which the food is cooked' ([42], Par 39) turned out to be stronger than these material restrictions. The 1961 Parker Morris report therefore recommended 'kitchens with room in which to take at least some meals' ([43], Par 6). Reflecting this acknowledgement, dining-kitchens start to appear in Stocksbridge in the 1950s, but the ideal of separate rooms for cooking, eating and living remained, for example in the Parker Morris recommendations to include a dining room where possible and the continued appearance of such rooms in larger homes in the post-war Stocksbridge estates.

The strategy of adding rooms to achieve a desired separation of functions was also used in the interwar years. The first wave of council housing had considerably more rooms than the '2-up and 2-down' houses repeatedly mentioned by interviewees as their predecessors. Tudor Walters recommended separate bathrooms – because 'the housewife does not want members of the family washing in the scullery when

[2] The scullery was the 'wet room' where activities like washing up, 'wet' parts of food preparation, personal washing and clothes washing would took place [9].

she is busy preparing breakfast' ([41], Par 117), and at least three bedrooms to achieve 'adequate separation of the sexes' in family homes ([38], p. 224). As becomes clear from a remark of Hilda [1934] that 'to come and have a bathroom, even though it was downstairs, it was luxury', reflects the generally positive attitudes towards these additional rooms among the interviewees, although for her it was mainly the luxury of having a toilet indoors with flowing water. The report also advocated the parlour as a third, formal downstairs room. After WWII, the parlour, which was by then considered 'old fashioned and obsolete' ([42], Par 43) disappeared from the local plans, but a third living room remained part of a portion of newly built homes in Stocksbridge in the form of the dining room. With bathrooms gradually settling upstairs, this new arrangement meant a shift to a '3–4 up, 2–3-down' arrangement.

In the early 1960s, the Parker Morris committee again identified a need for more domestic space to perform 'activities demanding privacy and quiet' ([43], Par 6), such as listening to records, watching television, do-it-yourself and homework. The latter of which was expected to grow because of further increases in the number of young people going to school longer.[3] Given restrictions on adding yet more rooms, the committee found potential in existing rooms by observing that bedrooms were used 'for sleeping only' ([43], Par 64). Design recommendations, meant to convert bedrooms into 'bed-sitting rooms' ([43], Par 36) for the first time explicitly included details of the heating system in use. While most council houses had heating provisions in the majority of rooms, repeated references to memories of 'the upstairs' as 'freezing' in the interviews indicate that these provisions (often open fires) were hardly used. This was recognised in the local housing committee report of 1945 which stated that;

> 'fires are not lighted in bedrooms except in case of sickness, nor are fires lighted in spare ground floor rooms except on rare occasions' [49].

To remedy this problem, the council committee report recommends background central heating[4] to be provided by a coal fired radiator system fed from a kitchen stove. In this arrangement, 'the housewife would thus have one continuously burning stove to tend' [49]. In line with this idea of making the heating of multiple rooms more convenient, Parker Morris recommended direct central heating in bedrooms – as opposed to indirect central heating from a radiator in the hallway – for cases 'where daytime and evening use of bedrooms is likely to be considerable' ([43], App 2 Par 1), thereby referring to the activities mentioned earlier, and in particular to doing homework.

To sum up, in the ideals of 'better' living expressed in the national and local housing committee reports, the pursuit of a separation of household functions – of cooking from 'living', eating both from 'dirty housework' and 'living', boys sleeping from girls sleeping, and activities such as personal washing, doing homework and listening to music from everything else – was a recurring preoccupation. These ideals underpinned rationales for adding rooms to the house (e.g., parlours, dining rooms, bathrooms, third bedrooms) and offering (or not) certain provisions in them (e.g., cookers in the kitchen and not in the living room, restricted space for eating in the kitchen, unheated 'working kitchens' and 'direct central heating' in the bedrooms). By creating certain housing circumstances and promoting ways of living associated with them – many of which are taken for granted today, these ideals and related material changes in housing designs have contributed to a spreading of activities formerly concentrated in a single living room throughout the home, and thus to a spreading of demand for space heating across domestic space. However, they were not the only contributor to domestic demand for heat actually spreading over the home.

4.2. Delegations of work and control to infrastructures and appliances

As becomes clear from the above narrative, the committees were constrained, but also helped and inspired by changing social, technical and economic possibilities. Important in this respect was the 'extension of public services' ([42], Par 13), notably water, gas and electricity infrastructures that were taking place on over the same period.[5] Changes to infrastructures of provision, and associated developments in end-use technologies facilitated a spread of space heating and heating-dependent activities throughout the home: cooking to the scullery, bathing to the bathroom and direct heating to the bedrooms. With pipes, rather than people carrying water, warmth and fuel, activities requiring heat and (warm) water no longer needed to be performed near the home's main coal fire. In addition, and as this section elaborates, the case study revealed another way in which these infrastructures and appliances contributed to increases in energy demand for domestic heating.

The second key process identified in the case study is the delegation of both domestic work and the control over certain domestic processes to infrastructures and related appliances. Delegation is a term that has been used to describe processes by which tasks previously undertaken by humans are delegated to machines and vice versa [50]. Various authors have argued that delegation transforms tasks and the webs of relations they are part of, of which the delegation of laundry work to washing machines is a well-known example [51]. The following section shows how delegation manifested in the case material and argues how it has fuelled a spreading of demand for space heating over domestic time. The connection of homes to electricity and gas infrastructure, together with the growing availability of portable gas and electric heat sources allowed for the coal fire in the main living room to be supplemented with what Dudley referred to as 'auxiliary sources of heat' in other rooms ([42], Par 187). The interview material contains various examples of how, in the post-war period, dining rooms, bathrooms and bedrooms were heated by turning such appliances on briefly before the anticipated use of the room and turned off again when leaving. The Parker Morris report refers to this type of heating as 'short-period heating' ([43], App 2). Notably, this is a form of heating that makes little sense with a coal fired appliance because of the time and effort required to light it. The delegation of fuel supply for heating to gas or electricity infrastructure therefore entailed a major change in everyday life, which is nicely illustrated in this quote about a household obtaining their first gas fire in 1969:

> 'Well [the gas fire] stopped the yellow carpet – which we were stupid enough to buy in the first place – getting dirty. Because we had to bring the coal through …. And then of course it was instant. Wonderful, you didn't have to put the sticks in, the paper and the sticks, and the coal on top, then light everything and wait for it start, you know setting the coal going. It used to take ages to warm up when we came home from work. So having a gas fire, that was wonderful.'

Compared to solid fuel, gas fired heating is experienced as 'instant' because it can be switched on and off easily. This characteristic of gas

[3] In the UK, education was made compulsory until the age of 15 in 1947, and to 16 in 1973.

[4] 'Background heating' refers to a system capable of heating the home to a temperature of 55F in bedrooms and 60F in the living room, meant to be combined with top-up heating with for example fireplaces, gas or electric fires.

[5] In Stocksbridge, town gas had been around since the late 19th century as a by-product in the production of coke for the steel industry. A gas mains connection seems to have been fairly standard in council housing from the first estate onwards except in some cases of all-electric homes. In 1925, the first homes in Stocksbridge were connected to electricity, and in 1950 the council decides to install electricity in all houses then still without it. Water mains seems to have been standard in all council housing. The interview data contains two cases of out of town cottages being connected to water mains after 1920, which was in the 1950 and late 1970 respectively.

fired heating enabled a reduction in the duration for which space heating was on, because the need for banking[6] fires disappeared. However, the new possibility of short period heating also made it easier for households to heat homes for short periods, such as the morning time before going to work – a practice that was on the rise with increased female participation in the work force. There are two similar accounts in the interview material (John [1943] and Barbara [1954]) where working couples changed their heating system from a coal fire to a gas fire and then started using heating in the morning.

The radical differences, in terms of labour and coordination, between lighting and tending a coal fire and the 'switching' on or off of a gas fired heating system affected not only morning time. As becomes clear from the quote above, the coal fire would go out at night, or when people were away during the day simply because there was nobody to add fuel to it.[7] This changed when fuel for the fire became supplied through gas pipes. With this change, ways of controlling the heating altered as well. For Hilda, [1934] – describing her current practice in a gas centrally heated home for example, 'leaving' the heating when she goes out and 'turning it down' at night does not mean that it will slowly go out like a coal fire. Instead, she explains how the heating will 'come on' automatically when the temperature drops below the value she has set on the thermostat. These examples show that the delegation of fuel supply to gas infrastructure, and the delegation of the need for active thermal monitoring and of control over when to add fuel to the system to thermostats has enabled homes to remain heated during times of absence or sleep.

To conclude this section, the delegation of work and control to utility infrastructures and related heating appliances has contributed to the spreading of space heating over the home, and notably, a spreading of heating in time, to 'short term' pockets of heat demand such as the time between getting up in the morning and leaving for work, and to times of people's absence or sleep. As the next section will argue however, these increases did not happen simply because there was now the technological possibility to heat more rooms for longer. In interaction with the development and spreading of new technological possibilities to heat the home, new practical arrangements and rationales necessarily developed for the use of these possibilities in everyday life.

4.3. New uses for heat – increases in sedentary, indoor activities

The third process identified in the case study is the development of new uses for heat, which involved a move towards more sedentary and indoor activities. Changes in the material arrangements of the council home implemented by local authorities have played a role in this trend, but there are other processes that have been primary contributors. So far, the processes identified have been discussed relatively narrowly in terms of the relationships at stake, where changes in spaces, heating provisions and activity are relatively closely connected. This final section links together a wider range of processes, trends, developments and changes with the narrative of growing domestic demand for space heating. After briefly discussing the role of the television in spreading domestic activity over downstairs rooms, the section focuses on bedrooms and their transformation from unheated spaces only used for sleeping and dressing, to 'bed-sitting' rooms served by direct central heating.

From the case study data, the introduction of a television to a home was often a critical moment in the reshaping of how spaces were used. With cooking moved to the kitchen and in many cases eating moved to the dining-kitchen or dining room in the early post-war years, the living room became used less, and therefore was heated less. This changed, however, with what was for many interviewees a memorable event: the arrival of their first television. The following quote from John's childhood reflects the changes this arrival made to heating use:

> 'Well I mean everything happened in the kitchen in those days … because there were no tellies, well we didn't get a telly until 1953 for the cup final … I'll never forget that. That's when we got our first telly, so that's when we started using the living room, [until then] you only used it for parties and Christmas if that.'
>
> (John [1943])

In its early days, television watching was considered a special occasion, for which some interviewees remember they would dress up (Hilda [1934]). Parker Morris mentions that by 1961 two thirds of UK households owned a television, and envisions a television, settee and two easy chairs among the main items in the living room ([43], Par 34). After the space had become emptied of purpose by the removal of cooking, eating and bathing from it in the interwar and early post-war years, watching television came to redefine the living room. As an emblematically sedentary activity, the arrival of the TV and its assimilation into daily routines represented a significant driver of demand for heating in this room.

Meanwhile, changes were also happening upstairs. Reflecting the expansion of the use and heating of bedrooms envisioned in the Parker Morris report, interviewees' memories of the later decades of the study period no longer refer to the upstairs as freezing. Prominent in these accounts are references to children. John [1943], whose children were born in the late 1970s, mentions that they installed central heating when their second child was born, because they now 'needed to heat two bedrooms'. This type of reasoning stands in contrast to ideas among older participants who had children in the 1950s that 'children do not feel the cold as much' (e.g. Hilda [1934]), and getting them 'accustomed to the cold' by letting them sleep outside – on nurse's advice (Phyllis [1926]). This contrast indicates a generational shift in practices of comfort and understandings of wellbeing in parenting that have affected demand for space heating.

Moreover, the interview material contains many examples of how children's play has moved from outdoors to indoors over the previous half century, a trend that is confirmed in other studies. Before the 1950s, homes tended to have little to no space dedicated for children's play so that 'pre-school children's only place to play was the street' ([52], p. 76). Doreen [1923] and Bethan [1937] for example explain that in the 1940s and 50s, their children would go to school and play outdoors independently from their parents from around the age of five. Since the 1950s, however, space considered suitable for (independent) play outside has reportedly decreased [53–55]. Since play indoors is likely to be more sedentary, and ideas about appropriate thermal care for children had changed, practices of play became receptive to space heating. Because council houses did not become larger, space for children's play had to be created in existing rooms of the house. In part, this has been in the downstairs living rooms, but – depending on the child's age – bedrooms also became occupied by play.

While some of the older interviewees relate how it was common in the 1920s to start working at the age of 14, interviews covering the later decades of the case and beyond reflect national trends of young people's increased time spent in education, and the rise of the teenager with their specific needs for privacy [56]. As the quote below illustrates, in which Edward [1932] talks about the time when his teenage son lived with him in the 1980s, these trends had their effect on the way in which the home, and in particular the upstairs, was used.

> 'if guests came he'd invite them upstairs and sit and talk to them up there. [] If they wanted to talk about their escapades from the night before or what they were going to do. [] he'd watch his own telly up there.'
>
> (Edward [1932])

As hinted at by this quote, the rise of the television forms another

[6] Banking refers to the practice of piling up coal to keep the fire smouldering for longer periods of time so lighting becomes easier than when it is simply left to go out.

[7] The Parker Morris report for example, implicitly assumes the coal fired central heating to be off at night in using a maximum 16h of heating per day in their detailed cost calculations ([43], App 1).

development that is interlinked in the mesh of related changes that have fuelled a spreading of demand for domestic space heating to upstairs bedrooms. This role isn't limited to their direct role in the rise and use of bed-sitting rooms[8]; a study by Willmott et al. [57] into life on a London estate in the 1950s mentions the aim of keeping children 'off the streets' (p. 143) as a rationale for acquiring a television.

So, when relating demand for domestic heating to changing patterns of domestic practice, the partly co-evolving trends of increased time spent on homework and study by young people, television watching and declining outdoor play emerge as key dynamics that link trends in national policy, technology development and collective norms of good parenting to domestic energy demand. More specifically, what binds these trends in their link to domestic energy demand is their contribution to the process of generating new uses of heat – which together created fertile ground for gas central heating to become a success – through a move towards more sedentary, indoor activities.

4.4. Implications for contemporary energy policy

Although focusing on a specific geographic locale, house type, and time period, identifying these historic processes has implications for understanding broader, contemporary dynamics related to domestic energy demand, and therefore for shaping contemporary energy policy. Developments like the shift from solid fuel to gas fired heating, increases in time spent in education and on television watching, decreased outdoor independence of young people, increased women's employment and the rise of teenagers are not restricted to Stocksbridge, and can be assumed to have contributed to rising levels of demand for heat in other contexts.

More generally, highlighting the relation between changing spatio-temporal patterns of domestic life and levels of domestic demand for heating reveals a blind spot in the sorts of policies aimed at reducing the energy demands of space heating highlighted in the introduction. UK energy policies, and this is symptomatic for similar policies on EU [58] and international levels [1], are largely reliant on increasing the efficiency of the technical delivery of heat, while their conceptualisation of demand remains limited to thermostat settings. Acknowledging the relevance of these patterns for shaping levels of energy demand implies further research into contemporary dynamics. The case study provides some indications as to where potential for policy interventions may then lie.

For example, our material indicates that most interviewees do not routinely heat their bedrooms. Out of the seven interviewees with whom contemporary central heating systems and their use was discussed, four would have the heating off in their bedrooms permanently and six did not tend to routinely heat their bedrooms during the night. Two interviewees (Beryl [1948] and Barbara [1954]) even complain that when using central heating, their bedrooms can get too hot for sleeping, reflecting the idea expressed by Edward [1932] that 'it's healthier to have clean, fresh air upstairs'. John [1943] is an exception here. His family was the only one in the sample using central heating throughout the house and day/night. His remark that 'people don't wear pyjamas these days, I mean, we don't' illustrates that heated bedrooms have become assimilated in the family's ways of dressing and assumptions about normal living.

Although not common in our sample, this practice of sleeping-in-a-heated-space is assumed and encouraged in various contemporary professional standards and recommendations. For example, the European Commission's eco label Energy Star® accepts a default setting of up to 16.7 °C for the 'sleep' setting in its requirements for programmable thermostats [59]. And the UK's National Health Services 'Keep warm, keep well' campaign [60] recommends that specific vulnerable groups, including everyone over 65 years old, keeps their bedroom at 18 °C all night, while their 'Healthy sleep tips for children' even recommend bedroom temperatures between 18 and 24 °C [61]. There are, however, others who argue that sleeping in a heated space might have negative impacts. McAllister et al. [62] for example, list a reduction in the variability of ambient temperatures as one of the contributors to the obesity epidemic, and Nicol and Humphreys [63] argue for widening the range of temperature standards more generally.

Further research is needed to assess the current use, or non-use of heating in bedrooms, but our findings, worryingly, indicate that there is still potential for demand for domestic heating to increase from its current levels, and that national health policy is promoting a move towards filling it. And sleeping is not the only practice which is currently undergoing change in concert with changing demands for heat. Strengers et al. [64] identify an increasing use of mechanized climate control as part of pet care, while increased home working [65] also clearly has implications for heat demand at home.

In addition to pointing to particular areas for further research, the explanation for historic increases in domestic demand for space heating offered in this paper implies interventions beyond heating technologies and practices. Examples, building on the assumption that sleeping-in-a-heated-space is emerging, might be to slow and reverse cultural changes towards heated sleeping, such as through funding further research into the benefits of naturally fluctuating temperatures for healthy individuals. Beyond the topic of sleeping, another example of a 'demand-side' measure could be to combine forces with initiatives that aim to increase the time children spend playing outdoors (e.g. the National Trust's 'Wild Network'). Further research in this area could for example explore such historic patterns regarding demand for cooling, diversity between households regarding these patterns, and the role of processes of retrofit and adaptation in relation to spatio-temporal patterns of demand for heat.

5. Conclusions

The research underlying this paper set out to gain insight into the processes by which demand for domestic heating changed over time. Analysis of changes in housing design, heating provisions and patterns of domestic practice in seven council estates successively built between 1920 and 1970 in a Northern English town identified three key interacting processes that played out through a series of iterative cycles of co-evolving housing circumstances and patterns of living, and progressively contributed to a spread in demand for heat over domestic space and time. These processes can be summarized as: 1) materializations of ideals of separating domestic activities; 2) the delegation of work and control to infrastructures and appliances; and 3) the emergence of new uses for heat following from a shift towards more sedentary, indoor activities.

In light of the need for large scale reductions, more radical, effective measures to address levels of domestic demand for heating (or cooling) are likely to be required. From this account we learn that which parts of the home are heated (or cooled) when matters for levels of demand, and that how much of the home is heated for what parts of the day changes over time. It also becomes clear that various areas of policy – not just energy policy – have had an impact on how these spatio-temporal patterns of demand for heat changed. This insight reveals opportunities for energy policy to collaborate with other policy areas.

Moreover, our material, and related work indicate that not all homes are fully heated all of the time, but that various developments, in health policy, practices of pet care, but also the implementation of heat pumps (currently promoted as one of the main means to reduce demand) might be pushing demand for heat to spread further [67]. Recognizing such developments at their onset might help to prevent a ratcheting – as Shove [66] refers to it, of increasing standards of comfort in the home that are difficult to undo once they become embedded and materialised in socio-technical fabrics.

[8] By the turn of the century, 63% of British youngsters had a television set in their bedroom ([44], p. 21).

Moving from implications for policy to energy research, the particular approach taken in the study sheds new light on the merits and limitations of related work on understanding domestic energy demand. The distinctive historical approach taken has enabled a focus on longitudinal change which has foregrounded the specific materiality and spaces of the home as a significant participant in the dynamics of everyday practices, in concert with changes in appliances, infrastructures of supply, and changes to practices in other fields of life, such as children's outdoor play. Moreover, the case study fully implemented the idea that 'demand is an outcome of what energy is for' [33]. It therefore goes beyond a focus on heating technologies themselves, and beyond those practices involving direct engagement with them, neither does it centralize notions of service such as comfort. Instead, it explores how demand for heat is implicated in 'the array of interwoven social practices' [33] that make up domestic life. As a consequence, there is direct engagement with ideas of 'the good life' that circulate in society, forwarding sensitive tensions such as those between health and energy, implicating non-energy policy (see also Strengers and Maller [46] for a discussion about such tensions regarding cooling), new insight into how current expected levels of demand for domestic heating came to be, accompanied by new avenues for change, namely by curbing or reducing the spatio-temporal spread of demand for heat in the home.

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