UsersTCP | Hard-to-Reach Energy Users

SEA Sustainable Energy Advice

Hard-to-Reach Energy Users: A Literature Review

User-Centred Energy Systems TCP: HTR Task

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Executive Summary

Background and motivation for this research

Energy efficiency (EE) programme administrators and policy makers have long encouraged the adoption of energy-efficient technologies and conservation practices (Ashby et al, 2020a). Energy users who haven't yet participated in efficiency and conservation programmes despite ongoing outreach, are often referred to as 'Hard-to-Reach' (HTR), or 'underserved' (e.g. CPUC, 2018). These individuals or organisations can include, for instance, *low income* (e.g. Cluett & Amann, 2015) or other *vulnerable* (e.g. Cappers et al, 2018) energy users on the residential side; and *small businesses* (e.g. Trianni & Cagno, 2012) or *commercial building operators* (e.g. Cowen et al, 2018), on the non-residential side. More effectively engaging underserved and HTR audiences is key to ensuring everyone benefits equitably from EE policies and programmes (VEIC, 2019). This is even more the case in light of the COVID-19 pandemic caused by the SARS-CoV-2 virus, and the implications for energy use and affordability for the most vulnerable (and newly vulnerable) members of our society.

In June 2019, EE and HTR researchers, practitioners, and policy makers from Aotearoa New Zealand, Sweden, the United States, the United Kingdom, and Canada embarked on a 3-year project in partnership with the *User-Centred Energy Systems Technology Collaboration Programme* (*Users TCP*) by the International Energy Agency (IEA). The purpose of this initiative is to characterise the diverse energy user segments commonly referred to as HTR and to uncover the barriers and behavioural opportunities to more effectively engage these audiences. We focus on HTR audiences from the residential and non-residential sector in this project (see Rotmann, 2019).

Within this context, the aim of this review is to provide an overview of the literature on HTR energy users, and to highlight literature relevant to countries participating in the project. Where available, we provide statistics and research from each of the participating countries, but we do not explicitly pursue comprehensive cross-country comparisons. This literature review focuses specifically on:

- **Vulnerable households** (including low-income and energy-poor)
- **High-income** energy users in the residential sector
- **Renters and landlords** in both the residential and commercial sectors
- **Commercial** sub-sectors that are HTR, and particularly,
- **Small to medium enterprises** (**SMEs**, also called small to medium businesses, or **SMBs**, in the U.S. and Canada).

These priority audience segments were selected based on surveys and interviews with HTR experts as part of the HTR Task Year 1 deliverables (Ashby et al, 2020b), as well as the most-commonly mentioned HTR audiences in the literature reviewed here. The review serves as a preparation for specific case studies analysing various engagement strategies and behavioural interventions aimed at HTR energy users, in Year 2 of this research collaboration.

We describe in this review:

- *Different motivations* for researching HTR energy users
- *HTR definitions* and their critiques
- *Specific HTR audiences* and:
    - how to identify and define them
    - their demographic and psychographic characteristics
    - their specific barriers and needs
    - the approximate size of these populations

- Main *energy-saving behaviours (ESBs)* to target for these HTR energy users
- A *gap analysis* of what is missing in the residential and non-residential HTR literature.

Methodology

Our primary method for this work is a full, integrative, narrative literature review (Pautasso, 2013). As stated above, HTR segments were pre-selected based on the input we obtained from the surveys and interviews with HTR experts, and participating countries' priorities (Ashby et al, 2020b). Then, as a starting point, we conducted an external literature search for primary and secondary literature (including peer-reviewed publications in academic journals and books, internet sources, industry trade publications, news articles, and online government resources) from the last 15-20 years, focusing on HTR and underserved audiences. For data collection three methods were utilised:

1. **Outreach to our professional networks**: HTR experts kindly provided us with key literature on specific HTR audiences (e.g. SMEs, non-domestic literature, energy poverty).
2. **Keyword search**: We also undertook a wider online search in *SCOPUS, Academia* and *Google Scholar*, using relevant keywords. Publications were required to either mention and define HTR audiences and/or EE / behavioural interventions targeting such audiences to be regarded as highly relevant to this review. Over 500 publications were marked as either highly relevant or relevant following this search.
3. **Backward and forward reference searches** of key literature.

In total, we reviewed 871 technical and scientific publications, and over 1000 references (including websites, news articles and footnotes) all up.

Key findings

HTR Definitions

We identify research aimed at reaching those hardest-to-reach populations from several sectors, including outside of the energy sector. Particularly, the social service, education, crime prevention and health sectors have undertaken in-depth research on these populations, over many years (see table in **Appendix A**). In the most general sense, HTR refers to those audiences who are hard-to-engage, -motivate or -reach with (usually, top-down) interventions, programmes or services. Many valid critiques of HTR terminology are raised in the literature. We also uncover a large range of other terms used in describing HTR (not all of them apply specifically to energy users in the literature, although theoretically, they all could be used as such). These are:

- *Underserved*
- *Disadvantaged communities*
- *Socially disadvantaged*
- *Hard-to-help*
- *Hidden populations / hard-to-hear*
- *Illegalised, criminalised and stigmatised*
- *Under-represented / invisible*
- *Unchangeable*
- *Hard-to-count*
- *Hard-to-engage / motivate*
- *Understudied / underexplored*
- *Hard-to-treat (homes)*
- *Hard-to-heat / cool (homes)*

There are semantic challenges with all of these terms. For example, the terms used depend on who is using them to define the target group, or what their focus is (e.g. communication / messaging, uptake of programmes, recruitment of research subjects). Some of these terms seem to put the onus on the 'Behaviour Changers' (see Rotmann, 2016 and glossary of terms in **Chapter 2**) needing to do more to identify, find and engage those energy users (e.g. 'underserved', 'overlooked', 'understudied / under-explored'). Other terms shift the responsibility (often unfairly) to the individual energy users themselves (e.g. 'service resistant', 'hard-to-motivate', 'invisible'). Different perspectives of Behaviour Changers (e.g. policy makers vs utility programme managers vs social workers vs researchers) seem to lead to different usage of terminologies. At least two of these definitions - 'hard-to-treat' and 'hard-to-heat/cool' - refer to the home environment (or building characteristics), rather than the residents.

HTR Audiences

Vulnerable households

By far the most literature and research we found was focused on this audience group, which encompasses *low-income, energy-poor* and *otherwise vulnerable* (e.g. elderly or very young, rural, minority) households. Extensive debates about the proper terminology (e.g. energy vs fuel poverty; energy burden or hardship; underserved vs HTR; vulnerability) can be found in the literature, highlighting differences between countries - in both the use of terminology, and the metrics and indicators how to identify these HTR audiences. Of the participating countries, the most research and policy focus on vulnerable households has been in the UK, with Aotearoa also drawing strong links between energy hardship, inefficient housing and health. In the U.S., energy poverty is not a federally-recognised term, thus, most low income EE programmes are implemented by utility program administrators in individual states (see Bednar & Reames, 2020). Very little research exploring energy poverty has been undertaken to date in Canada. Sweden has the lowest occurrence of energy poverty in the world and thus has limited research and policy focus on this group (EEPI, 2019).

There is generally a strong call for equity and energy justice for these vulnerable groups, across all participating countries, and structural inequalities and racism are mentioned by much of the research (yet few HTR research efforts study the underlying causes). These structural inequalities have been exacerbated by COVID-19, and the estimated audience sizes (already very large pre-COVID in the U.S., UK and NZ) have increased significantly due to the serious health, unemployment and housing insecurities that are consequences of this pandemic (e.g. PHE 2020). An important issue when looking at audience characteristics, and how to identify and target them best, is to understand the various *intersectionalities* compounding vulnerabilities. In other words, it is common that an energy user who would be considered vulnerable due to one factor, is also vulnerable due to others (e.g. low-income minority immigrant women renters who do not speak the native language may find themselves much more likely to also suffer from energy poverty and structural inequality). It is difficult to estimate the audience size, due to those intersectionalities, and due to lack of data for some vulnerable audience types, but Ramsay & Pett (2003) estimated them to be over 50% of energy users. Post-COVID, this estimate is more likely to be true, especially in the U.S. and UK.

High-income households

The reviewed literature shows that *income*, and related affluence, lifestyles and consumption patterns play a very important role in large energy-use disparities. Income-driven energy use disparities are observed across *and* within countries. Irrespective of specific geographical boundaries, stark differences in energy use globally exist today: whereas the lowest-income decile uses 2% of total final energy, the top-income decile uses 39% (Oswald et al, 2020). From a conceptual point, the bulk of the studies addressing high-income households and energy-use disparities based their estimates on various terms associated with income statistics, economics and inequality. However, the literature that

explicitly addresses the psychographics, demographics and needs of high-income households is limited and fragmented. Consistent with this, knowledge about specific barriers to EE improvements or conservation behaviour appear to be scarce, and different views exist about the role of price mechanisms in sending the right incentives to promote efficient energy use among this segment. Some studies show high-income households being less motivated to participate or engage in EE programmes. The reviewed literature suggests that behaviours that greatly affect energy use within this segment are mostly related to *mobility, appliances* and *recreation*. If we take per-capita income or decile as metrics, the potential size of this audience is substantial. For example, and from a global perspective, the World Bank (2020b) estimates that the high-income population segment reached 1.21 billion in 2018.

Renters and landlords

This was one of the most extensive, and complex audiences considered here. Partly, this is due to including both the residential and non-residential sectors in this review. In addition, this is also because the rental sector and its buildings, audiences and stakeholders, and lease arrangements are highly varied, including between countries. A lot of literature focuses on highlighting audience demographics, and, to a lesser extent, psychographics, and we also focus on the housing / building characteristics as it has such a large effect on the rental population. The *split-incentive issue* (arguably its main barrier, see e.g. Williams, 2008; Johnson et al, 2009) is most-commonly mentioned, compared with other barriers, although many different barriers are highlighted in the literature depending on audience segment, sector and building type. However, there is a lot less research on specific behaviours to target for behavioural interventions in the rental sector. The size of this audience is very large in all participating countries - over ⅓ of all residential buildings are rentals in the U.S. (Joint Center for Housing Studies, 2015) and NZ (Johnson et al, 2018); almost 60% in Sweden (Statistics Sweden, 2016) and the UK (BEIS, 2019); and almost half of U.S. commercial buildings are rentals (DOE, 2016).

Commercial sector

The commercial sector is also highly complex, in that so many different subsectors, building and business types occur in this sector, and that the locus of decision-making is spread between a wide range of internal and external Behaviour Changers and energy end users. We describe these different variables in some detail in this chapter. We also focus on some general audience characteristics but delve into specific audiences of different subsectors, where available in the literature. Audience barriers are also obviously varied, depending on subsector, building and business type, as well as specific audiences. Audience needs, however, were little researched, although key drivers and motivators are mentioned in some of the subsector literature. Because of the limited literature, it is not possible to focus on dimensions or specific target behaviours, although we do give some examples of behaviours specific to certain subsectors. The audience size is, again, extremely large and variable, depending on subsectors. For example, the *office* sector is the largest in terms of commercial floor space (around 18% of U.S. commercial buildings according to EIA, 2012), and it is by far the most commonly-mentioned in the literature (Paone & Bacher, 2018; Chester et al, 2020). However, office energy usage is actually significantly smaller than that of e.g. *food services* (Billhymer, 2016), *retail* (Janda et al, 2015), and the *lodging* sector (Cingoski & Petrevska, 2016). There is some obvious overlap between audiences highlighted in this chapter, commercial tenants (discussed in **Chapter 5**) and SMEs (discussed in **Chapter 7**). We have done our best to avoid duplication.

Small to medium enterprises (SMEs)

The SME ‘sector’, or segment, is possibly the largest, and hardest-to-reach audience group we are looking at in this report. It is also the one with the least amount of EE and behaviour change literature and research. We describe specific commercial subsectors (which all exist in SMEs as well) in the **Commercial Sector Chapter 6** and thus focus on general SME audience characteristics, with some

specific SME subsector literature, where we can find it. Barriers are, again, probably the best researched aspect of SME audiences, with audience needs being studied the least. Again, it was not possible to focus on dimensions or specific target behaviours, although we do give some sub-sector examples, where possible. Over 99% of all businesses in the world fall under the SME definition (though it should be noted that definitions vary between countries, e.g. up to 50 employees in NZ but up to 500 employees in the U.S.). Over half of the commercial and industrial sectors' total energy use and greenhouse gas emissions are created by SMEs in most countries (IEA, 2015). There is a very high estimated potential for low- to no-cost energy savings in this sector (e.g. DECC, 2014; IEA, 2015), which is largely underserved by current policy and programme interventions.

Main barriers and needs for HTR audiences

Given the myriad energy users who could be considered HTR, we hypothesised that there would be a similarly diverse set of barriers believed to hinder their engagement. However, the literature repeatedly mentions the following group of key barriers that is common to a variety of HTR audiences (see also Ashby et al, 2020b):

- Competing priorities
- Financial considerations
- (Mis)trust
- Market failures such as split incentives
- Informational barriers.

A lot more focus in the literature is spent on describing barriers to engagement than the actual needs of HTR energy users. Very few papers actively undertake needs assessments (which involves collecting and analysing information on a target population, then using results to create behaviour energy profiles and an action plan specific to this audience) with HTR audiences or their advocates.

Target behaviours

There was also rather limited information on defining specific target energy-saving behaviours for HTR audiences (especially in the non-residential sector) - consequently overlooking greatest user need or potential to help overcome barriers. Non-energy benefits (IEA, 2014) and costs (Allcott & Kessler, 2019) were mentioned, yet remain under-explored in the HTR literature. Most 'behaviours' are actually focused on the technologies (e.g. *lighting, HVAC, appliances,* see Chester et al, 2020) rather than the underlying services or actual behaviours (*investment, purchasing, maintenance and repair, curtailment* etc., see Boudet et al, 2016) that require specific interventions to change them. To some extent, an exemption is found in studies addressing high-income households that identify specific energy services (e.g. *mobility*) and consumption categories (e.g. *travel*), or studies in the residential sector analysing certain interventions (e.g. via *RCTs*) to promote specific energy-saving behaviours. However, the lack of information about specific behaviours is common across reviewed audiences. This lack of clear definition (based on qualitative and quantitative data collection from defined audience groups, see Karlin et al, *forthcoming,* and Rotmann & Weber, *forthcoming*) of target behaviours is concerning, especially seeing that many COVID-19 response behaviours such as *reduced non-essential flying and commuting, teleworking* and more *active transport* behaviours, could also help with post-pandemic recovery and resilience efforts, if embedded long-term via policy measures.

Estimated HTR audience size

Depending on the definitions and metrics, the potential size of the HTR energy users group is vast; estimated by some publications (Ramsay & Pett, 2003; Meyers & Guthrie, 2006) to exceed 50% of the (UK and U.S., respectively) population. This is especially the case when looking beyond the residential sector. The rental sector alone (see above) makes up more than ⅔ of commercial and residential

properties in most countries. The number of low-income and vulnerable households and small businesses is expected to rise due to COVID-19, and the huge number of people who are newly unemployed, furloughed or who have lost their businesses because of the economic fallout following extended lockdowns. This suggests that it will be more important than ever for policy makers and programme managers to identify, define and engage this large user group as part of COVID-19 recovery efforts, particularly in countries where vulnerable households (will) face excess utility bills by being forced to stay and work (and school their children) from home[1].

Gap Analysis

Overall, the available literature determines to a large extent the resulting knowledge gaps. For example, there is more information on residential audience *demographics* (though it had limitations around age, gender, and particularly race, see VEIC, 2019) than *psychographics* (Freimuth & Mettger, 1990). *Multiple, or non-energy benefits* (NEBs; IEA, 2014) appear to be also largely overlooked in the residential HTR literature. *Equity* considerations, although mentioned as important motivators to focus on (e.g. high- versus low-income groups) are still rather understudied, especially their underlying causes (VEIC, 2019). Furthermore, while certain studies do provide interesting figures or insights (e.g. disparities in per-capita energy use within countries), data is often outdated.

That said, and relatively speaking, there is a lot more literature focusing on the residential than the non-residential (primarily, commercial) sector. *Multi-family apartments* (MFAs) were commonly-mentioned in the literature, though there is a dearth of examples focusing on low-income MFAs. The non-residential sector is significantly more complex and difficult, and can almost be categorised as 'hard-to-reach' in its entirety (with the possible exclusion of *office buildings*, see Chester et al, 2020). Some of the gaps and issues that were highlighted included:

- A wide variety of commercial *subsectors*
- Many different *building types*
- Different *locus of decision-making* and energy user motivations
- Different energy-saving *behaviours* depending on subsectors.

Conclusions

The reviewed literature suggests that the first challenge in relation to HTR energy users is conceptual rather than empirical. Defining who is 'hard-to-reach' is difficult, and there are many different terminologies and approaches, some more complex than others. HTR audiences are highly diverse, are found across different (country) contexts, and have different barriers and needs. Even the HTR audiences described in this document are not monolithic - there are undoubtedly nearly limitless sub-segments and intersectionalities within each audience detailed here. Despite differing market and policy contexts, common hurdles across all HTR audiences include competing priorities, financial barriers, split incentives, motivations and (mis)trust of authorities or agencies such as energy suppliers (Ashby et al, 2020b). Unlike specific market barriers or failures and technology solutions, behavioural factors seem to be less understood and utilised by Behaviour Changers in the field (Mourik & Rotmann, 2013). We argue that precise audience definitions and in-depth examination of their barriers and needs, as well as clearly identifying target behaviours are essential steps to design better policy interventions and measures for HTR energy users. These findings highlight important knowledge gaps in this area, and which subtopics are ripe for further research. Additional study is particularly needed to identify how to embed positive energy-using behaviours long-term, especially during this unique historical moment of the global COVID-19 pandemic.

[1] https://eciu.net/blog/2020/winter-lockdown-families-in-the-leakiest-homes-will-bear-the-brunt

Chapter 1 - Introduction

Background on this HTR Task

Why did the *Users TCP*[2] by IEA decide to start an international research collaboration on hard-to-reach (HTR) energy users? The predecessor of this research collaboration, called *Task 24: Behaviour Change in DSM – Phase I*[3] *and Phase II*[4] showed, over an 8-year research period, how to successfully apply behaviour change interventions in both theory and practice (see Rotmann, 2017a; 2018, for a summary of outputs). Rather than focusing on a specific disciplinary approach or model of understanding behaviour (Mourik & Rotmann, 2013), *Task 24* showed that facilitating multi-stakeholder collaboration, visualising the 'behavioural socio-ecology' (e.g. Moore et al, 2013) of a given energy system, and collecting 'human-centred metrics' in addition to energy or financial metrics (see SCE, 2015), could lead to designing and implementing highly successful[5] behavioural interventions (e.g. Cowan et al, 2018). What *Task 24* also revealed, however, is that most behaviour change and energy efficiency (EE) interventions focus on generic energy user audiences, like 'households' or 'offices'. These efforts often fail to define and characterise detailed audience profiles based on their relevant contexts, barriers and needs. There is usually also only limited assessment of which specific behaviours could and should be targeted for change, by whom, in what way, and how to effectively measure impact and success of behavioural interventions (Mourik et al, 2015; Rotmann & Ashby, 2019). In addition, so-called 'Behaviour Changers' (those agencies or individuals tasked to change energy user behaviours via policies, programmes or pilots, see Rotmann, 2016) often struggle to effectively engage some audiences – especially those commonly-termed 'hard-to-reach'.

Well-designed behavioural and energy-efficiency interventions, and a 'human focus' on energy use (rather than a technological one, e.g. Rotmann, 2017b), have usually been regarded as an afterthought, if at all (e.g. Dunlop, 2019; Mundaca et al, 2019). Behavioural interventions receive significantly less funding (e.g. Overland & Sovacool, 2020), research and policy attention (aside from various 'Nudge Units', e.g. Ewert, 2019) than technological solutions to the energy and climate crises (Mundaca et al, 2019). This oversight of a key area of robust research has contributed to continued increases in our energy consumption and related greenhouse gas emissions, with associated implications for global heating, ecosystem breakdown and social inequality. That said, the COVID-19 pandemic, and the immense, global response focusing largely on behavioural changes (Fetzer et al, 2020), highlights the importance of behavioural science (e.g. Bavel et al, 2020; Betsch, 2020) and well-designed interventions (Karlin et al, *forthcoming*). Many of the short-term behavioural responses, if embedded long-term, can also help improve EE, public health, social inequalities, and the quality of our natural environment - even supporting the 'just transition' of our energy system (Henry et al, 2020). However, what the pandemic has also made clear is that any improvements at the micro-level will not be visible at the macro-level unless a significant number of homeowners and businesses start to consume energy differently (e.g. Bhattacharjee & Reichard, 2011), and we achieve a global transition to a clean energy system (e.g. Steg et al, 2015). Another impact of the COVID-19 pandemic is that many more energy users will now likely fall into audience groups often regarded as HTR (e.g. low income, unemployed, vulnerable households, and small businesses; Mastropietro et al, 2020).

Sovacool et al (2018) call for energy social science research "*to improve in terms of rigour (depth), interdisciplinary reach (breadth), policy-relevance, and the communication of results*." We hope that the *Users TCP HTR Task*[6] can contribute to answering this call. This international research

[2] https://userstcp.org
[3] https://userstcp.org/task/task-24-phase-1-closing-the-loop-behaviour-change-in-dsm-from-theory-to-practice/
[4] https://userstcp.org/task/task-24-phase-2-behaviour-change-in-dsm-helping-the-behaviour-changers/
[5] https://www.toolsofchange.com/en/case-studies/detail/718/
[6] https://userstcp.org/task/hard-to-reach-energy-users/

collaboration between multi-disciplinary academics, behaviour change consultants, policy makers and practitioners (i.e. *breadth*) seeks to characterise, in detail, the various audience segments that are commonly, but also vaguely, referred to as HTR in both the residential and non-residential (primarily commercial) sectors (i.e. *depth*), and to uncover the barriers, needs and opportunities for more effectively engaging these segments (i.e. *policy-relevance*). We have designed, and will follow and test a robust research framework based on Karlin et al's (*forthcoming*) 'Building Blocks of Behaviour Change' (see also Rotmann & Karlin, 2020; Rotmann & Weber, *forthcoming;* and Figure 1, below). It draws on the philosophy of '*critical realism*', in that it partly reconciles *positivist* and *interpretivist* perspectives and is consistent with both quantitative and qualitative research methods (see Sovacool et al, 2018: Table 1; **Glossary of Terms**). This multilevel framework also sits within a hybrid space emphasising the complex interactions among *agency, structure,* and *discourse* (ibid).

Year 1 of this Task focused specifically on conducting *landscape* (this literature review) and *stakeholder analyses* (Ashby et al, 2020a and b). This overall 'Needs & Opportunities Assessment' encompasses the *DISCOVER* (landscape and stakeholder assessment) and *DEFINE* (target audiences and behaviours) phases shown in Figure 1. The countries formally participating in this project include Aotearoa New Zealand (NZ), Sweden (SWE), and the United States (U.S.), with additional in-kind support and co-funding from the United Kingdom (UK) and Canada (CAN). When reviewing the (English-language only) literature, we have focused largely, but not solely, on research from these participating countries. This was done in an attempt to enable some cross-country comparisons between different HTR audiences, their barriers and needs, and to characterise these sub-audiences, their estimated HTR population sizes, and target energy-saving behaviours (ESBs).

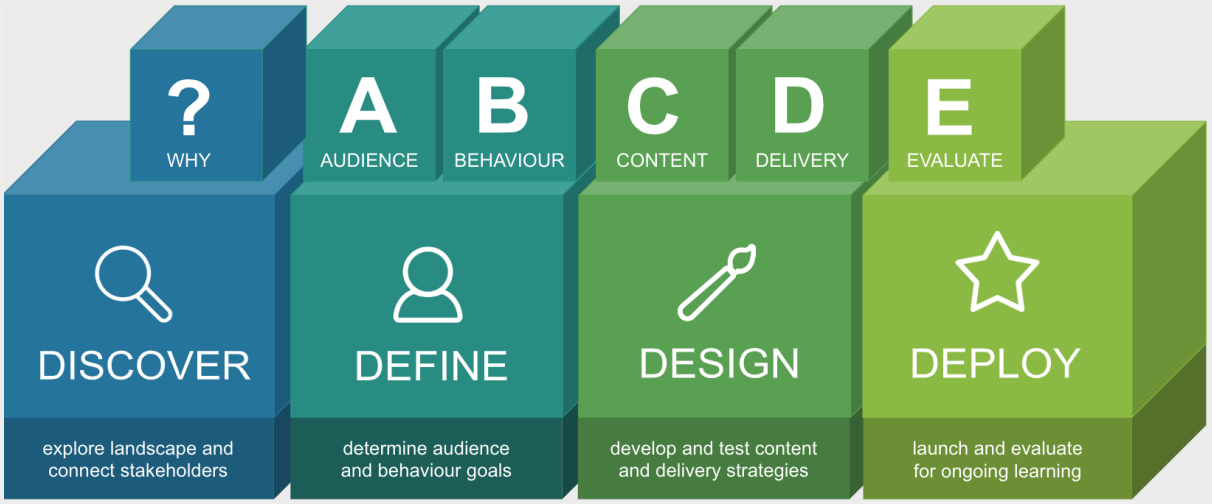


Figure 1: Building Blocks of Behaviour Change (Source: *See Change Institute*)

Motivation for engaging HTR Audiences

Regulated utility programmes

In the U.S. and Canada, EE programme administrators aim to better engage HTR audiences for several reasons (Ashby et al, 2020a). First, utility programme administrators recognise the *moral imperative* to ensure that all customers have equitable access to the value their EE programmes provide (e.g. VEIC, 2019). Additionally, many utilities have *mandates* specific to serving income-eligible and underserved customers within their service territories (e.g. Nowak et al, 2013; Drehobl & Tanabe, 2019). In some cases, these requirements include spending minimums for programmes aimed at these audiences. The first step to better serving those customers is defining and understanding these populations.

In addition, especially for regulated utility programmes, *participation* is an important metric for many aspects of EE programmes, including planning, development, implementation, evaluation, and efficiency potential studies (York et al, 2015). Despite the importance of participation data in many aspects of EE planning, this metric often does not get as much attention as energy-savings and cost-effectiveness metrics. As a result, the data is often not transparent or consistent. Regulators should also have access to better data and metrics on programme participation in order to enable tracking and assessing programme performance, but also for alleviating concerns about customer equity by fully assessing customer participation across entire programme portfolios (Woolf, 2013). These types of data are essential to track, assess, and address such underlying equity concerns (see also Bednar & Reames, 2020). They also are vital in identifying and serving HTR audiences.

Government goals and policy targets

In contrast, in Aotearoa, there is a highly deregulated utility industry (see Eusterfeldhaus & Barton, 2011). The main impetus behind government efforts to engage HTR is *improved health*, particularly for vulnerable populations (e.g. *Healthy Homes Initiative*[7], see Allen + Clarke, 2018), as is *equity*. NZ has particularly low-quality housing stock, which disproportionately leads to poor health and wellbeing outcomes for the most vulnerable (O'Sullivan et al, 2011; Howden-Chapman et al, 2012), including Māori and Pacific Island (Pasifika) communities (e.g. Howden-Chapman & Tobias, 2000; O'Sullivan et al, 2013). Government insulation subsidy programmes (e.g. *Warm Up New Zealand: Heat Smart*[8] or *Warmer Kiwi Homes*[9]) have also been less effective at reaching these groups compared to other populations (see Telfar-Barnard et al, 2011), and young people living in cold housing are at high risk for fuel poverty (O'Sullivan et al, 2017).

In addition, vulnerable energy users may suffer from split incentives, as they are predominantly renters in Aotearoa (see Johnson et al, 2018), and elsewhere (e.g. Pivo, 2014; Melvin, 2018). They may be underserved by their energy utilities as there are few utility programmes specific to these audiences, and they are often subject to higher pricing relative to their means. A recent *Electricity Price Review* (MBIE, 2019a) by the New Zealand Government was the first step towards addressing some of these systemic issues. Identifying, defining and characterising these populations in order to reduce the number of vulnerable New Zealand households and especially child poverty (NZ Government, 2018) was an important rationale for supporting this research effort.

The UK situation is similar to that of NZ in the sense that it also operates a highly-deregulated utility sector. Key drivers to engage HTR groups include the *moral imperative* to promote more *equity* across different socio-economic groups and reduce the *negative health* consequences to households with homes that are cold and unaffordable to heat. The UK has the least energy-efficient housing stock in Western Europe and energy prices are high relative to incomes (ACE, 2014; NEA, 2018). The UK's most vulnerable households are more likely to live in the worst performing properties (ACE, 2014), and the most vulnerable households have also been disproportionately affected by COVID-19 (Baker et al, 2020; NEA, 2020). Although much work has been done to understand the characteristics of HTR groups (see Ofgem, 2013 and 2019; Mould & Baker, 2017; Ambrose et al, 2019; and many others), policy initiatives designed to tackle the problem fail to reach those in most need (UKERC et al, 2018; Committee on Fuel Poverty, 2019). Ramsay & Pett pointed out in 2003 that competition between energy suppliers for the 'easy-to-reach and help' audiences is very high, and that there was concern from analysts of a diminishing return on these easy pickings, meaning that EE targets would not be met. This concern has more than borne out in the 17 years since.

Other mandates and drivers

[7] https://www.health.govt.nz/our-work/preventative-health-wellness/healthy-homes-initiative
[8] https://www.eeca.govt.nz/news-and-events/news-and-views/the-warm-up-new-zealand-insulation-programme/
[9] https://energysmart.co.nz/subsidies-and-grants/warmer-kiwi-homes/

In Sweden, the initial policy discourse to engage with HTR-related research or initiatives built upon two main aspects. First, when it comes to direct energy use, there are concerns about growing intra-national *energy use disparities*. This has led to *high-income, high-use* groups being mentioned frequently in Sweden because they are both hard to motivate using standard policy interventions (e.g. energy taxes), but also likely to be using an 'unsustainable' level of energy. The behaviours and motivations of this group are also the least understood (see **High Income Chapter 4,** below). Second, and when it comes to indirect energy use, *mobility* as energy service also deserves more policy attention. As the nation has become wealthier and purchasing power has increased, travel frequency and distances travelled have also increased, raising carbon emissions. Prior to the COVID-19 crisis, trends suggested that greater policy efforts to reduce energy use in certain population segments, such as very high energy users, and resulting consumption-based emissions were highly necessary. However, it remains to be seen how the COVID-19 crisis will reshape mobility patterns (e.g. Badr et al, 2020; Kanda & Kivimaa, 2020) and energy use (e.g. less use of public transport, more use of private cars, less travel abroad, much more teleworking with all its pros and cons[10], more energy use in the residential sector; e.g. NEA, 2020), and demand more specific (and urgent) policy interventions (see Mastropietro et al, 2020 for a review).

From stakeholder interviews in the participating countries, as well as from North American experts and utility program managers who gathered at our first HTR Task workshop in Sacramento (see HTR Task, 2020), it became clear that *equity* and *improved health and wellbeing* outcomes were major drivers to focus on the HTR (see Figure 2 below, for overarching goals in participating countries). However, staff from *Efficiency Vermont* (VEIC, 2019) pointed out that equity is an incredibly complex goal and noted how little equity considerations currently factor into energy industry thinking, compared with other sectors such as housing, and social and environmental justice (see **An important note on equity** section, below). Given that COVID-19 has disproportionately impacted the most vulnerable and minority groups, equity and energy justice considerations may be especially relevant during the pandemic recovery process (Brosemer et al, 2020; Henry et al, 2020).

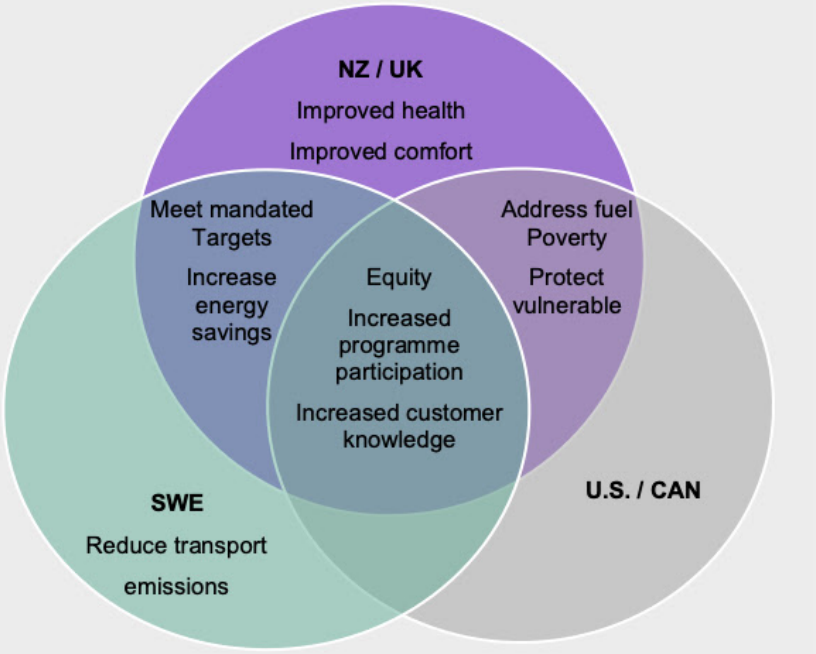


Figure 2: Venn diagram of overarching goals for countries participating in the HTR Task (Source: Ashby et al, 2020b)

[10] https://www.nytimes.com/2020/06/29/technology/working-from-home-failure.html

Added motivation in response to the COVID-19 pandemic

The rationale for participating countries focusing research on the HTR are further emphasised by the COVID-19 pandemic, related impacts and global response. As Brosemer et al (2020) write: "*The COVID-19 crisis is actively revealing crises of energy sovereignty (defined as the right for communities, rather than corporate interests, to control access to and decision making regarding the sources, scales, and forms of ownership characterising access to energy services) in at least four ways. First, there are many whose access to basic health services is compromised because of the lack of energy services necessary to provide these services. Second, some people are more vulnerable to COVID-19 because of exposure to environmental pollution associated with energy production. Third, energy services are vital to human well-being, yet access to energy services is largely organised as a consumer good. The loss of stable income precipitated by COVID-19 may therefore mean that many lose reliable access to essential energy services. Fourth, the COVID-19 crisis has created a window of opportunity for corporate interests to engage in aggressive pursuit of energy agendas that perpetuate carbon-intensive and corporate-controlled energy systems, which illuminates the ongoing procedural injustices of energy decision making*."

For example, new research (Dooley et al, 2020) shows that children from low-income families will be hit the hardest by those policy interventions, with energy use of some households with children rising by 75% (NEA, 2020). Sovacool et al (2020) summarise some of the worrisome public health and economic predictions, including that 300 million people worldwide are likely to lose their jobs. At the end of April 2020, more than half (54%) of the entire global population was under some kind of lockdown, with the share of energy use exposed to containment measures reaching 50% (Sovacool et al, 2020). In April 2020, when Europe was declared the center of COVID-19 outbreak by WHO, all European countries except for Sweden (due to its different policy on lockdowns), showed major electricity demand reductions (e.g. up to 25% in Spain; see Bahmanyar et al, 2020). The mobility index for most major cities was below 50% (for American ones it was below 20%) at the end of June 2020 (Abu-Rayash & Dincer, 2020). In addition, a large part of the world is in mental distress, which will likely last post-COVID-19 (Abu-Rayash & Dincer, 2020). We also know that certain behavioural changes, like working from home, differed between different energy users (e.g. the most vulnerable, low income households who often included essential workers, were also the ones least likely to be able to work from home[11]).

No research effort focusing on behaviour change and HTR audiences can shy away from the short- (during COVID-19 *response*), medium- (*recovery* post COVID-19 lockdowns, but before a vaccine has been deployed globally), and long-term (building post-pandemic *resilience*) impacts, positive and negative, that this pandemic has wrought - although undertaking energy social science research under these circumstances certainly brings added challenges and uncertainty. As Fell et al (2020), in an *Energy Research and Social Science* Special Section on COVID-19 and energy research (ERSS Volume 68), warn: "*The magnitude, speed, and reach of the changes to our lives are of a different order to anything that most people alive today have experienced. Given the scale and rapidity of change, how can we ensure that conclusions drawn from data collected during the pandemic are valid, representative, generalisable to a post-pandemic world, and comparable to the pre-pandemic one?*"

Although the COVID-19 pandemic may eventually abate, its significant *economic* (e.g. widespread unemployment, whole job sectors disappearing), *health* (e.g. chronic illness and disabilities, susceptibility to other respiratory diseases), and *social* consequences (e.g. high level of evictions and homelessness, compounded structural inequalities) will likely persist (Kanda & Kivimaa, 2020). In addition, the number of people who will fall into the various HTR audiences described here, has certainly increased due to COVID-19. Vulnerable households and businesses will likely suffer disproportionately from additional global challenges, such as the climate crisis, economic recession /

[11] https://www.rapidtransition.org/stories/when-behaviour-changes-overnight-from-stay-at-home-to-smoke-free-air-and-switching-sides-of-the-road/

depression, racial protests etc. (Chen et al, 2020). On a positive note, COVID-19 could also lead to improved *environmental* outcomes (e.g. reduction in greenhouse gases and air pollution; Bauwens et al, 2020), ongoing embedded *behaviour changes* (e.g. more work from home, less non-essential flying; Fell et al, 2020; Kanda & Kivimaa, 2020; Abu-Rayash & Dincer, 2020), and systemic *governance changes* (e.g. improved social welfare, just energy and labour transitions; Henry et al, 2020; Kuzemko et al, 2020). This pandemic has certainly helped to highlight deep, structural inequalities in our societies, and foster research on (newly) vulnerable populations who are in dire need of support, and who are often also hard-to-reach for energy Behaviour Changers.

Shared goal of this HTR Task
In the first HTR Task workshop (HTR Task, 2020), National Experts and funders of the research developed the following shared goal (see HTR Task website for glossary of certain terms):

"Our shared goal is to identify, define, and prioritise HTR audiences; and design, measure and share effective strategies to engage those audiences to achieve energy, demand response and climate targets while meeting access, equity, and energy service needs."

An important note around equity in the clean energy sector
When we asked about a focus on income inequalities and other vulnerabilities, the motivation of achieving 'equity' (e.g. to EE programmes and affordable energy access) came up often among the funders and stakeholders of this research collaboration (Ashby et al, 2020a and b). It is indeed a hugely important consideration, especially in light of COVID-19 and the vast inequities and inequalities the virus has exposed in our societies - for example, how it caused much higher death rates in *Black, Asian and Minority Ethnic* (BAME) health workers[12] in the UK and among *African-American*[13] and *Pasifika*[14] populations in the U.S., *women* in NZ[15]; and the *elderly* in Sweden[16]. Inherent, systemic vulnerabilities of these populations have been exploited by this virus, replicating and increasing existing inequalities (Fawcett Society, 2020; PHE, 2020; Brosemer et al, 2020). They will also be the hardest-hit from the economic fall-out[17] and other environmental impacts (Shonkoff et al, 2011).

The pandemic has particularly hit *women* (Fawcett Society, 2020; PHE, 2020; WBG, 2020; Wenham et al, 2020), especially *BAME women*, as well as the *elderly* (PHE, 2020) very hard, increasing the need for targeted research on *gender / age / race* and EE (highlighted by VEIC, 2019; Fell et al, 2020; see also **Appendix D**). This makes it even more important that policy makers and programme managers do all they can to identify and target these HTR groups (especially those with several intersectionalities) with specific (energy) policies and programmes that help (re)build their resilience. Bednar & Reames (2020) also call for a federal recognition of the ⅓ of U.S. households living in energy poverty in order to better address the structural inequalities they are facing.

VEIC (2019) published an in-depth analysis into standardising equity measurements in the clean energy sector, which has several implications on the HTR audience groups we are reviewing here. The authors lament that the term 'equity' is rarely used in the U.S. clean energy industry (which spends by far the most money, annually, on targeted EE and behaviour change interventions[18]) and

[12] https://www.theguardian.com/world/2020/may/25/six-in-10-uk-health-workers-killed-by-covid-19-are-bame
[13] https://www.theguardian.com/world/2020/may/07/black-people-four-times-more-likely-to-die-from-covid-19-ons-finds
[14] https://www.theguardian.com/us-news/2020/may/22/pacific-islanders-california-coronavirus-death-rate
[15] https://www.stuff.co.nz/business/women-of-influence/122366842/women-bearing-brunt-of-covid19-job-losses
[16] https://foreignpolicy.com/2020/06/23/sweden-coronavirus-failure-anders-tegnell-started-long-before-the-pandemic/
[17] https://www.forbes.com/sites/korihale/2020/03/17/the-economic-impact-of-covid-19-will-hit-minorities-the-hardest/#7bf41e2010c0
[18] https://www.eia.gov/todayinenergy/detail.php?id=42975

mostly refers to an equitable split in programme spending between the residential and commercial sectors, in proportion to the fees collected from utility ratepayers to fund the programme. The main focus of EE programme administrators in the U.S. is on *low-income* customers, as they are relatively easily identified and targeted with e.g. *Weatherization Assistance Programs* (WAPs; see Bednar & Reames, 2020). Other target HTR audiences are *renters*, and a few programmes target the *geographically-remote* or *non-native language speakers* as well as *small businesses* (VEIC, 2019)*, including minority-owned and women-owned SMEs* (Commonwealth of Massachusetts, 2020a).

The most common terms used in the U.S. clean energy industry for vulnerable energy users are: *low-income, energy burdened, hard-to-reach, underserved,* and *disadvantaged* (VEIC, 2019). Even though key indicators (e.g., *energy burden*) are commonly measured, the clean energy industry does not explicitly address the underlying ethical concept that it is unfair for some people to have a bigger burden than others. It could of course be argued that this is not directly their mandate, which is more around ensuring equitable access to clean energy and EE programmes. However, not adequately targeting HTR audiences using specific demographic and psychographic data when designing EE interventions, does mean that there continues to be something of a blind spot in understanding why they might be hard-to-reach. VEIC (2019) also assert that the lack of focus on important demographic indicators of vulnerability such as *race, gender and age* is due to programmes in the clean energy sector being designed and implemented by a certain demographic ('white, male and middle class', see also Coleman, 2011; Reid et al, 2015; and Waitt, 2017) that does not necessarily represent and understand the audiences that these programmes aim to engage. In order for us, globally, to achieve greater equity in the clean energy sector, as well as target and support the most vulnerable energy users, we will need to shift from these rather one-sided perspectives, and we will need to do so fast.

Research questions

In the *HTR Task Work Plan* (see Rotmann, 2019), we describe several motivations for this research, and underlying research questions. The motivations underpinning this literature review are:

1) *To explore the many differing definitions of what constitutes a 'hard-to-reach' (and thus -motivate and -engage) energy user in the residential and non-residential sectors and to assess different approaches and barriers when targeting these users.*

   Associated research questions (for this review):

- Who are the main HTR energy users in each participating country?
- How can they be defined and characterised?
- How materially are these HTR segments underserved (by current policies and programmes)?

2) *To test the hypothesis that this underserved user group may entail a large number of energy users (>30%), which also means that there is significant potential for energy efficiency and conservation improvements targeting these specific audiences.*

   Associated research question (for this review):

- What is the approximate, estimated size of the HTR user group in each participating country?

Research objective

The overarching objective of this research is to provide country participants with the opportunity to learn and share successful approaches on how to identify and better engage HTR energy users. The

research will facilitate the development and testing of a robust social science-based framework for designing policies, pilots and programmes that are better tailored to specific HTR audiences and specific target behaviours.

The main objective of this literature review is to assess existing HTR research in order to:

- Identify priority HTR audiences
- Characterise and describe these HTR audiences using demographic and psychographic data, as well as audience barriers and needs assessments
- Understand the wider contexts and dimensions influencing these audiences
- Identify specific energy-saving behaviours to target for these audiences
- Estimate the size of these audiences (and how that may have changed with COVID-19)
- Undertake a gap analysis of the research on HTR energy users.

Chapter 2 - Methodology and Glossary

Literature review methodology

Our primary method for this work was a full, integrative, narrative literature review (Pautasso, 2013). We intend this review to be a compilation and integration of existing research, to help us identify the current state of knowledge on HTR energy users, and identify specific research gaps. As a starting point, we conducted an in-depth search for primary and secondary literature on HTR energy users (focusing on peer-reviewed publications in academic journals, but also including internet news sources, industry trade publications, and online government resources, where relevant) from the last 15-20 years. In this literature search, we used three methods:

1. **Outreach to personal networks**. The *IEA DSM* (now *Users TCP*) *Task 24* research collaboration on *Behaviour Change in DSM* identified a number of international case studies and behaviour change and/or HTR experts, including several PhD students and government funders. They kindly provided us with key literature on specific HTR audiences (e.g. SMEs, non-domestic literature, young adults, energy poverty). We collected this literature (over 200 publications) in a shared *Mendeley* library.

2. **Keyword search**. We also undertook a wider online search in *SCOPUS, Academia* and *Google Scholar*, using keywords ('hard-to-reach', 'energy (efficiency) AND hard-to-reach', 'energy (efficiency) AND underserved', 'energy (efficiency) AND vulnerable'). We excluded articles from medicine, nursing, mathematics, physics, earth sciences and engineering. All up, we identified over 1000 publications, which we further broke down into being highly-relevant (green), somewhat relevant (orange) and not-relevant (red) for this literature review (see key research questions, in the **Introduction Chapter 1** above), using a traffic light system in a shared *Literature Master List*. Publications were required to either mention and define HTR audiences and/or energy efficiency (EE) / behavioural interventions targeting such audiences to be regarded as highly-relevant to this review. Over 500 publications were marked as either highly-relevant or relevant, following this search.

3. **Backward and forward reference searches**. Finally, in the most high-impact / key publications we searched the references or works cited in those articles (backward search) as well as articles that cited those articles (forward search).

We also *Google* searched for country statistics (e.g. for audience size estimates) for our participating countries. In the end, we read, analysed and synthesised 871 different publications from all over the world (excluding the news articles and websites presented in footnotes here - this would bring the total number of sources to well over 1000). This review thus likely represents the most detailed and comprehensive collection of literature that is useful to characterise and define HTR energy users and the wider contexts surrounding them. We focused predominantly on publications offering *definitions and critiques of HTR terminology* as well as other *energy user audience characteristics* (such as demographics and psychographics, barriers, needs and dimensions) and, to a lesser extent, specific *energy-using behaviours* that were targeted in the HTR literature. We also provided an overview of estimates of *audience size*, where possible, and a *gap analysis* of HTR research.

To the extent possible, we aimed to provide something of a cross-country comparison between the participating countries. Considering the limitations mentioned below, we specifically looked for (English-only) publications on Sweden (*n = 40*), Aotearoa (*n = 50*), the U.S. (*n = 127*) & Canada (*n = 8*), and the UK (*n = 113*). Figure 3 shows the country breakdown of publications related to the topic of

HTR, with North America and the UK providing almost 60% of all country-specific literature. This comes as no surprise, due to their much larger populations than NZ and SWE (which also does not have English as a native language). 'Other' (*n=57*) included publications from South America, Africa, Asia, Australia, and individual EU nations (not captured under the EU heading [*n=23*], which refers only to cross-EU research), with most of the remaining country-specific research coming from Australia (*n=11*), China (*n=14*) and the Netherlands (*n=5*).

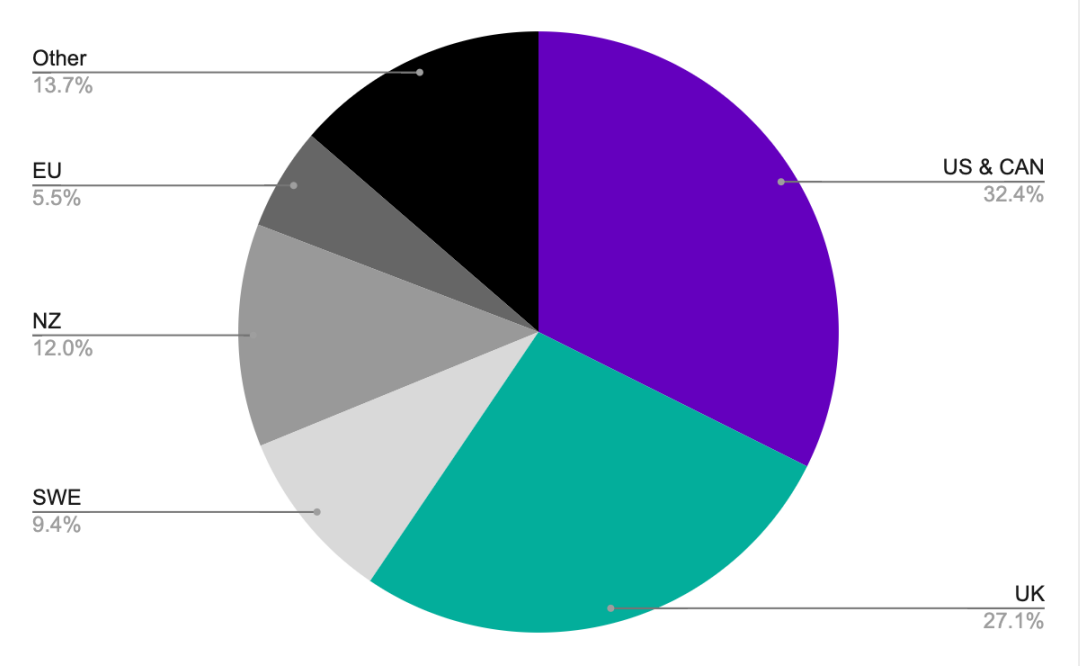


Figure 3: Breakdown of country-specific publications in this review.

When we broke down the publications by chapter, the audience **Chapters 3-7** had the highest number of publications, as expected (*n = 670*). It is worth highlighting that **Chapter 3,** focusing on *vulnerable* (including low-income and energy-poor) *households* contains almost twice as many publications (*n = 270)* as the two next-largest audience chapters (**Chapters 4** [*n = 143*] **& 5** [*n = 120*]). The non-residential chapters (*commercial* **Chapter 6** [*n = 93*] and *SMEs* **Chapter 7** [*n = 45*]) combined include only half the literature of **Chapter 3**. Also worth highlighting is that we found 33 new publications on COVID-19 and its potential impacts on HTR energy users.

Scope

This literature review focused specifically on the following audiences. It includes literature where they were addressed both explicitly (by being called HTR or underserved), and implicitly (by describing interventions aimed at these groups, but not specifically naming them as HTR):

- *Vulnerable households* (including low-income and energy-poor households, **residential**)
- *High-income energy users* in the **residential** sector;
- *Renters and landlords* in both, the **residential and commercial** sector
- *Various **commercial** sub-sectors* that are HTR, but particularly
- *Small to medium enterprises* (SMEs, **commercial**).

These focus audience segments were selected based on surveys (n=139) and interviews (n=49) with HTR experts (Ashby et al, 2020a and b; see Figure 4), as well as the most-commonly mentioned HTR audiences in the literature reviewed here. We have not (yet) focused on specific case studies showing various engagement strategies and behavioural interventions, as this will form part of separate publications with 19 case studies from 8 countries (**Case Study Analyses**) in Year 2.

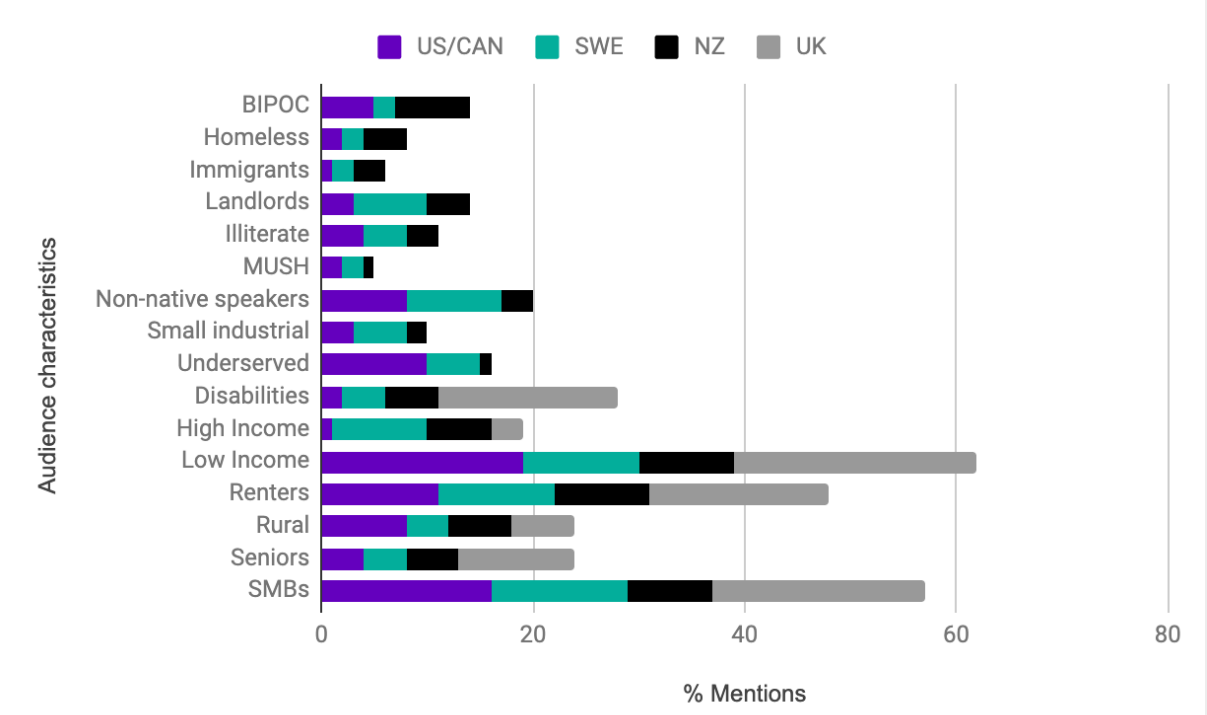


Figure 4: Percentage Mentions of HTR audience characteristics by country (Source: Ashby et al, 2020b).

Limitations

The main limitation is that this literature review was conducted on English-language literature only. Seeing that one of our participating countries (SWE) conducts and publishes research in both Swedish and English, we may not have captured all, or even the most-relevant literature from this country here. That is why this is not a comprehensive cross-country analysis of the HTR literature, although we do try to provide HTR audience statistics and examples from all participating countries, where possible.

We also occasionally provide some statistics and field research examples from countries other than the ones participating in this HTR Task, but only where they contribute interesting or unique facts. For example, there are important differences in manufacturing SMEs in developed vs developing countries, and seeing how large this market segment is in developing countries (and how much all of our supply chains depend on them), we deem them worthy of investigation by a 'global' research collaboration such as this one.

It is also important to note that, seeing that this review focused on HTR definitions and audience characteristics, we kept specific definitions in block quotes, rather than attempting to rephrase them. This was done to preserve the original language and semantics by the authors, which enables us to probe further into their intention.

We go in more detail into the gaps in the literature (quite significant for some sectors and audiences) in the **Gap Analysis** of the literature, presented in **Chapter 8,** and **Appendix D**.

Glossary of terms

We have provided a glossary of commonly-used terms in this report, and where they derived from, below.

Energy efficiency reduces the final energy consumed while achieving the maximum energy services possible (Lopes et al, 2012). According to the U.S. Energy Information Administration (EIA), "*unlike*

conservation, which involves some reduction of service, energy efficiency provides energy reductions without sacrifice of service". The World Energy Council (2008) considers energy efficiency a matter of individual behaviour reflecting the rationale of energy consumers, and of using the appropriate technology, such as thermal regulation of room temperatures or automatic standby mode for idle equipment.

Energy conservation is, according to the U.S. EIA "*a reduction in energy consumption that corresponds with a reduction in service demand...unlike energy efficiency, which is typically a technological measure, conservation is better associated with behaviour, habits and routines*" (see also Lopes et al, 2012).

Energy behaviour refers to "*all human actions that affect the way that fuels and carriers (electricity, gas, petroleum, coal etc.) are used to achieve desired services, including the acquisition or disposal of energy-related technologies and materials, the ways in which they are used, and the mental processes that relate to these actions*" (Rotmann & Mourik, 2013).

Behaviour change thus refers to "*any changes in said human actions which may be directly or indirectly influenced by a variety of interventions (e.g. legislation, regulation, incentives, subsidies, information campaigns, peer pressure, infrastructural changes etc.) aimed at achieving specific behaviour change outcomes*" (Rotmann & Mourik, 2013).

Behaviour Changers are "*those people, organisations or groups who are tasked with, and can affect the conditions for energy saving and efficiency behaviours in end users. They fall into five main segments:* Government *('the Decision-makers'),* Industry *('the Providers'),* Research *('the Experts'),* Service Sector *('Middle Actors', see Parag & Janda, 2014) and the* Third Sector *('the Conscience'). Each one of the Behaviour Changers has important tools at their disposal, but each also faces restrictions due to their specific mandates and stakeholders. They may have expert knowledge needed for saving energy; or have information about the occupancy and energy use of residences throughout the year; or have knowledge about the heating and cooling systems or other appliances; or have influence on decision-making that affects current practices; etc*." (Rotmann, 2016).

Targeted energy-saving behaviours (ESBs) are those clearly defined by Behaviour Changers who are targeting change in these behaviours in specific audiences via behavioural interventions (see definition for behaviour change above to how broadly we apply the term 'interventions' here, Rotmann & Mourik, 2013). These interventions, which can be policies, programmes, projects or pilots, are typically based on implicit or explicit application of behavioural theories and models.

Behavioural theories and models include "*all theoretical approaches and insights to investigating, assessing and measuring energy-using behaviours and theories to change them on the individual and societal level*" (Rotmann & Mourik, 2013).

Policy measure refers to "*a specific type of political action or market intervention designed (usually by [national and/or federal] government) to persuade energy consumers to improve energy use and encourage market parties to promote energy-efficient goods and services*" (Rotmann & Mourik, 2013).

Programme is "*an organised set of projects targeted towards defined parties over a specific time period to achieve increased end-use EE or reduced use of energy services. A package of selected policy or practical measures may be used. This selection is based on a programme theory*" (Rotmann & Mourik, 2013).

Project is "*an organised set of activities to create output/s*" (Rotmann & Mourik, 2013).

Pilot refers to "*a smaller study (often called feasibility study) conducted in advance of a planned project*" (Rotmann & Mourik, 2013). A pilot may also be a small-scale, shorter-term test of a programme to assess efficacy prior to a potential full rollout among a larger group of energy users.

Intervention can be defined as "*a system, institution, a programme, a service or a combination thereof except when purposely distinguished; for example, the offering of energy conservation techniques is a discrete intervention but implicates a bigger programme (the energy conservation service provider) or institution and system (the energy utility and its investors, employees, governing bodies, and regulatory framework*"; see Martín & Lewis, 2018).

HTR Audience refers mostly to energy users in the residential and non-residential sectors who are regarded as hard-to-reach, but also includes HTR Behaviour Changers, allies and stakeholders (Rotmann, 2019).

Underserved energy users are people or populations (Ashby et al 2020a):

- Who are marginalised or otherwise not served equitably in our society;
- Who do not receive commensurate benefits in return for their ratepayer[19] funding of programmes and services;
- For whom "*outcomes represent less than the target population share relative to the total population or…targeted programme impacts are less than those from other programmes on a per participant basis…*" (from VEIC, 2019);
- Whose 'Participation Rate' or 'Participant Distribution' dips below a predetermined threshold, calculated as (from VEIC, 2019):
    - Participation Rate = (Number of programme participants from energy user group) / (Total number in energy user group)
    - Participant Distribution = (Number of programme participants from energy user group) / (Total number of participants in programmes).

Vulnerability can be understood as "*the conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards*" (Barth & Vincent, 2018).

Vulnerable households are those with one or more members that meet the criteria for vulnerability outlined above; e.g. those living on low incomes, pensioners, those that are chronically sick or living with a disability, or people living in rural areas (Atherton, 2018). The concept of 'vulnerability' is central to understanding 'hard-to-reach' in an energy context. Households in vulnerable circumstances are often the same as those described as HTR and there are similar debates on how vulnerability should be understood.

Unmet demand occurs *"when the amount of energy needed in the home exceeds the amount of energy a household can access or afford to purchase. Where there is unmet demand a household may endure substandard living conditions, reduced usable living space or resort to dangerous alternative heating methods" (IEA, 2011).*

Equity at any point in time is "*the aggregation of past actions and outcomes that resulted in disparities. The original disparity and its effects may persist. The community that was negatively affected by a past disparity may also connect all programmes governed by similar service structures as part of the same system that caused the disparity regardless of whether an individual programme was responsible*" (Martín & Lewis, 2018).

[19] Note that this refers to utility ratepayers in the U.S., not homeowners (see Rotmann & Ashby, 2019)

Energy insecurity is defined as "*an inability to adequately meet basic household energy needs*", although various behavioural, physical and economic dimensions intersect to create a mutually-reinforcing phenomenon. A common concept in the United States, household energy insecurity "*varies in severity depending on a combination of parameters such as usage, payments, budgets and other factors, to provide a measurement of self-sufficiency*" (Colton, 2011). Jessel et al (2019) proposed the new terms 'acute' and 'chronic' energy insecurity to further understand and break down household energy issues.

Energy justice "*promotes equity for vulnerable populations throughout the energy production and consumption continuum, and recognises sacrifice and insecurity as central tenets of the present energy landscape*" (Hernández, 2015). Energy justice seeks to embed principles of justice, fairness and social equity into energy systems and energy system transitions, favouring a move toward healthy, sustainable energy production and access to the best-available energy infrastructure that provides affordable energy and uninterrupted service. The three core tenets of energy justice include:

1. *Procedural justice* - the ability of people to be involved in decision-making procedures around energy system infrastructures and technologies
2. *Distributional justice* - questions of the siting of energy infrastructure and economic issues of benefits and burdens ('who gets what')
3. *Recognition justice* - understanding the basis for social inequalities and the acknowledgement or dismissal of marginalised and deprived communities in relation to energy systems (Sari et al, 2017).

Institutionalised racism is defined by Jones (2000; in Signal et al, 2007) as "*...differential access to the goods, services, and opportunities of society by race. It is structural, having been codified in our institutions of custom, practice, and law, so there need not be an identifiable perpetrator. Indeed, institutionalised racism is often evident as inaction in the face of need*."

Deprivation is classified using the *Index of Multiple Deprivation* and encompasses a wide range of aspects of an individual's living conditions including income, employment, education, health, crime, housing and living environment (PHE, 2020).

Energy poverty is, according to the *European Commission* (but see different definitions for different EU nations in Insight_E, 2015; NEA, 2019), "*the need to spend more than 10% of a household's income on energy costs in order to maintain an adequate level of warmth*." This 10% threshold is also commonly used in the U.S. (VEIC 2019), although the U.S. has not formally recognised energy poverty as a problem distinct from general poverty at the federal level (see Bednar & Reames, 2020). Current measurement and metrics in the U.S. hinge on the distribution of government resources and the number of vulnerable households assisted, rather than improving household well-being and reducing overall energy poverty (ibid). Energy poverty is also broadly understood as the inability of a household to achieve sufficient energy services, due to a combination of access, affordability, energy efficiency of housing and appliances, and needs. It is commonly termed 'fuel poverty' in the UK (Boardman, 1991; DECC, 2012).

Energy burden is a term more commonly-used in the U.S., and includes the following process (VEIC 2019): "*The amount of energy consumed multiplied by the price of energy equals a household's energy spend. Energy burden is then calculated as a household's annual spend on energy, divided by their annual income. Most programmes use U.S. Census data to capture income data."*

Fuel or energy hardship is a term more commonly-used in Australia and Aotearoa (e.g. Willard et al, 2017; MBIE, 2019a), and includes: "*...households that cannot afford to heat their homes adequately, or*

afford other basic energy services, for example, sufficient hot water. In some cases households may not be able to afford heating at all" (Statistics NZ, 2017).

Excess Winter Deaths (EWD) reflect how many more deaths there are during winter months compared with the non-winter months of the year (UK Power Networks, 2014).

Weatherisation refers to "*retrofit measures taken to improve a building's resilience to the elements. Weatherisation measures address the building shell and ventilation as well as internal components such as water heating and piping insulation and replacing inefficient appliances and equipment*" (IEA, 2011). It generally improves the energy efficiency of a home.

Intersectionality is the "*interconnected nature of social categorisations such as race, class, age, and gender as they apply to a given individual or group, regarded as creating overlapping and interdependent systems of discrimination or disadvantage*" (based on definitions from *Oxford Languages*). In other words, it is common that an energy user who would be considered vulnerable due to one factor, is also vulnerable due to others (e.g. low-income minority immigrant women who do not speak the native language may find themselves more likely to also suffer from energy poverty and structural inequality).

High-income households are defined here as households that belong to the top income decile (or quintile), and exhibit considerably high, unsustainable energy use patterns (or energy footprints).

Split incentives arise between a building owner and tenant when "*capital improvements that yield energy savings result in one party paying for improvements while the other party receives the benefits of reduced utility costs*", according to the U.S. *Consortium for Building Energy Innovation*.

Principal Agent Problem (PAP) is an economic term. "*The split incentives between renter and owner are a classic example of a PAP. In a typical PAP, the agent is entrusted to carry out an important task on behalf of the principal. The agent may lack sufficient incentives to carry out his responsibility, however, and it is often difficult for the principal to monitor the actions of the agent to ensure that the task is carried out with due diligence. The essential elements of a principal-agent problem include: transaction (or agency) costs of monitoring the agent's performance; misaligned incentives; and asymmetric information*" (Williams, 2008).

Socio-technical refers to a perspective "*which acknowledges the interrelatedness of social and technical aspects of an organisation or society as a whole*" (CSE & ECI, 2012).

Subjective norms refer to the belief that an important person or group of people will approve and support a particular behaviour. "*Subjective norms are determined by the perceived social pressure from others for an individual to behave in a certain manner and their motivation to comply with those people's views*" (Ham et al, 2015).

Rebound effect (also called 'Jevons Paradox') The *European Environment Agency* (EEA, 2013) differentiates between three types of rebound effects:

- *Direct rebound effect*, where increased efficiency and associated cost reduction for a product / service results in its increased consumption because it is cheaper.
- *Indirect rebound effect*, where savings from efficiency cost reductions enable more income to be spent on other products and services.
- *Economy-wide rebound effect*, where more efficiency drives economic productivity overall, resulting in more economic growth, and hence additional consumption at a macroeconomic level.

'Prebound' effect refers to "*a recurring gulf between the quantity of energy predicted that will be needed by governments for different types of housing, and the amount homeowners actually use. The discrepancy is greatest among the least energy-efficient homes, where householders appear to be consuming far less than national energy usage standards predict*" (see Sunikka-Blank & Galvin, 2012; van den Brom et al, 2018).

Demographics are the statistical characteristics of human populations (such as age, gender, education or income) used especially to identify markets and population or audience segments.

Ethnicity is "*the ethnic group or groups that people identify with or feel they belong to*" (Marriott & Sim, 2014).

Psychographics is the "*study and classification of people according to their attitudes, aspirations, norms, and other psychological criteria*" (e.g. motivation to engage; energy literacy; awareness; energy knowledge; concern and connection; personal and social norms; performance and response efficacy; see SCE, 2015).

HTR Dimensions are defined as the group of elements or properties that support the characterisation of a given HTR segment and help determine the breadth and depth of current related knowledge. HTR dimensions include economic, social, technical, geographical, legal, institutional and psychological aspects, for example. HTR dimensions provide context about the most critical elements or features that are necessary to describe a HTR segment. HTR dimensions facilitate or provide a framework for the identification of barriers and behaviours affecting energy use and/ or efficiency improvements in a given HTR segment. In turn, HTR dimensions can also support the design and evaluation of policy interventions targeting those barriers or behaviours (Mundaca, *pers comm)*.

Indirect energy use: According to Simonsen (2010), the use of indirect energy can be disaggregated into two processes:

1. Manufacturing of transport means for the transport system (road, rail, air etc)
2. Construction, operation and maintenance of infrastructure for the transport system.

Reinders et al (2003) describe it as "*the energy embodied in consumer goods and services*". They found that the indirect energy requirement is linearly-related to the total household expenditure.

Energy-efficiency gap or 'energy-efficiency paradox', describes the slow rate of uptake of EE products and services even when they are economically beneficial - or simply, the gap between optimal and actual energy use (Jaffe & Stavins, 1994).

Rural energy-efficiency gap describes the "*seemingly slower uptake of EE upgrades in small, isolated communities even when higher energy costs and energy burdens often make these home improvements even more cost-effective than in areas with lower energy prices*" (Winner et al, 2018).

Market barriers and failures: Market barriers are "*circumstances that discourage entry into a market*", while market failures occur when "*one or more of the conditions necessary for markets to operate efficiently are not met*" (IEA, 2007).

Barriers to energy efficiency are defined as "*postulated mechanisms that inhibit investment in technologies that are both energy efficient and (apparently) economically efficient*" (Rohdin & Thollander, 2006). Barriers can be intentional or unintentional and can prevent or hinder action or impede progress towards realising potential (DECC, 2014): "*Barriers are not only purely technical and*

economic, but also social and cultural: that is, expectations, conventions and decision-making processes will play roles alongside costs and practicalities."

Drivers for energy efficiency are key motivating factors for energy users to change their investment, purchasing, energy use, and repair and maintenance behaviours and routines. There is a need to understand the relationship between drivers and barriers and to appreciate the synergies and tensions between them. Revell et al (2010) note that what appear to be drivers can actually be experienced as barriers: "*For example, whilst customer demand may be perceived as a potential driver, a lack of it, or a customer base that does not value energy-efficient products (potentially, because they have not been designed to meet their specific needs), can act as a barrier in that it does not provide businesses with legitimation and motivation for investment*."

Needs analysis of audiences and stakeholders involves identification of individuals and organisations that have some form of interest in the project outcomes, and assessing the particular needs of each group. The needs assessment is conducted early in the project, so that steps can be taken to effectively manage diverse interests and expectations throughout the project (Karlin et al, *forthcoming*).

Multiple benefits (also termed 'co-benefits', 'multiple impacts', 'non-energy benefits', 'non-energy impacts', 'intangible benefits') denote "*all benefits and costs related to the implementation of low-carbon energy measures which are not direct private benefits or costs involving a financial transaction and accruing to those participating in this transaction*" (Ürge-Vorsatz et al, 2016). The multiple benefits of increased use of EE and, sometimes, renewable energy may "*include avoided or deferred transmission and distribution investments for customer-sited renewables, energy security, job creation and development opportunities, poverty reduction, an increase in disposable income, economic output and total wages, and a contribution to meeting air quality standards and reduction in local environmental damages*" (IEA, 2011; 2014; Fawcett & Killip, 2017).

Small to medium enterprises (SMEs) are defined by the OECD as "*non-subsidiary, independent companies that employ fewer than a given number of employees*". This number varies across countries. Many countries break down SMEs into micro, small and medium-sized enterprises. The most frequently used upper limit is 250 employees (used by the European Union). However, caps vary from 20 employees in NZ to 1,000 employees in China. The U.S. typically considers SMEs to include companies with fewer than 500 employees. Average energy consumption, annual sales, revenue, assets, capital or investment may also be used to differentiate between SMEs and large organisations. In India, for example, the definition of SMEs is based on investment in machinery (IEA, 2015).

Positivist, interpretive and critical realism are described in Sovacool et al (2018) as follows: **"***Theories in the* positivist paradigm *assume that reality is objective, focus upon generating and testing hypotheses and are well suited to quantitative research methods such as multivariate regression. In contrast, theories in the* interpretive paradigm *assume that reality is (at least partly) subjective, focus upon uncovering the meaning actors give to events and are well suited to qualitative research methods such as participant observation.* Critical realism *is a more recent philosophy of science that partly reconciles these different perspectives and is consistent with both quantitative and qualitative research methods*."

HTR Definition

The term 'hard-to-reach' is actually quite common in a certain research literature, not necessarily always within the energy sector. We start by a broad overview of the literature using the HTR term or focusing on HTR audience groups and then narrow it down to the energy users which are the focus of this HTR Task. This is to provide an overview of the semantics, definitions and critiques in the broader

HTR literature and to then highlight what is of interest and importance to energy users and the Behaviour Changers trying to engage these energy users, specifically. It is relevant to highlight the broader literature here, as these non-energy researchers have often spent significantly more time, effort and investment in researching these audiences and our energy sector Behaviour Changers may learn from their various approaches and valid critiques of the concepts.

Examples where HTR Definition is used outside of energy research

Despite the various, valid criticisms (see below) of using the term 'hard-to-reach', it is the most widely-used terminology in the broad literature reviewed here. It is used to encompass a large array of individuals, communities, populations and organisations, inside and outside the energy research area. In Table 3 (see **Appendix A**), we highlight the main publications that came up using the HTR keyword search (outside energy research), including the main audience groups, themes / sectors and geographic locations (note that all keyword searches and publications were in English only).

From this table it becomes apparent that, outside the energy sector / theme, there is a strong focus on *gender* (both male, e.g. young fathers, or related to sports, and female), *age* (the very young and very old, as well as young fathers and vulnerable teenagers), *parents and families,* and generally *vulnerable* populations such as minorities, formerly incarcerated individuals, homeless, immigrants and sex workers. Only some of the same themes and demographics are researched similarly in-depth in the HTR energy literature (see **Gap Analysis Chapter 8**).

Most research focusing on the HTR comes from the health, education and social service sectors and many of these publications not only hone in on HTR definitions (and valid criticisms of them), but also various engagement strategies and sampling approaches used to better reach them (see a short summary of the main strategies and barriers sampling these audiences in **Appendix A** as well).

Critiques of HTR Definition

The terms ‘hard-to-reach’ and ‘hard-to-hear’ are widely used by health and social care service providers, by national and local governments wanting to make sure everybody has a say in consultations or by any organisation providing a service intended for the general public. For example, the Haringey Council (2010) in the UK defined them as “*those groups which are difficult to engage with from an organisational perspective because they do not feel empowered to do so, or due to barriers which may be overcome.*” Meyers & Guthrie (2006) defined commercial HTR as “*market segments with low penetration of EE technology and low participation rates in EE programmes are classified as hard-to-reach (HTR) markets and represent a large untapped efficiency reserve. Specific definitions of HTR vary but typically include customers with* small facilities *that do not have easy access to programme information or generally do not participate in energy efficiency programmes due to* language *(i.e., primary language non-English),* business size *(less than ten employees); or* geography *(i.e., outside major metropolitan areas).*”

That said, there is often a distinct lack of clarity about the meaning of terms, such as ‘hard-to-reach’ or ‘hard-to-hear’ when used in the literature (Freimuth & Mettger, 1990). In the past, HTR audiences have often been labeled unfairly as being the ‘problem’ (ibid). Similarly patronising and fallacious labels are also often used inconsistently to describe any form of minority group, such as homeless people, drug users, people with disabilities, recent migrants, private renters, or even young or old people in general (Cardiff Council, 2009). Particular care needs to be taken to keep any value judgement or one-sided perspective of the HTR audience being at fault out of efforts aimed at engaging them. Better understanding and characterising HTR audiences, and their barriers and needs, as well as potentially including (volunteer) representatives of these audiences or trusted intermediaries when designing targeted programmes could go a long way to remove stigma from labels such as HTR.

An alternative term sometimes used in care and social services is 'seldom heard' (IRISS, 2011). Many commentators argue that using an umbrella term such as HTR implies a homogeneity within groups that does not exist (Brackertz & Meredyth, 2008). This is an extremely important point and one that we hope we can thoroughly underpin with the detailed investigation into audience heterogeneity in this review. It also implies that there is something about such people that makes their engagement with services difficult, rather than service providers failing to make sure their services are inclusive. This is perfectly encapsulated by this quote from research on working class Manchurians by Symons (2018): "'*Hard-to-reach!*' exclaimed Kelly. '*We're not hard-to-reach, we're right here! They are the ones who are hard-to-reach*.'"

Harder-to-reach community members can also be especially difficult to engage and recruit due to the homogeneity and privilege of those trying to reach them, which is in sharp contrast to the diversity of energy users targeted for better engagement (Goopy & Kassan, 2019). Combined, these challenges make it difficult for researchers to even study these communities and individuals. Traditional research approaches tend to privilege the researcher over the research participant (ibid) - a particular issue with vulnerable groups. Research methods often encourage, albeit implicitly, non-reflexive tools for research (see **Appendix A**). Goopy & Kassan (2019) give this example: "*The traditional structured interview leaves little room for a participant to tell the story they want told; a survey leaves little room (even with qualitative questions) to evoke the unknown or unanticipated*."

An additional set of problems concerns the willingness of individuals from marginalised, HTR groups to provide information to survey interviewers, especially about the type of sensitive matters that define their marginality: Agadjanian & Zotoya (2012) argue that the same social characteristics and constraints that hinder access to these individuals may also impair their willingness or ability to answer survey questions. This was certainly borne out in the HTR Task interviews with NZ and UK experts - commonly-mentioned groups which were extremely hard to engage by HTR practitioners were e.g. the homeless[20], those recently-released from prison, those who live in gang houses, the disabled, and single mothers (Ashby et al, 2020b; see Figure 4, above). In addition, matters of privilege, personal status, or identity are rarely explored in HTR research (Goopy & Kassan, 2019).

From an industry perspective, the *Californian Public Utilities Commission* (CPUC) has grappled with defining hard-to-reach, or the closely related and often interchangeably used term 'underserved' since the late 1990's (CPUC, 2018). The Commission's primary concern at that time was that utility programmes were not making progress in expanding programme reach into the customer segments that had historically not participated in ratepayer-funded energy efficiency programmes at the level of their representation as ratepayers. The Commission also recognised that 'underserved' or 'hard-to-reach' are not static terms, and that a particular customer or market segment, once successfully targeted for programme participation, is no longer underserved relative to others that programme administrators have yet to target.

In the late 1990's and early 2000's, residential and small commercial customers were underserved relative to large businesses, which benefited disproportionately from the utilities' EE programmes (ibid). Programmes since then have specifically targeted those customer segments, to varying levels of success (see e.g. the negative evaluation of *Weatherization Assistance Programs (WAPs)* by Fowlie et al, 2015). Even though a lot of thought and work has gone into clearly defining U.S. and especially Californian utility HTR customers, and indicators to identify them (see below), some parties

[20] This did not just refer to homeless shelters. The homeless actually have certain energy requirements, especially around charging their cellphones - for 90% of them, this is their only means of contact (N. Pierse, *pers comms*). Charging cell phones is often done in shelters but sometimes also in businesses, or halfway houses, or interim residences such as social housing, or at friends' or relatives' places. Even though they may not be homeless if they stay in an interim residence or couch surf with friends (or stay in people's garages, which happens quite frequently in NZ as there is such a rental shortage), they are technically homeless as these are not their confirmed addresses and they are not utility bill payers.

suggested that the HTR should instead be defined in terms of the barriers that implementers face in providing EE services to certain customer segments. For example, "*Contractors doing business in urban areas contend with extreme traffic congestion, limited and expensive parking, and higher vendor costs and contractor wages, making customers in high-density urban communities undeniably hard-to-reach*" (CPUC, 2018).

Factors influencing definitions and conceptual connotations

Some UK policymakers also argue that the term 'hard-to-reach' is context-specific and there is no single list that can define groups of people that are HTR (Nottinghamshire Council, 2007; though see the attempts by the CPUC (2001, 2018) to create such lists). While the context-specific nature of engaging HTR households and organisations suggests there are numerous and wide-ranging barriers to engagement, it is possible to identify certain overarching barriers that can be applied to almost all groups (Cardiff Council, 2009). These include:

- Methods of involvement
- Physical barriers
- Attitudinal barriers
- Financial / resource problems
- Cultural issues
- Gender
- Timing;
- Perceptions of relevance.

Doherty et al (1999), when defining the HTR in terms of crime-prevention strategies, also outlined the following, similar factors as imperative when defining these audiences:

- Physical or social isolation of the client or client group
- Aspects of the client's behaviour
- Population characteristics associated with the individual or group
- Client or group needs (perceived or actual)
- Whether the individual or group has had a negative experience of services in the past
- Whether service information is accessible to the group e.g. in an appropriate language
- Whether the targeting strategies used are effective in identifying and engaging the group.

Most, if not all of these factors are also useful to consider when characterising HTR groups in the energy sector - particularly those who live in highly-vulnerable circumstances, as per UK and NZ examples from interviews, given above (see Figure 4). Of note here is that client and group needs are specifically mentioned, something rarely addressed in any depth in the energy literature (see **Gap Analysis** and audience chapters on audience needs assessments). These defining factors will be outlined in more detail in each of the chapters delving into specific audiences.

Alternative terms to HTR

Not all of the terms outlined below were specifically-mentioned by the energy literature, however, most of them could be applied to the HTR audiences we focus on in this review. We include all the terms here, for the sake of comprehensiveness.

Underserved

The definition of 'underserved' energy users for this Task was taken from VEIC (2019): "*If outcomes represent less than the target population share relative to the total population or if targeted programme impacts are less than those from other programmes on a per participant basis, the targeted group may be said to be underserved*." It is commonly used in the North American utility industry and refers largely to individuals, populations and groups that are inequitably served by energy (efficiency)

programmes and policies (see Goldman et al, 2018). A broad study of Oregon utility customers (NPCC, 2018) offered numerous perceptions regarding possibly-underserved market segments, including:

- Low-income households
- Middle-income households
- Customers in rural regions
- Small business owners and/or business tenants
- Multifamily tenants
- Manufactured home dwellers
- Customers of small and rural utilities.

Disadvantaged communities

The *Californian Public Utilities Commission* (CPUC) has done a lot of work over the years, together with the public utilities, to both define and serve HTR energy users (e.g. Quantum Consulting 2001, CPUC 2013, 2018, 2020). In a decision on EE business plans for one of their utilities (CPUC, 2018), they clearly defined so-called 'disadvantaged communities' as follows:

1. *Areas disproportionately affected by environmental pollution and other hazards that can lead to negative public health effects, exposure, or environmental degradation.*
2. *Areas with concentrations of people that are of low income, high unemployment, low levels of homeownership, high rent burden, sensitive populations, or low levels of educational attainment.*

HTR energy customers, on the other hand, were defined as follows (ibid): *"Hard-to-reach residential customers are 'those customers who do not have easy access to programme information or generally do not participate in energy efficiency programmes due to a language, income, housing type, geographic, or home ownership (split-incentives) barrier.' Hard-to-reach business customers also include factors such as business size and lease (split-incentive) barriers*."

The distinction and similarities between disadvantaged communities and HTR residential energy customers is described as follows (CPUC, 2018): *"The socioeconomic characteristics of disadvantaged communities overlap considerably, but not perfectly, with criteria for identifying hard-to-reach customers or market segments. A clear difference in the designation of disadvantaged communities is the Pollution Burden indicators that inform the CalEnviroScreenTool, though even in that respect there are likely parallels beyond mere coincidence between customers considered hard-to-reach based (in part) on where they live, and residents of a disadvantaged community."*

Socially disadvantaged

A systematic review of health research focusing on HTR audiences defined socially-disadvantaged groups as "*socially, culturally or financially disadvantaged compared to the majority of society, implying individual, environmental or social restrictions to their opportunities to participate in health research*" (Bonevski et al, 2014). They pointed to the difficulty of researchers to access, engage and retain participants from socially-disadvantaged groups, resulting in labels such as 'hard-to-reach' or 'hidden'. Many groups that are discussed in the **Vulnerable Households Chapter 3** would also fall under the category of 'socially-disadvantaged' (e.g. *low income, non-native language speakers, geographically remote, refugees,* or *undocumented immigrants*).

Socially excluded

Hidden groups of a population are often socially excluded from broader society, and they lack opportunities for their further development - this doesn't just affect only excluded persons but also

the whole society (Horakova, 2013). The term 'social exclusion' has been deployed in France in the 1970s as a response to the problem of sustaining social integration and refers to people who didn't want (or weren't able) to integrate into society - i.e. people with mental disabilities, elderly people, adult offenders, or drug abusers (ibid). The concept of social exclusion later became part of EU policy with a clear shift in the meaning: "*It was assumed that social exclusion existed not because poor people were necessarily unwilling to integrate, but because significant changes in the economy and labour market resulted in greater poverty and unemployment*" (Caidi & Allard, 2005).

Hard-to-help

Ramsay & Pett (2003) distinguish between 'hard-to-reach' and 'hard-to-help' audiences, both of which they say encompass a significant number of UK domestic energy users: "*These audiences are defined here as the 'hard-to-reach' (those that are not currently identified by government programmes) and the 'hard-to-help'*[21] *(those that cannot use the help that is available). The hard-to-help were classified as those who live in homes that cannot be made more energy-efficient using the cost-effective measures and technologies prescribed by UK programmes targeting the 'easy-to-reach/help'.*" They were categorised into two main sections: 'non-standard homes' and 'homes off the gas network'. No-cavity wall homes[22], which make up at least 36% of the UK housing stock and which cannot be insulated easily, fall largely under the first category; around 20% of UK housing stock relies on fuels other than the mains gas network. HTR energy users fall into 3 categories according to Ramsay & Pett (2003): 'Low-income, ineligible households', 'non-claiming households' and 'isolated households' (differentiating between physical isolation and 'ideological' isolation). They assert that it is an overriding challenge to define exactly how many households this HTR audience consists of. Anecdotal evidence has indicated that there may be significant numbers of individuals in each category (Ramsay & Pett [2003] estimate 40% who are 'hard-to-help' and 30% who are HTR, with considerable overlaps between the two groups) that are not being reached by government programmes, but they are a hidden group about which little is known.

Hidden populations / Hard-to-hear

Sydor (2013) comments that "*hard-to-reach populations are difficult for researchers to access*", and Lambert & Wiebel (1990) define hidden populations as "*those who are disadvantaged and disenfranchised: the homeless and transient, chronically mentally ill, high school drop-outs, criminal offenders, prostitutes, juvenile delinquents, gang members, runaways and other street people*". These groups are difficult for researchers to access cost-efficiently in large numbers necessary for statistically powerful study designs (see also Pawelz, 2019). The same 'hidden populations' are called 'hard-to-hear' in a review by Cardiff Council (2009).

Illegalised, criminalised and stigmatised populations

Pawelz (2019) describes these hidden HTR audiences further (see also Marpsat & Razafindratsima, 2010): "*In general, hard-to-reach or hidden populations may be illegalised or stigmatised or criminalised persons or those who fear to be when revealing their identity. Illegalised populations can be illegal immigrants or illegal working populations, stigmatised populations may refer to drug addicts, homeless, homosexuals or prostitutes. Criminalised populations can be, for example, drug traffickers, religious extremists or terrorists, or gang members. Populations are also hard-to-reach when, for instance, there is no defined sampling frame (e.g., homeless people), persons who prefer not to be part of the population of interest due to a stigmatisation of it (e.g., prostitution), persons with blocked*

[21] This term generally got superseded by the term 'hard-to-treat', referring to the difficulty and expense of insulating older properties or those built with non-standard construction techniques.

[22] Homes without wall cavities such as those built of brick or stone. In the UK, such homes are usually referred to as 'solid walled' properties. These properties can be insulated – it is just a lot more expensive and disruptive than installing cavity wall insulation in homes built with cavities. Incidentally, homes built with bricks in the UK since roughly the mid-30s were built with cavities.

accessibility (e.g., high political or wealthy elites), and persons who are hard-to-reach because they prefer not to be reached due to their operation in the underground and illicit activities, such as gangs and other illegalised collectives." Many of the groups and minorities mentioned above were also mentioned by HTR practitioners, especially from the UK and NZ (Ashby et al, 2020b; see Figure 4). It will be interesting to see if newly-disenfranchised victims of the COVID-19 economic fallout will fall into the category of preferring not to be part of the population of interest due to fear of stigmatisation (Logie & Turan, 2020). This could make them even harder-to-reach than those vulnerable audiences who are used to engaging with welfare and social organisations.

Under-represented / invisible / service resistant

Doherty et al (1999) have identified three main hard-to-reach groups within service involvement related to crime prevention: 1) the under-represented; 2) the invisible / overlooked; and 3) the service resistant. Representatives of all of these groups also fall under the 'vulnerable households' category and were mentioned by some of our HTR interviewees (Ashby et al, 2020b; see Figure 4).

1) **Minority groups** (ethnic minorities, asylum seekers and transient groups especially) are outlined particularly in regard to being under-represented. A tragic example is the recent outbreak of COVID-19 cases in crowded migrant dormitories in Singapore - after the country was lauded for its initial response to the pandemic, it exposed "*two Singapores with very differing realities*[23]."
2) **Invisible / overlooked groups** include those caring for others, those with mental health problems, service users who fall just outside the statutory or usual remit of a provider, or whose needs are apparently not so great as to grant access to a service. Osborne (2015) points out that one such group, young fathers, is not invisible but 'unseen', by authorities.
3) **Service-resistant groups** are those unwilling to engage with service providers, the suspicious, the over-targeted or disaffected. This includes families 'known' to agencies such as social services, who are wary of engaging with providers, or others who are distrustful and potentially hostile to service providers, possibly due to a link to drug use, alcohol abuse or criminal behaviour.

Unchangeable

Lutzenhiser et al (2009) refer to this market segment of energy users that are simply unwilling to change their energy behaviours, an 'extreme niche' among energy users (as well as 'super conservers' on the opposite end of the spectrum). Note that Murtagh et al (2014) use the term 'unchangeable' to describe perceptions around energy-use practices, not the energy users themselves. Mogles et al (2018) instead refer to changeable and unchangeable behavioural determinants in some behaviour change models (e.g. BJ Fogg's).

Hard-to-engage / motivate

Murtagh et al (2014), in a qualitative study on the impact of in-home devices (IHDs) on energy behaviour, found a group (around 20% of participants) they called '*the Energy Non-Engaged*'. This group had higher-than-average energy consumption and was actively ignoring their IHDs, and were not trying to reduce energy waste, like the other groups were. This group segment was similar to that suggested by DEFRA (2007), with the '*Energy Non-Engaged*' mapping to their '*Honestly Disengaged*'.

Hard-to-count

Terry et al (2017), presents findings from a 2010 Census ethnographic evaluation with a record check, conducted to identify factors affecting enumeration among racial/ethnic groups. Ethnographic themes that contributed to record check inconsistencies include respondent access difficulty, language issues, and cultural issues, which made them 'hard-to-count'.

[23] https://www.washingtonpost.com/opinions/2020/04/16/singapores-new-covid-19-cases-reveal-countrys-two-very-different-realities/

Understudied / under-explored

At least one paper (Janda et al, 2014) referred to 'minor league players' in the commercial sector (such as SMEs and NGOs) as 'understudied'. The paper examined some problems involved in under-explored areas: what is (un)known about SMEs and other minor subsectors, leases, energy management practices, and metering infrastructure. This background built a concept of the groups that have lower ability to measure and manage their energy use, which Janda et al (2014) call the 'minor leagues'. These groups are often either data-poor, analytically underprivileged, or both.

Hard-to-treat (homes)

The UK *Building Research Establishment* (BRE, 2008) defines hard-to-treat homes as those "*that for a variety of reasons cannot accommodate 'staple energy efficiency measures*'". They may include homes that are off the gas network, homes with solid walls, homes with no loft space, homes in a state of disrepair, high-rise blocks, etc. The UK *Center for Sustainable Energy* (2012) defines hard-to-treat homes as "*a home is considered hard-to-treat when it is not possible to improve its energy efficiency with the most cost effective improvements – such as cavity wall and loft insulation – due to the age of the property or nature of its construction. They may also be off-gas, relying on more expensive heating fuels such as oil. For these reasons, hard-to-treat homes are often difficult and costly to heat to a comfortable level*." Gilchrist & Craig (2014), in a review for the Scottish government describe Hard-to-Treat (HtT) homes as "*those with: solid walls, no loft space to insulate, no connection to the gas network, high rise residential blocks and tenements, and timber-frame buildings constructed before 1982. These properties cannot be improved easily or in a cost-effective way with improvements like CWI, loft insulation or modern gas central heating*." This included a majority of rural homes in Scotland (ibid).

Hard-to-heat / cool (homes)

Ramsay & Pett (2003) conflate the 'hard-to-help' energy users (see above) with the 'hard-to-heat' homes they live in (those largely with solid walls or non-cavity wall construction, often built before 1944 in the UK). They estimate that about 40% of UK housing stock falls under this category. In Australia, the opposite phenomenon affects those households living in heat stress, who do not have adequate access to cooling technologies such as air conditioners (Hatvani-Kovacs et al, 2016). Air-conditioning increased dependence upon it, limited passive adaptation and only people living in homes with whole-house air-conditioning had fewer health problems during heatwaves. Tenants and respondents with pre-existing health conditions were the most vulnerable, particularly as those with health conditions were not aware of their vulnerability (ibid).

Problems with all definitions

Defining the 'hard-to-reach' can depend on who is doing the defining, or what exactly they are focusing on (e.g. communication / messaging, uptake of programmes, recruitment of research subjects). HTR energy users can be those who are falling under the categories of 'disadvantaged communities', 'socially disadvantaged', 'hidden', 'invisible', 'illegalised, stigmatised or criminalised', 'service resistant, 'hard-to-motivate', 'hard-to-engage', 'hard-to-hear', 'hard-to-help' or 'unchangeable'. These terms somewhat seem to put the onus on the users with the barriers being associated on behalf of the Behaviour Changers or implementers trying to engage them (e.g. mistrust of authorities, out of their remit / jurisdiction, refuse to engage).

Some of the definitions seem to put more onus onto the Behaviour Changers needing to do more to identify, find and engage those energy users. Those are 'underserved', 'overlooked', 'understudied / under-explored' and 'hard-to-count'. Here, the main issues revolve around lack of data / knowledge of these audience's barriers and needs, where / how to find them, or the difficulty in sampling them (see **Appendix A**).

And at least two definitions, 'hard-to-treat' and 'hard-to-heat/cool', refer to the homes, rather than the residents. There are some clear overlaps between e.g. socio-demographic and socio-economic indicators that can identify those living in hard-to-treat/heat homes as being often HTR (e.g. rural, elderly, renters, low income). In addition, those homes usually don't get targeted by Behaviour Changers due to the difficulty and dearth of EE interventions available to them, making them by definition hard-to-reach. However, the target of the definition (and thus, the associated programme or policy intervention) is not necessarily the energy user per se.

HTR Task Definition

In light of these complexities and critiques of the HTR terminology, we decided to develop our own HTR definition for this research collaboration, which was co-created with the funders and experts of the HTR Task. We will further refine this working definition, as needed. Our HTR Task working definition currently reads[24]:

"In this Task, a hard-to-reach energy user is any energy user from the residential & non-residential sectors, who uses any type of energy or fuel, and who is typically either hard-to-reach physically, underserved, or hard-to-engage or -motivate in behaviour change, energy efficiency and demand response interventions that are intended to serve our mutual needs."

Some caveats and concerns need to be highlighted in response to the broadness of this definition, which encapsulates vast numbers of energy users (estimated by some sources [e.g. Ramsay & Pett, 2003; Meyers & Guthrie, 2006] as over 50% of the population!), as it stands:

1. It is and continues to be, a *working definition* and it may ultimately change, e.g. following this literature review.
2. We agree that it is very broad and thus *not that useful* for policymakers who may want to target more specific audiences.
3. We decided to leave it this broad so we did not constrain ourselves from capturing and examining *all possible HTR audiences*, including those who normally would not be covered (e.g. the very wealthy, or building operators in commercial buildings).
4. This was done because we see *significant gaps in the literature* (such as a pretty universal focus on low income or energy poverty, but a lack of deeper audience analysis in the non-residential sector, e.g. Chester et al, 2020) that we feel a 'global' research collaboration under the *Users TCP umbrella* could and should fill.
5. Following this wide-ranging literature review and surveying and interviewing of HTR experts (Ashby et al, 2020b), we can now narrow down and *further define individual HTR audiences*.
6. This literature review will enable *prioritisation of HTR groups* based on countries' contextual factors such as socio-demographics, level of energy poverty, indigenous populations, degree of geographic remoteness, access to technology, as well as any changes in response to COVID-19.

[24] Please see https://userstcp.org/task/hard-to-reach-energy-users/ for a glossary of terms used in this definition.

Chapter 3 - 'Vulnerable' Households

Background

Improving the energy efficiency (EE) of housing occupied by vulnerable households can cut energy bills and improve health, comfort and well-being for their occupants (UKERC et al, 2018). It is often regarded as one of the most important interventions to promote 'equity' and reduce 'energy hardship' in the clean energy sector in many countries (e.g. Cadmus, 2018; Energywise, 2018; Martín & Lewis, 2018; MBIE, 2019a; VEIC, 2019). Even though 'low-income' and 'energy-poor' households were the most commonly-mentioned vulnerable groups in the EE and HTR literature reviewed here; as well as in surveys and interviews of HTR researchers and practitioners undertaken by this HTR Task (see Ashby et al, 2020a & b; and Figure 4, above), it is well known that inequity within communities is exacerbated by additional factors beyond income, such as *race, ethnicity, citizenship, physical ability, age, educational opportunities* (all VEIC, 2019)*, access to transport services* (e.g. Titheridge et al, 2014; Robinson & Mattioli, 2020)*,* and *fluency with the dominant language* (e.g. Cadmus, 2018).

Jessel et al (2019) found that "*the literature does not sufficiently consider the intersectionality of vulnerability types and multiple hardships. Furthermore, the use of numerous terms for household energy insecurity further compartmentalises energy issues by geography and discipline, hampering the possibility for a comprehensive, or systematic literature base. This compartmentalisation foregoes the opportunity to address energy insecurity as a complex, interdisciplinary, intersectional, and multidimensional issue*." It is imperative for Behaviour Changers, such as policymakers and EE programme managers, to identify and define additional intersectionalities that can exacerbate household vulnerability.

Some policy interventions, such as the UK's *Energywise*[25] collaboration, for example, specify *Black, Asian, Minority Ethnic* (BAME) households where *English is not the first language,* and the *Elderly* as HTR in the context of smart meter rollout (Energywise, 2016). Energywise (2016) specifically found that groups less likely to accept a smart meter include those *over 75 years; those who cannot speak English well;* and/or *those who have a disability* such as being partially sighted or blind. Groups likely to have to wait longer to be offered a smart meter included those in *energy debt,* as well as those *living in high rise buildings* (ibid). According to a smart meter customer experience study in the UK (BEIS, 2017), members of these groups - namely, *social housing renters*, as well as those with a total *household income of less than £16,000 a year*, were, however, also most likely to use smart meters at least weekly to check on their energy consumption. This clearly shows some of the intersecting 'vulnerabilities' that can cause energy users to be regarded as HTR, even for an extremely common intervention such as smart meter rollout and use.

Some measures that are related to domestic energy use and can indicate the risk of vulnerability among households are outlined by UK Power Networks (2014) as follows:

- *Ethnic background* and *language barriers*
- *Employment*
- *Age*
- *In receipt of* Pension Credits *(a welfare benefit for low income pensioners)*
- *Health and disability*
- *Low income – high (energy) costs*
- *Child poverty*
- *Excess Winter Deaths* (EWDs) and *Excess Summer Mortality*

[25] https://innovation.ukpowernetworks.co.uk/projects/energywise/

It is also worth noting that, similar to Hill's (2012) *Low Income High Cost (LIHC)* definition of UK fuel poverty, which acknowledges that it is a spectrum and not a binary distinction, it is expected that changing energy behaviours in response to fuel poverty also lie on a spectrum (UK Power Networks, 2014). Thus, there will be no sharp distinction between those just in fuel poverty and those other vulnerable households just outside it. In addition, recent work has highlighted the issue of 'double energy vulnerability', "*the increased likelihood of negative impacts upon well-being, owing to the intersection of domestic energy poverty and transport energy poverty*" (Robinson & Mattioli, 2020).

Definitions

There are several concepts that add further complexity to understanding 'hard-to-reach' audiences and 'vulnerable households' in relation to demand and provision of energy services. We summarise the key literature of various terminologies, which are also outlined in the **Glossary of Terms Chapter 2,** and an extended explanation of important terms is provided in **Appendix B**. For extensive multi-country comparisons (EU-only) of different (and sometimes, highly-variable) definitions for energy poverty and vulnerability, see NEA (2019: Table 2) and Insight_E (2015: Table 5).

Vulnerability

The concept of 'vulnerability' is central to understanding 'hard-to-reach' in an energy context. Households in vulnerable circumstances are often the same as those described as 'hard-to-reach' and there are similar debates on how vulnerability should be understood and framed. For example, Ofgem (the UK energy regulator) now emphasises the situational aspects of vulnerability and the notion that vulnerability can be temporary for some consumers. Ofgem (2013) defines vulnerability as "*when a consumer's personal circumstances and characteristics combine with aspects of the market to create situations where they are:*

- *Significantly less able than a typical consumer to protect or represent their interests in the energy market. And/or*
- *Significantly more likely than a typical consumer to suffer detriment, or that detriment is likely to be more substantial*."

Ofgem's *Priority Services Register*[26] includes people who:

- Are of pensionable age
- Are disabled or chronically sick
- Have a long-term medical condition
- Have a hearing or visual impairment or additional communication needs
- Are in a vulnerable situation - described as a variety of situations, examples of which are:
    - People with certain mental health conditions which impact understanding of a bill
    - people who cannot top up their prepayment meter due to injury
    - Temporary circumstances, where you might need extra support for a limited amount of time (i.e. unemployment or a bereavement)
    - Living with children under five years old.

The term 'aspects of the market' points towards market failures (e.g. information asymmetries, negative externalities which are not reflected in energy prices) or structural factors as giving rise to consumer detriment, that is, energy suppliers and the institutional arrangements in which they operate give rise to vulnerability. Or as Stearn (2016) argues: "*Consumer vulnerability cannot simply be seen as consumers' failure to engage with the market when markets are failing to engage with consumers*." However, the phrase 'less able' could be interpreted as suggesting 'failings' on the part of certain

[26] https://www.ofgem.gov.uk/consumers/household-gas-and-electricity-guide/extra-help-energy-services/priority-services-register

consumers, rather than placing culpability on service providers for failing to ensure inclusivity. Ofgem's (2013) definition encompasses both structural and individualistic factors as giving rise to vulnerability. The dynamic and often temporary nature of energy vulnerability is reflected in Atherton's (2018) explanation of vulnerability that "*anybody can find themselves in a situation (of suffering detriment) but examples of high-risk consumers could be people living on low incomes, retirees, those that are chronically sick or living with a disability, or people living in rural areas*."

The UK *Commission for Customers in Vulnerable Circumstances* (2019) identified three types of vulnerability that can affect energy consumers:

1. ***Financial vulnerability*** - essentially those consumers whose income is insufficient to cover their essential household bills, including energy.
2. ***Health and capacity-related vulnerability*** - consumers whose capacity or condition prevents them from accessing services or engaging with the energy market.
3. ***Location-based vulnerability*** - rural consumers face a range of vulnerabilities arising from their location.

Energy poverty / burden / insecurity / hardship

A related concept that adds further complexity to understanding 'hard-to-reach' and 'vulnerability' within energy services is *energy poverty*, or *fuel poverty,* sometimes also called *energy burden, insecurity, vulnerability* or *hardship* in different countries (see **Glossary of Terms** above; discussion in **Appendix B**; and Bouzarovski & Petrovska, 2015; Jessel et al, 2019 for more detail). The English-language (and European) literature on this important topic tends to be very UK-centric - as a consequence of its long history of academic scholarship, practice-based responses, and policy frameworks to address the issue (Thomson et al, 2017b; Statistics NZ, 2017; Mahoney et al, 2020). It is also characterised by single-country studies, thus we hope that the multi-country approach of this review will add value.

Energy poverty is broadly understood as the inability of a household to achieve sufficient energy services, due to a combination of access, affordability, energy efficiency (EE) of housing and appliances, and needs. Commonly-termed 'fuel poverty' in the UK (Boardman, 1991), and 'energy poverty' in many other countries (IEA, 2011; Bouzarovski & Petrova, 2015), official definitions and monitoring of the scale of the problem and remedial policy impact assessment vary between countries (Thomson et al, 2017a). Previously, the term 'fuel poverty' has been understood as a distinct and smaller subset of 'energy poverty'; with 'fuel poverty' having typically been used in developed countries, where the focus has been lack of affordability, particularly for adequate heating, and 'energy poverty' describing lack of access (as well as affordability) in developing countries as a result of inadequate basic infrastructure (IEA, 2011, Bouzarovski & Petrova 2015).

More recently, Bouzarovski & Petrovska (2015) argued convincingly that more useful international comparisons could be made when considering energy poverty as a total concept encompassing access and affordability for achieving adequate energy services (including warmth, or cooling as necessary), and viewed from a vulnerability lens. Understanding 'energy vulnerability' has been pivotal in bridging the previous gap between 'fuel poverty' and 'energy poverty' to allow energy poverty to be considered as a global problem (see Jessels et al, 2019 for discussion). In France, the concept of 'energy precariousness' has become enshrined (see Bafoil et al, 2014), and although 'energy deprivation' is a common descriptor of energy poverty in the EU, it is less commonly used in U.S. (e.g. Harrison & Popke, 2011) and Australian (e.g. Chester & Morris, 2011) scientific and policy literature. In Aotearoa, the term 'energy hardship' is becoming predominant in government documents (Statistics NZ, 2017; MBIE, 2019a). Several internal and external factors influence energy poverty or vulnerability to energy poverty (see Figure 5).

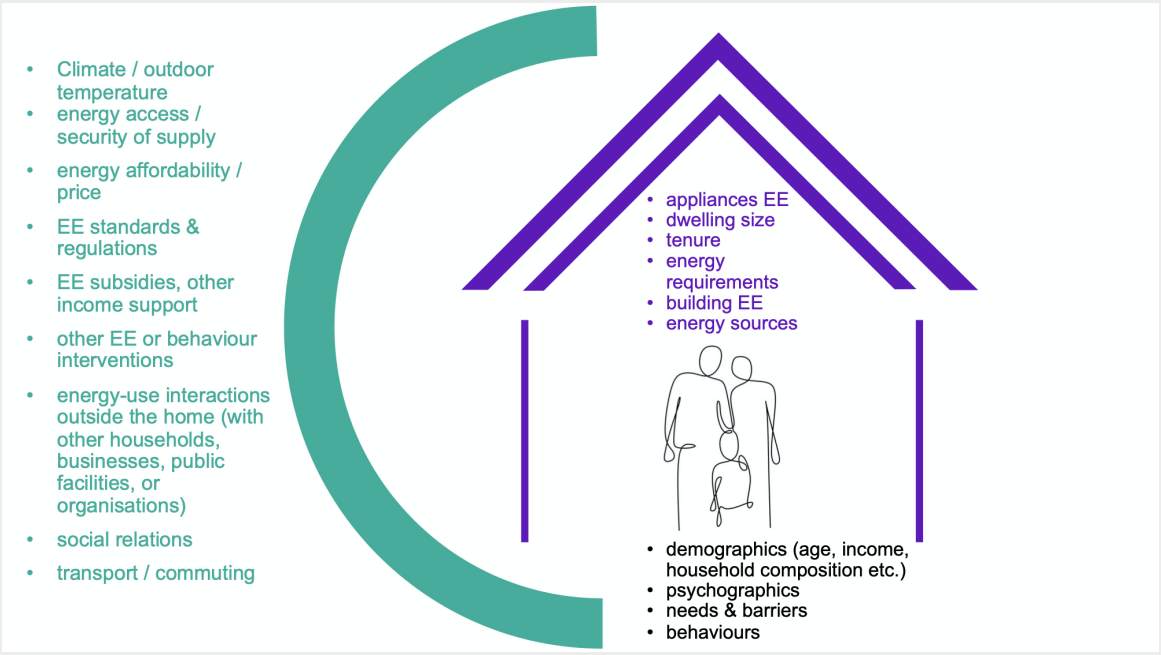


Figure 5: Contributing causes to household energy poverty (internal and external factors).

Low income is central to the concept of energy poverty. Low-income households are the most likely to have high energy burdens, particularly those who are limited to using high-intensity and expensive fuel sources (VEIC, 2019). Though this metric is frequently referenced, it may not fully capture the complexity of low-income customers' relationships to energy expenses (ibid): "*Many low-income households have low energy expenditures because they are cost-constrained. The impact of energy efficiency measures also depends heavily on the energy rates. Energy burden is a useful tool for describing the challenges of addressing energy use in low-income households but may not fully capture the challenges of reaching and adequately addressing the needs of low-income customers*." The general poverty status of a household in Sweden, for example, is assessed using two criteria (Gustafsson et al, 2017): First, the *disposable income* of the household in which the person lived in 2007 must be below 60% of the median equivalent income in Sweden as a whole. Second, to be classified as *'twice poor'* a household's *net assets* must be below SEK 10,000 (around US$1,100).

Notwithstanding debates over how energy poverty is understood, it is important to recognise that energy poverty and vulnerability, while related, are two distinct issues which are context-dependent. From a policy perspective, Insight_E (2015), an energy think tank advising the EU Commission, explains the difference as follows: "*Measures focused on vulnerable consumers offer protection within regulated markets, and facilitate access and participation. They are often short-term in nature, providing relief or ensuring ongoing supply in the face of indebtedness. Energy poverty measures on the other hand are explicitly focused on lower-income households, and seek to address longer-term structural problems of building energy efficiency*."

Energy poverty and energy vulnerability require different metrics for definition and different measures to tackle them, although many will overlap (Castaño-Rosa et al, 2019). As noted above, all energy consumers are at risk of facing detrimental circumstances, and are thus 'vulnerable' when they do, for example, because of a change in their situation which may be temporary or long-term. The COVID-19 crisis is a perfect example of an external circumstance causing increased vulnerability for millions of households and small businesses, all over the world. While low income is an important risk factor for vulnerability, there are many others, for example those relating to ill-health or disability, or being of an ethnic or racial minority (often also being non-native speakers). Intersectionality of any such risk factors, which can increase household vulnerability, needs to be acknowledged and understood before

designing interventions targeting e.g. 'low-income households'. For example, households in vulnerable circumstances are also more likely to live in energy poverty, particularly if they have poor health or long-term disability. Yet it is not merely a function of people's life circumstances (e.g. being poor, older, disabled, having young children) but also a function of, e.g. a complex intersection of life circumstances, social circumstances, availability of infrastructure, market (de-)regulation and the political climate (Bouzarovski, 2013; Middlemiss et al, 2019; Robinson, 2019).

Robinson (2019: Table 2, p.225), in their research on socio-spatial differentiations of susceptibility to energy poverty highlights the need to conceptualise the intersections and mutually-reinforcing relations between *gender* and other axes of social (*socio-*) difference, including *class, ethnicity, race, disability, sexuality* and *age*, and how these inequalities manifest in certain places (*-spatial*) with varying intensity (see Figure 6, below). However, there are many who do not live in energy poverty *per se*, but face other forms of detriment. They nevertheless should still receive equitable benefit from EE programmes and services.

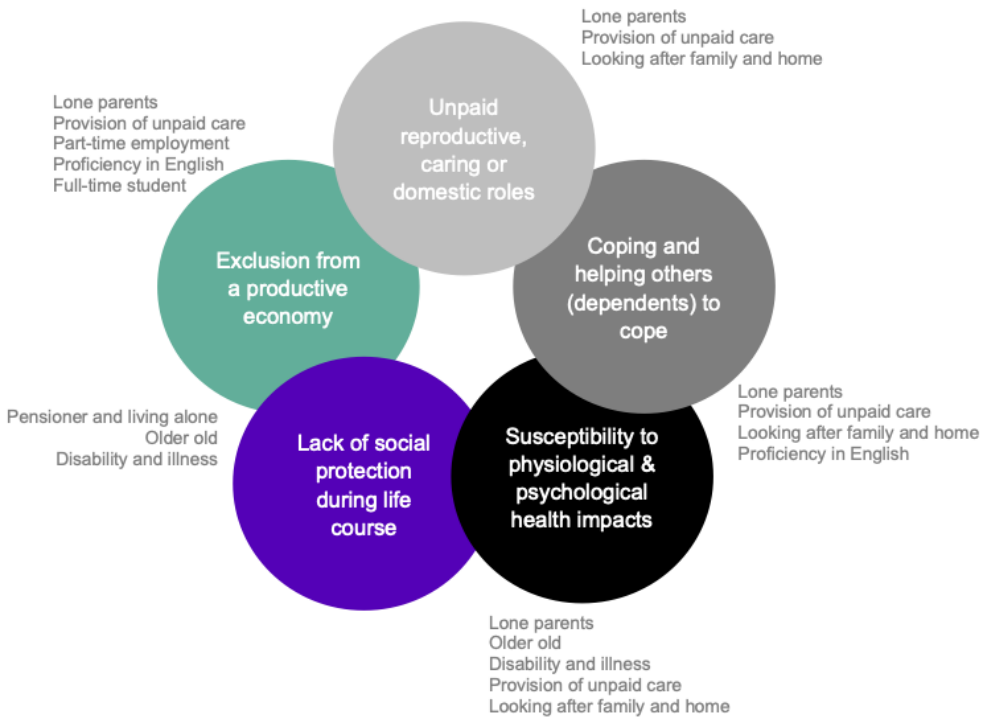


Figure 6: Dimensions of gendered vulnerability to energy poverty and associated indicators (Adapted from: Robinson, 2019)

HTR vulnerable audience groups (not defined by low income)
Below, we outline several audience groups that fall under vulnerable households, outside of (or in addition to) the low-income definition (please note that there is an entire chapter on another vulnerable household group, namely renters - see **Renters and Landlords Chapter 5**). We have focused on these specific groups, based on how commonly-mentioned they were in the literature reviewed here, as well as the interviews and surveys with our HTR researchers and practitioners undertaken in 2019 for this Task (see Ashby et al, 2020a & b). The identified target (sub)audiences are:

- *Rural households* (geographical isolation)
- *Minorities* (gender, race / ethnicity, and health-based isolation)
    - Women
    - Racial / ethnic minorities

        - Indigenous / First Nations
        - Black, Asian, Hispanic minorities
        - Migrants and refugees
    - Mental or physical ill-health and disabilities
- *Stigmatised and criminalised* (societal isolation)
    - (Ex)convicts, gang houses, drug users
    - Homeless (including shelters)
    - Sex workers
- *Elderly; pregnant women*; and *single parents with young children* (age-based isolation)

We provide some short definitions for each of these groups (and all other following audience chapter groups) in **Appendix C**. We have highlighted any obvious cultural or country contexts and differences, where they arose.

Audience characteristics

In this, and all following chapters that focus on specific HTR audiences (Chapters 3-7), we will provide insight from the HTR literature on relevant audience characteristics, such as demographics and psychographics, their barriers and needs, and the broad dimensions (e.g. economic, geographic, technological or psychological) that provide context about the most critical elements necessary to describe a HTR segment. We break this into sub-audience characteristics, where specific literature can be found.

Demographics

VEIC (2019), in a report investigating standardised equity measurements in the clean energy industry, pointed out that at the heart of equity measurement is comparison between groups, and that there are many ways those groups can be defined (and thus, compared). The fields of housing, health, education, and environment commonly identify groups based on *race, gender, income, age,* and *location*. The authors (ibid) recommend Behaviour Changers to "*prioritise the collection of information on the communities perceived to be disadvantaged historically*", something that has not been common practice in the energy sector to date, but that is necessary to ensure equitable access to EE. VEIC (2019) also notes that EE programmes, when targeted at all, have disproportionately focused on groups defined by *income*, with an abundance of programmes targeting 'low-income' households and comparably little attention to groups defined by other demographic characteristics. This is certainly an issue that we also found in the literature reviewed here (**Gap Analysis** and **Appendix D**).

Energy poverty / hardship / burden

In Aotearoa, the recent *Household Economic Survey*[27] provided an interesting demographic breakdown on various energy hardship indicators (see Table 4): there was little difference in energy hardship between genders, however, *females* were more likely to "*put up with the cold a lot*" than males (52.3% to 47.7%), whereas males were more likely to report damp and mouldy homes (54.1% to 45.9%). The main feature highlighted by the age demographic was that the *elderly* were significantly less likely to complain of the cold, damp or heating being a major problem. *Couples and single parents with children* were the most likely to highlight issues around the cold, damp or inability to pay for heating. Additionally, people identifying as *Māori or Pasifika* in Aotearoa are at higher risk of experiencing energy poverty (O'Sullivan et al, 2013). Among *youth*, Māori rangatahi (youth) are also at highest risk, followed by Pasifika youth (O'Sullivan et al, 2017).

27 http://archive.stats.govt.nz/browse_for_stats/people_and_communities/Households/energy-hardship-report/measuring-energy.aspx#gsc.tab=0

Rural households

Rural households are not commonly studied in behaviour and EE research (MacDonald et al, 2020)[28], and only relatively few EE programmes directly target rural audiences (e.g. Penny, 2005; Baker et al, 2008; CSE, 2012; NPCC, 2018; Shoemaker et al, 2018; Winner et al, 2018; and Canada's First Nations' EE programmes[29],[30]; Crane, 2017). Even though more energy-saving gains can be realised in highly populous areas, rural regions could see a higher amount of wasted energy per capita because of the longer distance from generation to delivery, while *lower-income* and *older* populations associated with many rural regions, as well as *higher electricity and heating fuel costs* could increase the audience's vulnerability and need for more energy-efficient homes (Winner et al, 2018). The risk of poverty and social exclusion is often more difficult to identify in rural areas than in urban ones (European Commission, 2008).

Despite remarkable differences among rural areas, it has been shown that *average living standard*, as expressed as GDP per head, is generally lower in rural than in urban areas; but that there are different 'at-risk' groups in rural compared with urban areas (ibid). The UK is the most urbanised country in the EU, and Scandinavia and Eastern Europe have the most rural areas (though Sweden now only has about 12.3% of its population in rural areas). Strong urban migration by *young women* has led to *older, single women* being the predominant demographics in rural settings in Europe (ibid). However, some countries, e.g. Norway and France, have reported a specific risk of social exclusion for *poor male farmers*, who tend to remain single, because women are reluctant to share their poor living conditions (ibid). The problem with an aging rural population is compounded by social isolation and physical distance from health and other services. COVID-19 has further compounded vulnerabilities among low-income white rural youth and Black youth, both "dropping out of colleges in alarming numbers."[31]

Women

Women are often disadvantaged, including in sustainable energy interventions, despite not being a minority *per se* (e.g. Pachauri & Rao, 2013; Grünewald & Dianokona, 2020). In addition, COVID-19 has laid bare an enormous amount of inequalities that specifically hit women the hardest - although men are disproportionately more likely to die from the disease (e.g. Fawcett et al, 2020; PHE, 2020; WBG, 2020; Wenham et al, 2020). The UK *Womens' Budget Group* (WBG, 2020) summarises these key inequalities as follows (again, showing up the many *intersectionalities* that further compound vulnerability):

- Women are the majority of *health* (77%) and *social care* (83%) workers.
- Women are the majority of workers (77%) with *highest exposure to COVID-19*.
- Over a million of these essential workers are paid *below 60% median wages*. 98% are women.
- *Young women* are disproportionately (36% vs 25% of young men) likely to work in the sectors that have been hit hardest by the lock-down.
- Women are more likely to be *low-paid* (69%) and in *insecure* (74%) *employment*.
- Women are the majority of people living in *poverty* (90% of *lone/single parents* in poverty are women) and female-headed households are more likely to be poor.
- There were already huge disparities between *mortgage and rent affordability* between women and men due to the gender pay gap, which have been further exacerbated by COVID-19.

[28] See also: https://energycentral.com/c/ee/energy-efficiency-rural-areas-what-are-utilities-doing
[29] https://saveonenergy.ca/For-Your-Home/First-Nations-Conservation-Program
[30] https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/community-energy-solutions/first-nations-energy-efficiency-building-policy-program
[31] https://www.washingtonpost.com/business/2020/09/16/college-enrollment-down

- *Private renters* are in a particularly precarious financial situation (63% reported having no savings at all). Meanwhile, the housing affordability gender gap in the UK is massive: average rents take 43% of women's median earnings but just 28% of men's.
- Pre COVID-19, 39% of women (vs 34% of men) struggled with *debt and bills*. On average, women carry out 60% more *unpaid work* than men.
- Women are more likely (20% vs 4% in men) to experience *domestic and sexual violence* and *abuse*.
- Women are the majority (67%) of people living in *homelessness*, with *single parents* leading two-thirds of homeless families with children.

Indigenous / First Nations peoples

Four of the five countries involved in this Task have Indigenous populations: *Native Americans / indigenous communities* in the U.S., *First Nations* in Canada, the *Saami* in Sweden, and *Māori* in Aotearoa New Zealand. All of them, to varying degrees, suffer to this day the ill-effects and aftermath of colonisation, including in their access to, and burden of energy generation and supply, and its associated costs (see e.g. Cornell, 2005; Crane, 2017; Johnson et al, 2018; Normann, 2020; Brosemer et al, 2020). Indigenous self-determination and self-government are essential bases for improving the socio-economic conditions of Indigenous peoples. In all four countries (US, CAN, NZ, AUS) that Cornell (2005) compared, *Indigenous poverty* has been deep, widespread and persistent.

Tribal or equivalent groups range widely in size from populations of under one hundred, found in each country, to the Navajo nation, more than a quarter of a million strong. More than half of the Indigenous population in the U.S. live in *urban* areas; an even higher percentage of Māori do, whereas most Swedish Saami live in the *remote* northern parts (Normann, 2020). Indigenous groups are among the *poorest* populations in each country (except in Sweden, see Burmeister Hicks & Somby, 2005), but there are significant differences in social and economic conditions (Cornell, 2005). In Australia, for example, Aboriginal *life expectancy* at birth in 1991 was 59.6 years, but it was 70.5 years for New Zealand Māori (which is still 9.5 years lower than non-Māori, see Signal et al, 2007), and registered First Nation peoples in Canada, and 73.5 years for indigenous communities in the United States.

In terms of absolute measures, with the exception of Pacific Islanders in some cases, Māori as a group continue to suffer lower levels of *educational attainment, employment, income, health and housing* relative to non-Māori New Zealanders (Humpage, 2005). Signal et al (2007) showed that, in Aotearoa, inequalities in *health*, and in the determinants of health, are pronounced and have been shown to be increasing. They include inequalities between *ethnic groups*, people of different *socio-economic status*, *geographic inequalities*, inequalities of *gender,* and inequalities experienced by people with *disabilities*.

Baker et al (2010) also showed that there were marked ethnic differences in the distribution of *close-contact infectious diseases* (CCID). CCID rates were highest in *children* less than 5 years, the next most vulnerable group was *adults aged 70+*. Respiratory hospitalisations made up roughly half of all CCIDs, something of particular concern in the age of COVID-19 (Baker et al, 2020). Poor, energy-inefficient *housing* and *overcrowding* (both of greater concern for indigenous and Pacific people in NZ, ibid), of course contributes to both, the susceptibility to, and the severity of the impact of respiratory viruses such as SARS-CoV-2.

Black, Asian, Hispanic minorities

Ganong et al (2020) showed that Black and Hispanic households *cut their consumption* by 50% and 20% (respectively) more than white households when faced with a similarly-sized income shock due to COVID-19; and they explained nearly all of this differential pass-through of income to consumption, by differences in *liquid wealth*. An incredible 42% of Americans reported (in the *Current Population*

Survey) that they do not have money set aside that could be used for unexpected expenses or emergencies. This number is raised to 55% of Black households, as compared to 38% of white households (ibid). Jessel et al (2019) also found that, across all income levels, Black households suffered the highest level of energy insecurity. Similar to Ganong et al's (2020) findings, Fawcett Society (2020) also found that 43% of UK Black, Asian and Ethnic Minority (*BAME*) *women* said they believed they would be in more debt, post-pandemic, compared to 37% of white women, and 34% of white men. A similar proportion of BAME women said they would struggle to make ends meet over the next three months, and a quarter of *BAME mothers* reported that they were struggling to feed their children (ibid).

BAME women in the UK are three times more likely to be in *precarious work*, making them less likely to qualify for government support during COVID-19 (WBG, 2020). In addition, they are also more likely to be *low-paid* and already *living in poverty*. Similar to what Ganong et al (2020) found in the U.S., in the UK, BAME groups, and especially *women*, also have *lower levels of savings* to cope with a fall in earnings (WBG, 2020). *BAME families* are statistically more likely to have *more than 3 children*, which means they face additional burdens from school closures. Misinformation about COVID-19 and its origins has been associated with increased incidents of *racist hate crime* and *xenophobia*, in the U.S. (Gover et al, 2020) and UK[32]. People from ethnic minority backgrounds, particularly Indian, Black African and Black Caribbean people are also over-represented in *essential workers* jobs in the UK, especially front-line, health and social care roles, compared to white people - leaving them more susceptible to infection. At the same time, within all ethnic groups, *women* are over-represented in key worker roles compared to men (WBG, 2020).

Migrants and refugees

Migrants differ in their audience characteristics and needs - *highly skilled labour migrants* will have other characteristics and needs than *refugees, foreign students, family migrants* or *temporary workers* (see e.g. Horakova, 2013; Gustafsson et al, 2017). There are many factors causing migrants to be disadvantaged when it comes to accessing (urban) *services, infrastructure and facilities*. Liu (2005) provides a good example in the case of the *hukou system* in China, which led to strong social inequality between urban and rural China. In the case of Beijing, the hukou system continues to have significant influences on *employment levels* and *workers' costs* in migrant households. The chances of a member of a migrant family being employed are reduced, and migrant workers can suffer more *commuting time* costs; the current hukou system and its related institutional arrangements still influence and intensify social inequities, e.g. with job accessibility (Zhao & Howden-Chapman, 2010).

Teschner et al (2020), when discussing two minority groups (the Romani and Bedouin communities in Romania and Israel, respectively), found that the *lack of access to energy / electricity* was strongly associated not only with the transition to a modern lifestyle, but more importantly with the barriers they face in accessing society at large. This was partly due to policy makers perceiving energy vulnerability to be less urgent than other challenges for these communities (ibid). Gustafsson et al (2017) found significant differences in *poverty* levels in *elderly non-Swedish born migrants*: Only 1% of elderly Swedes are regarded as 'twice-poor' (i.e. income and asset poor; see full definition in section on *Elderly*, below). In contrast, among older persons born in low-income countries (who migrated to Sweden), almost three out of four were classified as poor according to one of the criteria, and not fewer than one in three according to both. In fact, Gustafsson et al (2017) highlight that the hugely-successful Swedish welfare state does not seem to function for one audience group, specifically: *late-in-life migrants*, particularly those *originating from middle- or low-income countries*. This is also a relatively recent problem, as migrants who arrived in the 1950s and 60s were labour migrants, rather than refugees or those joining family members. The older they are at entrance to Sweden, the less likely they are to find employment, and thus the lower their *pension income* will be.

[32] https://www.theguardian.com/world/2020/may/13/anti-asian-hate-crimes-up-21-in-uk-during-coronavirus-crisis

One example of where this structural inequality led to fatal consequences, is the heavy toll that COVID-19 took on (mostly *elderly*) *Somali immigrants* in Sweden.[33]

Heisig et al (2017) showed that the *retirement income gap* between immigrants from non-European countries and EU natives from 16 countries is substantial. Canada has a similar pension system to Sweden's - they both require residency for a minimum of 40 years starting at age 18 to be eligible for a full pension (Gustafsson et al, 2017). Marier and Skinner (2008) scrutinised income inequality among recent migrant men and women in Canada and found *lower pensions* among migrants, especially *women*. In the U.S., migrants also earn *lower wages* than do native-born workers with the same characteristics (Sevak & Schmidt, 2007). In the UK, Vlachantoni et al (2017) demonstrated that *BAME elders* are more likely to receive pension credit and less likely to receive state or occupational / private pensions. People who had lived in the UK for between 10 and 39 years were less likely than those born in the UK to receive state pensions.

Up to 44% of those born in low-income countries fall under the Swedish definition of poverty (Gustafsson et al, 2017). Thus, *poverty* among *older* persons born in *low-income countries* is 4.3 times as prevalent as among older Swedish-born persons. Net asset poverty is 6.1 times as prevalent among older persons born in low-income countries than among Swedish-born older persons. This is why they are classified as vulnerable compared with those persons born in Sweden or other high-income countries. In addition, being an *older person and single* is also considered a risk factor for poverty (Gustafsson et al, 2017). Immigrating after 40 years of age increases the probability of being *twice poor* (i.e. income and asset poor) at an older age, although the risk is considerably lower if the non-Swedish-born person has had a *long post-secondary education* compared to having a shorter education. This is likely because the more-educated migrants have been more successful at finding employment, thereby accumulating better pension rights. However, the poverty risk is still higher than for Swedish-born persons with lower education levels.

Pene et al (2009) in their research on Tokelauan immigrants to Aotearoa also showed that, for migrants, *extended family living* is often an important cultural and economic strategy to facilitate their adaptation to a new country. In the case of Pacific peoples in Aotearoa New Zealand, it also reflects the realities of the norm of lives in villages, where land is limited and owned collectively by families. Like the Pacific population as a whole, the Tokelauan population is relatively *young*: the median age is about half that of the total New Zealand population (19 years versus 36 years, see also Ashby et al, 2020b for average age comparison between our participating countries). Tokelauans have a level of *extended-family living* almost three times higher than that of any other ethnic group (37% compared to 10% for the total population), leading to *crowding* in often poor, energy inefficient housing (ibid).

There is strong evidence that crowding increases the risk of *close-contact infections* such as meningococcal disease, rheumatic fever, tuberculosis and skin disease (Baker et al, 2010). Rates of these diseases for Māori and Pacific peoples are double those for Pākehā (white New Zealanders). PHE (2020) point out that the relationship between ethnicity and health is complex and likely to be the result of a combination of factors, such as ethnic minorities and migrants being more likely to live in *urban* areas, in *overcrowded* households, in *deprived* areas, leading to poorer health and comorbidities, and having *jobs* that expose them to higher risk. Crowding also increases the risk of being exposed to second-hand smoke (Howden-Chapman & Tobias, 2000), which irritates the airways and increases the risks from infectious diseases. These are all additional risk factors during the global COVID-19 pandemic and may be one of the reasons why, for example, Pasifika were the hardest-hit population in the U.S.[34]

[33] https://www.trtworld.com/magazine/coronavirus-can-sweden-do-more-to-protect-the-somali-community-37227
[34] https://www.rnz.co.nz/international/programmes/datelinepacific/audio/2018757750/the-pacific-island-battle-against-covid-19-in-the-us

Refugees and asylum seekers are also some of the UK's most vulnerable and marginalised people, often living in *gender-specific destitution* (WBG, 2020). These audience groups are at increased risk of *poverty* and *homelessness*. WGB (2020) found that migrant *women* still have no recourse to public funds, meaning that if they lose their jobs or homes they cannot claim social security (similar to the 200,000 New Zealanders living in Australia who have no social security support[35]). Migrant women *victims and survivors of abuse* (which also increased to devastating levels during COVID-19[36]) cannot access women's refuges / shelters in the UK. Despite being overrepresented in *frontline work* like health and social care in the UK, migrants are paying for the *National Health Service* (NHS) twice, through the *Immigration Health Surcharge* and their taxes. In addition to suffering the highest rates of COVID-19 fatalities (PHE, 2020), *BAME migrants* (especially *women*) are also hugely susceptible to becoming destitute and homeless.

Mental and physical disabilities

Several HTR authors have mentioned the lack of focus on those living with *mental and physical disabilities and chronic ill-health*, including families with young children, compared with the needs of older people (Laxton & Parckar, 2009; Snell et al, 2015; O'Sullivan et al, 2016; UKERC et al, 2018). Snell et al (2015) also show that, despite recognising disabled people within research and policy as being vulnerable to energy poverty (e.g. Fahmy et al, 2011; DECC, 2012), there is very limited evidence that explicitly considers the interconnectedness of energy poverty and disability (see Laxton & Parckar, 2009 for a discussion of this issue). Compounding this lack of evidence is that, within policy, disabled people are typically treated as a single group with homogenous needs, despite highly varied needs and eligibility for energy poverty or welfare support in the UK (Walker & Day, 2012).

There is a well-documented relationship between (energy) poverty and disability (Snell et al, 2015): Disabled people are both *less likely to be employed* than non-disabled people, and if they are working they are more likely to *work part-time*, and for *lower wages*. In addition, disabled people are also *less likely to have savings* and often face *increased living costs* - suggested by some to be as much as an additional 25% compared to non-disabled people (Parckar, 2008). The combination of these two factors means that disabled people may be less resilient to financial shocks, or meeting unexpected bills (Wood et al, 2011) - this is obviously a particular concern post COVID-19. The relationship between poverty and disability extends to *housing conditions* and *tenure type* (Parckar, 2008); for example, the UK *Department for Work and Pensions* found that in 2008 that "*one in three households containing disabled people were situated in non-decent housing conditions"*. Disabled households, especially those with *disabled children* were also found to live in much less efficient and suitable housing than abled people. As well as disabled children being disadvantaged, *older people* with chronic illness and/or disability were also more likely to live in energy poverty and substandard housing (Parckar, 2008). Disabled *women* are also twice as likely as nondisabled women to *experience domestic abuse* and face *more barriers seeking support* (WBG, 2020). Any loss of earnings (seeing they already own *fewer assets* and earn *lower wages*) could further be detrimental to their wellbeing and quality of life.

Data from the *English Housing Survey* suggest that disabled people are more likely to be in *rented* accommodation than non-disabled people (DCLG, 2014). Williams et al (2008) identified that disabled people in the U.S. also were more likely to live in *social rented* accommodation than the general population, and that disabled people were under-represented in the private rented sector in comparison with the population at large. A further difficulty for disabled people living in the rental sector is that the range of properties that are 'accessible' *is often limited* (Pro-Housing Alliance, 2012) impacting particularly those with limited mobility who cannot readily find alternatives. In addition, *energy price increases* hit people with disabilities particularly hard (Snell et al, 2015). Certain health

[35] https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=12330664

[36] https://www.bbc.com/news/av/world-53014211/coronavirus-domestic-violence-increases-globally-during-lockdown

conditions or impairments may require *higher temperatures* or *longer periods of heat*, and an absence of this may prove harmful or indeed fatal (ibid). This is compounded by the fact that disabled people or those with life-limiting illnesses usually spend more time in the home, and thus the impacts of any measures or behaviors in favor of energy efficiency will be compounded. Additional factors that may increase energy use are, for example, the cost of energy-intensive equipment such as a breathing apparatus or contraptions to help lift or transport the mobility-impaired. The initial fuel poverty definition by Boardman (1991) failed to account for some of these specific conditions for increased energy needs, and artificially-inflating household incomes by including disability benefits incorrectly suggests that these benefits are available to pay for energy costs (Snell et al, 2015).

Finally, it needs to be acknowledged that discrimination due to disability and ill-health can literally have fatal outcomes. Standards of care were lowered by the *UK Coronavirus Act 2020*, leaving many disabled people fearful for their care and also possible denial of care; if care providers needed to self-isolate, disabled people could be left without vital support (WBG, 2020). In addition, WBG (2020) warned of serious concerns that disabled people and people with serious health conditions were being or may be denied treatment for COVID-19, even where these conditions have no impact on their chance of benefiting from such treatment: "*Age UK has described pressure on some older people to sign 'do not resuscitate' forms as 'morally repugnant' following reports that GPs and in one case an entire care home have been asked to get some patients to agree to 'do not attempt CPR' forms*" (WBG, 2020). Other governments have also struggled with these difficult ethical issues. For example, when ethics teams in Massachusetts were asked to develop guidelines for who would receive ventilators if hospitals ran out, an individual's *disability status* was explicitly mentioned as a factor that could not be considered in the decision-making (see Commonwealth of Massachusetts, 2020b).

Physical health issues and disabilities

Respondents of a survey by Snell et al (2015) reported a range of impairments and conditions that gave rise to a variety of disabilities. Survey participants relying on disability payments discussed greater problems relating to energy costs and highlighted how they *rationed energy, cut back on food, wore extra clothing* to lower energy costs, and *sold possessions* in order to pay energy bills. A key difference to the generally-similar experience of those living in energy poverty was the significantly increased energy needs associated with certain impairments and conditions. In Sweden, Thomson et al (2017b) found an important difference (~30%) between non-energy poor and energy poor populations in relation to their self-reported health status.

Energy *poverty* rates in the *private rental sector* are consistently high, particularly among households containing disabled people (Snell et al, 2015). A similar pattern can be found in owner-occupied homes that include a disabled person. *Older disabled* people on *regulated tenancies* were viewed as a particularly vulnerable group. However, some of the highest energy poverty rates were found among *single disabled people of working age*, who also have been least protected by UK welfare reforms and are less likely to be eligible for the main forms of energy poverty support (ibid). A key criticism made by disability agencies was a lack of data matching for those under retirement age.

An increase in *hospital admissions* for respiratory conditions in older people (aged over 65) has been observed during winter (Castaño-Rosa et al, 2020). The risk of death by a respiratory infection can further increase if a person suffering from a chronic respiratory illness sleeps in a cold bedroom, leading to the *Excess Winter Deaths* observed in the UK (e.g. UK Power Networks, 2014; NEA, 2020) and Aotearoa (e.g. Howden-Chapman, 2015). With the escalating climate crisis there are now also increased issues surrounding the (in)ability to cool homes during summer heatwaves, leading to *Excess Summer Mortality* in extreme cases (e.g. Robine, 2008; Guo et al, 2018). Disability associated with *aging* increases the possibility of housing and health problems, which can lead to stress and

costs to older people, their families, the community and the government (Howden-Chapman et al, 1999). Growing numbers of older people with *dementia* will also need particular housing assistance.

Mental health issues and disabilities

Little research has been done on the connection of mental health and EE in housing (WHO, 2018), although there were some interesting findings in Aotearoa (Howden-Chapman et al, 2007), the UK (Poortinga et al, 2017; though another study found no such impact, see Grey et al, 2017), and the U.S. (Breysse et al, 2015), that insulation improved poor mental health and depression. Additionally, Singh et al (2019) carried out a thorough literature review collecting evidence on the longitudinal impact of *housing disadvantage* on mental health, and confirmed that households who are exposed to housing disadvantage may experience mental health issues in the future. COVID-19 has had, in and of itself, highly-detrimental impact on global mental health (Torales et al, 2020). Counselling and other mental health support during COVID-19 has been moved to telephone and online. This was thought to have a negative impact on *women* with *ongoing physical or mental health* conditions (WBG, 2020).

Stigmatised and criminalised

Hards (2013) and Reid et al (2015) were some of the few researchers who investigated how status and stigma are implicated in everyday energy practices, and how they may act as facilitators or barriers to EE and behaviour change. They explained that domestic energy practices may be status-enhancing (e.g. 'green consumerism') or stigmatising (e.g. conspicuous excess energy consumption), and in some circumstances individuals may actively manage the visibility of their energy practices. Reid et al (2015) highlighted three main aspects to assess related to potential stigma:

1. The nature of the energy-efficiency *technology*, and in particular its visibility.
2. The nature of the *dwelling* (including both the *building fabric* and the *tenure* type).
3. The *income level* of the household.

The stigma discussed by Hards (2013) around energy practices, was clarified to not be as severe or harmful as that pertaining to other domains, such as disability, race-discrimination or crime.

Former prisoners, gang houses, drug users

Gang members, former prisoners and drug users usually exist at the margins of society, they face long-term alienation from mainstream communities due to the 'triple prejudice' of *ethnicity, low socioeconomic status*, and *antisociality* (Lee et al, 2014; Tamatea, 2015; Matsuzaki et al, 2018). *Gangs* can have oversized influence on already-vulnerable households - through the impact of intergenerational continuity in membership of gangs (Augustyn et al, 2018); preying on the vulnerability of its members or 'clients' (e.g. Tamatea, 2015), and even taking over vulnerable households to sell drugs[37]; but also by offering employment, both illegal and legal, sometimes becoming the largest 'employer' in the most stigmatised communities (Pawelz, 2019). In fact, Pawelz' (2019) research showed that "*gang leaders provide social welfare, food, and financial support to single mothers and poor people and also send children to school. In their own narrative they were legitimate community leaders. One social worker described them as informal support systems. They were also seen as father figures*." Despite this outsized influence and 'societal fear factor', gangs as a social phenomenon appear to be largely under-researched (Tamatea, 2015), including in energy efficiency research. There are, however, some efforts to provide green jobs, including in energy efficiency, for former prisoners[38].

[37] https://crimestoppers-uk.org/campaigns-media/news/2018/may/rise-in-drugs-dealers-taking-over-vulnerable-peopl
[38] https://usgreentechnology.com/green-jobs-ex-convicts/

Homeless (including shelters)

Like prisoners, homeless persons constitute an extremely vulnerable population (Umamaheswar, 2018). Those experiencing homelessness are among the most seriously disadvantaged members of a society. They often suffer from additional vulnerabilities and intersectionalities, from acute *mental and physical health* issues, to severe *poverty* (Liu et al, 2009), and difficult histories of *drug and alcohol abuse* (Van Geest & Johnson, 2002), as well as *criminal records* (Stein & Gelberg, 1995), and they are highly stigmatised by most societies (Horakova, 2013). Now, they are some of the most-threatened groups in terms of COVID-19 infections and fatalities[39] (e.g. WBG, 2020). Usually, when researching homeless populations, *shelters* have been used as fieldwork sites (Liu et al, 2009), however, this does not capture all those suffering homelessness. Persons living in shelters represent a distinct sub-group of the homeless population insofar as they are both willing and able to seek the assistance of the shelter system. Not all who are homeless are sleeping in shelters (see below). It is important to acknowledge that only considering homeless persons residing in shelters limits our knowledge about the true scope and experience of homelessness and obscures the unique challenges of this highly vulnerable HTR audience for energy Behaviour Changers.

Housing is a key determinant of health, justice and social development outcomes, and it directly affects economic and security (Pierse et al, 2019). Of people who were homeless in Aotearoa, 96% had at least one recorded *hospitalisation* in their lives prior to becoming homeless (ibid). It is therefore important to integrate approaches to addressing the complex needs of those experiencing chronic homelessness, with an emphasis on housing. The homeless (and vulnerable migrants) were found to have the poorest health outcomes under COVID-19 (PHE, 2020). This is a consequence of being exposed to multiple, overlapping risk factors, such as facing barriers in *access to services*, *stigma* and *discrimination*. In addition, there is a massive *gender* inequality among the homeless: In the UK, 67% of statutory / chronically homeless people are women and housing unaffordability is also closely linked with violence and abuse (WBG, 2020).

However, it is not just about ‘rough sleeping’ (i.e. sleeping without adequate shelter, often in the open air), which is the visible face of homelessness and only the tip of the iceberg. For every person sleeping rough on the streets, there are 12 households that are homeless (ibid) - i.e. they do not pay utility bills and cannot be easily found at an address, but they do need to use energy to survive. They are often in temporary accommodation provided by the Council, staying temporarily with friends and family or sofa-surfing. *Women* are the majority of those in these circumstances and *single mothers* are overrepresented in homeless families (ibid). A recent UK modelling exercise (see PHE, 2020) estimated that in a “do nothing” scenario, 34% of people living in hostels and sleeping rough would be infected with COVID-19, leading to over four thousand hospital admissions. Other countries have reported severe outbreaks in homeless shelters[40] and among migrant workers[41].

Sex workers

Over 40 million people are working in the sex-business worldwide, most of them since they were 14 years old[42] - yet, we could find no literature in the clean energy sector focusing on this highly vulnerable, stigmatised and often illegalised audience group. Street sex workers or lower-ranking prostitutes are the most vulnerable group in the sex-business, often suffering from *poverty, addiction, violence* and may be victims of *human trafficking* (Horokova, 2013). Their situation of not taking action in response to their needs is “*because the need has become so entwined with their daily life that they do not experience it as a problem*” (Stilwell, 2002). Sex workers are also particularly exposed to health (including *chronic mental health*) problems and many do not have adequate health insurance,

[39] https://www.nature.com/articles/d41586-020-01389-3
[40] https://www.nature.com/articles/d41586-020-01389-3
[41] https://www.voanews.com/covid-19-pandemic/singapores-coronavirus-outbreak-sends-malaysia-scrambling-test-migrant-workers
[42] https://www.statisticbrain.com/prostitution-statistics/

especially in the U.S. (Horokova, 2013). Because of social stigmatisation and poorer access to medical services at night when they are usually working, most of them seek medical help only when disease has developed to an advanced stage (ibid). It can be expected that these vulnerable people (the majority of whom are women) also struggle with paying their utility bills, however, we are aware of no specific research that has focused on that issue.

The Elderly, single parents with young children, and pregnant women

The Elderly

Demographically, the impact of the baby boom means that the proportion of the population 65 years and older will rise for the next few decades (Howden-Chapman et al, 1999). The proportion of people aged 60 or over in Aotearoa will increase from 15.4% in 1996 to 25.3% in 2030. Some of the key trends associated with population ageing are an increase in *lone-person households* (predominantly *female*, due to greater longevity and widowhood), and an increasing proportion of people *over the age of 80*. *One-person-superannuitant* households have among the *lowest incomes* of any household type in Aotearoa, with *elderly women* having significantly lower incomes than men (ibid). The disparities in wealth, in terms of *assets*, appear more marked in those over 65 than in other age groups (see also IEA, 2011).

Home ownership in Aotearoa has decreased dramatically over the last few decades, while housing rental costs have increased (Johnson et al, 2018). People in *rented* properties, particularly those in the public-rental sector, have higher death rates than people in owner-occupied households. Those who are better *educated*, are employed in *higher status jobs*, have *higher incomes* and live in *socioeconomically advantaged neighbourhoods*, will have better health and longer life expectancy (ibid). Three-quarters of Pākehā lived in mortgage-free housing (vs only half of *older Māori*) and 87% (vs 70% in Māori) lived in owner-occupied housing in 1996. For older Pacific people, only 25% lived in mortgage-free housing, and 54% in accommodation which they owned. Housing *rental costs* have also increased significantly over the last decades, thus older Māori and Pacific people are likely to have been more economically affected than white New Zealanders. Many older homeowners in Aotearoa are dependent on *government pensions* for day-to-day living expenses, leaving little left over to pay for repairs and modifications to housing, negatively affecting their energy bills and health (Howden-Chapman et al, 1999).

In the UK, older adults make up around 17.7% of the population and have outnumbered those under 16 for the first time in the 2001 census (Office for National Statistics, 2016). Gustafsson et al (2017) highlights the Swedish approach of defining poverty (see energy poverty definitions, above) as particularly relevant to the elderly, many of whom receive *low incomes* but also possess not-trivial *net assets*. Many countries have systems of widows' pensions protecting *married women* from severe income loss due to the death of their spouse. However, as Sweden has moved to dual-income households since the 1950s, widow pensions have started being phased out (ibid). Surprisingly, Gustafsson et al (2017) found several studies showing that many income-poor households were *homeowners*. Poverty rates were substantially lower when the *value of the home* was considered, especially among older adults with more wealth than the *poor young*. *Single* and *single-parent* households are more likely to be twice-poor (ibid). *Income poverty* rates among those aged 65 or more years increased by more than 8% between 2007 and 2015, to 18% (ibid). For vulnerable populations like the elderly, extremely *cold temperatures* can be deadly, even indoors. For example, elderly patients admitted to the intensive care unit for hypothermia in the U.S. are more severely affected and die more frequently when found indoors, compared to those found outside with equivalent body temperatures (Reames, 2016).

Willand et al (2017) showed that elderly low-income households and tenants are more likely to live in homes with *sub-standard thermal performance*, and often *lack the financial resources* and *agency* needed for retrofits. In the context of the UK *Energy Saver Study*, low-income households represented those with an *income in the bottom 40%* of the national income distribution, people who were *socially disadvantaged*, received *financial governmental support* or were recognised as experiencing *energy hardship*. At least three quarters of main respondents in the study were *women* and *over 70 years old* and *retired* (ibid). Petrova & Simcock (2019) also highlight that *elderly women* are more likely to suffer from energy poverty in the Global North than men. In most homes with elderly residents, someone was at home at all times, which is directly correlated with higher energy consumption (Battarcharjee & Reichard, 2011). The large majority of main respondents had a *long-standing illness, disability or infirmity* (Willand et al, 2017). The combination of low income and the *poor thermal quality of the dwellings* suggested energy stress and possible exposure to low temperatures. Thomson et al (2017b) suggest a number of reasons for this relationship: the higher likelihood of older people having underlying health conditions, less subcutaneous fat, and being in the home for longer periods. *Single family detached homes* were found to be the most energy-intensive type of dwelling (Battarcharjee & Reichard, 2011). The authors found that the most significant demographic determinants of household energy consumption were: *family size, age distribution, the number of wage-earners in the household,* and *the occupancy time in the house*.

Gender pension inequality also means that *women pensioners* are significantly more likely to be living in *poverty* than men. Men were found to have 11 times the *private pension wealth* of women, on average, and 23% of *single woman pensioners* are living in poverty (ibid). Accessing necessities is complicated for older people if they *cannot leave the home*, especially given the lack of availability of online deliveries. Care / nursing homes were found to present serious risk of exposure and deaths especially given staff shortages, in all participating countries (e.g. WBG, 2020)[43],[44]. Even in NZ, where only 25 COVID-19 deaths have been recorded to date, 54% occurred in care homes[45] and all but one death occurred in someone aged 60 years or older (as of September 25, 2020).

Single parents (with young children) or pregnant women

Households with *children* represent a large number of households (between 30-40% in our participating countries[46],[47],[48]), and they generally experience more difficulty paying energy bills, have reduced *family income* and higher and less predictable energy use, are more likely to be at home during the day, are more likely to adopt new technologies, and may contain children who are more vulnerable to heat and cold than healthy adults (Nicholls & Strangers, 2015a; Jessel et al, 2019). *Women* are the majority of single parents (90%) in the UK and nearly half are living in *poverty* (WBG, 2020). Lone parents are more likely to rely on social security and struggle with housing costs (ibid). A recent study by Lu et al (2019) showed that the average total *income* of *single mothers* was lower than the average U.S. household, and that single fathers were more likely to be *white* and *older*. *Age, marital status, years of experience,* and *region* were found to be critical factors for predicting the income and poverty status for single parenthood (ibid). Despite this high incidence of vulnerable households, little EE research has been done that studies this audience (e.g. Kleinschafer & Morrison, 2016). Somewhat more research has concentrated on engaging *children* in energy efficiency (e.g. Fell & Chiu, 2014; Aguirre-Bielschowsky et al, 2015; 2018). Similarly rare is EE research specifically addressing the plight of vulnerable *pregnant* women. In Aotearoa, a recent government initiative called the *Healthy Homes Initiative*, focuses on this highly-vulnerable group (see submission by the NZ

[43] https://www.spectator.co.uk/article/the-fatal-combination-behind-covid-care-home-deaths
[44] https://www.cidrap.umn.edu/news-perspective/2020/06/nursing-homes-site-40-us-covid-19-deaths
[45] https://www.cidrap.umn.edu/news-perspective/2020/06/nursing-homes-site-40-us-covid-19-deaths
[46] http://archive.stats.govt.nz/browse_for_stats/people_and_communities/Children/census-snapshot-children.aspx#gsc.tab=0
[47] https://www.statista.com/statistics/242074/percentages-of-us-family-households-with-children-by-type/
[48] https://www.statista.com/statistics/526013/sweden-number-of-households-by-type/

College of Midwives in 2018, in support of this programme based on the importance of energy-efficient housing on pregnancy and infant wellbeing).

Reproductive and sexual health is an area of concern that has also been repeatedly side-lined in past epidemics, as it has with COVID-19 (WBG, 2020). This is an issue because *access to contraception* is likely to be affected by the disruption in global supply chains and because *pregnant women who are undocumented* have to pay for essential ante-natal and maternity care, saddling them with substantial debt (ibid). Pregnant women are amongst those with *pre-existing health conditions* who need to work from home, yet the UK Government has not extended necessary furlough to those who cannot (e.g. essential workers). *Self-employed parents* who have taken recent maternity or parental leave will have a higher risk of their income being reduced. For single parents, having children at home whilst also trying to go to work or work from home presents an impossible challenge. If they become unwell, they risk infecting their children for lack of other support networks (ibid).

Psychographics

UK researchers uncovered an important variable when studying energy poverty and the impacts of policies and interventions on HTR audiences: *social relations* (e.g. Middlemiss et al, 2019; Hargreaves & Middlemiss, 2020). To quote an important insight from Hargreaves & Middlemiss, 2020 which affects energy use, including that of vulnerable populations: "*Humans are social animals: our relationships shape our experiences, decisions and actions. Energy demand is no exception: how we consume energy is shaped by relationships of conflict, consensus, collaboration, companionship, solidarity and oppression with our fellow human beings. When people talk about using energy at home, work or in their communities, they also talk about their relationships with others to explain how and why they consume in the ways they do*." This research (Middlemiss et al, 2019; Hargreaves & Middlemiss, 2020) focused on how *relationships* (with family, friends, agencies etc.) impact on people's ability to cope with energy poverty - instead of only focusing on them as discrete and isolated individuals. They found that the connection between social relations and energy poverty is such that good social relations can both enable access to energy services, and be a product of such access (ibid). Structural factors, e.g. access to a range of resources, membership of particular groups, and the common reasons used to explain energy poverty, also shape these connections. The quality of people's social relations is crucial in terms of *how people feel isolated by energy poverty,* given that they rely on their friends and families for information support and advice, on key intermediaries for access to resources, and are also constrained by wider societal discourses of poverty. Those who are socially-isolated are severely disadvantaged in terms of accessing energy services, and often *feel stigmatised*, which in turn makes them harder-to-reach by Behaviour Changers.

As well as the importance of social relations, comparisons of energy poverty in the Pacific highlighted that influences outside of the home were also important drivers of energy poverty experienced by young people, who were impacted by energy use and inadequate energy services available at work in small businesses, at school, or in churches (Teariki et al, 2020). It is common among Pasifika for energy use such as cooking to occur outside of the home in traditional cook houses which may be shared between families (ibid). These cultural idiosyncrasies and social relations need to be understood by HTR researchers and practitioners before designing potentially flawed interventions.

Main psychographic variables found among vulnerable households are *tolerance for thermal comfort*, *price-sensitivity, competency* to manage their EE, *confidence*, and *attitude towards authorities* (Russell-Bennett et al, 2017). In this respect, there are important aspects to take into consideration when reaching out to vulnerable households, such as the concept of 'energy' being a *relatively new topic* for them; they are *unsure how energy fits into their lives*; have an especially *high / low threshold for thermal comfort*; are *fearful of the system* and, consequently, unlikely to change providers (ibid).

Waitt et al (2016) also highlight the concept of 'tyrannies of thrift' where "*'doing the right thing' and reducing energy use at home was integral to how many participants made sense of themselves in the context of home as thrifty consumers, carers, parents and grandparents, rather than environmental citizens or rational economic subjects*."

Lawson et al (2015), in a case study in Aotearoa, showed that the people who spent more than 10% of their annual household income on energy were different from those who *admitted to going without energy* because they could not afford it. Lawson & Williams (2012) state that "*the commonly accepted 'objective' measure of energy poverty, i.e. proportion of household income spent on energy, is only moderately related to self-identified instances of energy poverty, and the objective measure suffers from the obvious defect that it is based on household income, not household* disposable *income*." Households in energy poverty already take a lot of steps to reduce the use of energy in their homes, they own many fewer appliances that draw on energy in the home, and live in smaller, older, often rented homes (Lawson & Williams, 2012). It raises the question of understanding the *tradeoffs* that people might be making as to whether or not they are choosing to spend money on energy from a limited budget. Surveys and interviews with electricity consumers using prepayment meters in Aotearoa explored these tradeoffs, finding that these households particularly cut back on grocery spending (O'Sullivan et al, 2013) and heating use (O'Sullivan et al, 2014; 2016). This has also been observed in the U.S. (Frank et al, 2006; Cook et al, 2008) and in the UK (Powell-Hoyland et al, 2016). It also raises issues around *health*, for example when people are using inefficient, unhealthy or outright dangerous heating sources such as open fireplaces fueled with driftwood or treated, recycled timber, or unflued gas heaters[49]; or simply 'put on another jumper / sweater' *instead of complaining* when living in a freezing home (e.g. Cupples et al, 2007; Mourik & Rotmann, 2013).

Kearns et al (2019) showed in a Scottish study that individual and household characteristics influence *attitudes* towards energy conservation, use of energy, and ability to manage energy bills, thereby affecting *energy poverty*. Furthermore, the role of *social connectivity* was also a potential protector from energy poverty, with wider family relations found to be both protective and curative of energy poverty. Johnson (2020), in her research on gender roles in demand-response programmes asserted that many low-income women described chore-doing as a way of expressing love as well as managing a household's consumption and finances. Chen et al (2020) highlight how various contextual and social-psychological factors (such as *social norms, attitudes, technology anxiety* and *trust in utilities*) are important determinants of smart home technology adoption intention during COVID-19.

For *Indigenous* people, additional stressors stemming from structural racism and colonisation arise. Cornell (2005), in their comparative analysis of Indigenous peoples in the U.S., Canada, Aotearoa and Australia found the following grounds for comparative enquiry:

- All four countries are *settler societies*, states in which "*the predominant population arises from immigrants and the indigenous population has become a displaced minority*".
- All four contemporary societies are of predominantly *British* heritage. All are predominantly *English-speaking* societies today, with most language and cultural identity having been suppressed. This fact profoundly structures the experience of their Indigenous peoples.
- Indigenous populations in each of these societies are at or near the bottom of the scale of *socioeconomic welfare*. In each case, Indigenous populations survive, many of them not simply as aggregations of individuals but as distinct communities concentrated on *remnant lands* that have been the keys to their survival and over which they exercise varying levels of control.
- Furthermore, in all four cases the Indigenous populations – either as individuals or as communities – have long occupied *legal positions that differ* in critical ways from those of

[49] https://www.propertyguides.com/new-zealand/news/heating-your-property-in-new-zealand/

mainstream populations. Among the issues debated in all four countries and not entirely resolved in any has been that of the rights of Indigenous peoples to govern themselves in their own ways – in short, *rights to self-determination*. They remain at the very heart of Indigenous concerns and of inter-group tensions in each case.

- Native American reservations rank at the bottom, or near the bottom, of the scale of *income, employment, health, housing, education* and other indices of poverty. Strikingly, however, this situation is not uniform across Indigenous nations. The most consistent predictors of sustainable economic development on reservations are not economic factors such as location, educational attainment or natural resource endowments but rather largely *political* ones:

    - Sovereignty or self-rule (including energy sovereignty, see Brosemer et al, 2020).
    - Capable governing institutions.
    - A congruence between formal governing institutions and Indigenous political culture.

In contrast to the Indigenous people colonised by the British described by Cornell (2005), the Scandinavian *Sami* or *Saami* people have successfully fought to create a healthy Indigenous community in northern Fenno-Scandinavia (Burmeister Hicks & Somby, 2005): "*The Nordic Sami have been extremely successful in their use of two distinctly different but co-dependent strategies. The first strategy has been to create a* common Sami identity and culture *during the last half-century and utilise the* Nordic sense of morality and human rights *to attract support for the Sami as a people.*" Poverty is now at an all time low in the northern parts of Scandinavia and the Sami language will soon be recognised as an official language in Norway and Finland (in contrast, te reo Māori has been an official language in Aotearoa [together with English Sign Language] since 1987). Increased resource rights allowed the Sami to maintain a subsistence lifestyle and increased their legitimacy as an Indigenous people - more than other Indigenous populations. All that said, it is somewhat ironic that clean energy developments and striving for carbon neutrality is leading to a new form of 'green colonialism', in the Arctic regions where new wind and hydroelectric developments impact on the Sami in their ancestral land and violate their rights (Normann, 2020).

The culture of *gangs* is complex and permits a network of relationships that members rely on for *validation* and *social support*. According to Tamatea (2015), it leads to "*a collective outlook that is explicitly oppositional and antisocial threatens to subvert deterrence efforts and to facilitate ongoing offending by exposing individuals to violence and risky situations*. *New Zealand gangs are forms of community with norms, values, processes and practices that possess an internal logic that is understood by members*." Their very nature at the edge, or in criminality and social stigma, means that they are extremely distrustful of authorities, including social or welfare agencies (ibid). This is a similar issue with *people who have been previously incarcerated* (e.g. Lee et al, 2014), and *drug users* (Matsuzaki et al, 2018). Interviews with NZ HTR researchers, practitioners, and policymakers for this Task (see Ashby et al, 2020a and b) have brought up the issue of how difficult it is to access houses associated with gangs, drugs or other criminal activities because of this distrust.

Reid et al (2015) also highlight that households might refuse to engage with the initiative as a direct result of seeing the 'targeted' EE programme as compounding their already stigmatised status. Humans frequently evaluate themselves against others, which can lead to powerful levels of anxiety about their status when they don't compare favourably (ibid). Batty & Flint (2013) state that "*individuals on low incomes are very concerned about stigma, negative images and stereotyping… which generates a 'spoiled' or 'discredited' identity contributing significantly to low self-esteem, exacerbated by feelings of being 'looked down on' or being a scrounger or good for nothing*". In direct contrast, some households may be "*reticent to take up the offer of targeted EE technology, because it may be regarded by their neighbours and friends as evidence of engagement in ideological practices which might be considered pretentious*" (ibid). Technological solutions to the EE gap usually gloss over -

sometimes, to their peril - the experiences or feelings of householders in relation to these interventions. Umamaheswar (2018) showed that even once access is gained, studying vulnerable populations can be particularly difficult because members of these populations often have *low literacy levels* (complicating the typical process of obtaining written informed consent), and their ability and/or *willingness to participate* which is often contingent on factors out of the researchers' control.

This is a similar issue for trying to research or engage *homeless* populations: The *instability* that often characterises the lives of those experiencing homelessness means that researchers cannot reasonably count on participants consistently being *able and willing to participate* in a research study (Kiddey & Schofield, 2011). Umamaheswar (2018; *unpublished*) investigates homeless ex-convict men's *constructions of masculinity* in the context of further understanding why so many homeless men end up incarcerated and vice versa, and if there was indeed a 'nexus' based on their self-imposed views, or failure to conform with conventional masculine ideologies. Rice et al (2017) also found, when investigating *perceptions of fatherhood and masculinity* among homeless men, that there were specific physical and psychological challenges, e.g. *feelings of low self-esteem* related to their perceived difficulty fulfilling the role of providers for their family, and having to adapt their view of 'typical fatherhood' such as that of a guide, teacher, and role model.

In the *elderly*, the key factor for wellbeing seems to be the degree of *control* people have over their lives - home ownership provides a degree of control and *security* over accommodation (Howden-Chapman et al, 1999). The *autonomy* afforded by owner-occupation was seen as highly advantageous in Howden-Chapman et al's (1999) research: 95% of the tenants agreed that owners had more freedom and independence in what they do with their homes. They speculated this to be particularly true of older people, who are no longer in the paid workforce. Most older homeowners would also *never seek any kind of government assistance* to modify their home, and would instead rather cope by themselves or with the help of their families or friends (ibid). Some older people were found to keep the temperature of their living accommodation too low for comfort, something Collins (1993) called a state of *'voluntary hypothermia*'. Howden-Chapman et al (1999) describes anecdotal evidence during the oil crisis that "*many older people felt a* heightened sense of civic consciousness *and economised unduly on heating fuel*", despite being more susceptible to hypothermia. It has been estimated that 30,000 people aged over 65 die of hypothermia each year in Britain. Using similar assumptions, the estimate for hypothermia-related deaths each year in the U.S. is 25,000 people, making it the sixth leading cause of death for old people. Using NZ data, Taylor et al (1994) found that 86.6% of the domestic hypothermia related fatalities occurred in those over 65 years. Gyllerup et al (1991) also provide evidence from Sweden on a strong regional association between cold exposure and high coronary mortality.

Brown & Markusson (2019) also showed that *older adults* were generally *more aware* of their energy use (even pre-smart meters), and practiced energy-saving behaviours *learnt from upbringing*. This *traditionalism*, however, led to negligible positive benefits and low engagement with the device. Other limiting factors included *lack of technical skills* and *confidence*, and the *risk* of losing the comfort and convenience of using electrical appliances. Smart meters also triggered *negative emotions* and *depression* amongst some older adults surrounding electricity usage they felt was too high, which could potentially lead to them turning down/off heaters and living in dangerously cold homes (ibid). Older adults are traditionally excluded in the design and use of Information and Communication Technologies (ICT), leading to an *age-based 'digital divide'* (Neves & Amaro, 2012). Research has shown that older adults are *less likely and willing* to use technology than younger people (Brown & Markusson, 2019). Marquie et al (2002) also reported older adults' *negative self-efficacy* as being 'too old for technology' with some experiencing *fear and anxiety* when trying to learn how to use a computer. However, Hanson (2010) showed that older adults are more likely to put effort in learning to use a technology if they are *interested in it* or it is perceived as *filling a need* in their lives.

Nevertheless, there is ground for concern that older adults may not be able to engage with new technologies (like SEMs) and will be disadvantaged and left behind in contemporary society (Brown & Markusson, 2019).

Parents interviewed by Nicholls & Strengers (2015a and b) said they "*faced additional or heightened pressures since having children including increased work to be done in less time, reduced focus on personal needs, and extra emotional and financial pressures*". Family comfort and quality family time were - unsurprisingly! - always regarded as more important than managing their energy usage. Many of these households were experiencing financial insecurity, including one in five households who were on *high incomes* (but dealing with high bills; ibid). Financial pressures were widespread in *low-income and sole parent* households, and were exacerbated by households with children with ill health or complex health needs. Almost half of the *single mothers* in a NZ study (Todd, 2008) reported suffering symptoms of *poor mental and physical health* as a consequence of stress relating to single mothering on a benefit. They reported feelings of *inadequacy, stigma, failure and low self-esteem* due to being depicted as 'bludgers and second-class citizens'. They also said that *negative representations* and *social attitudes* affected their relationships with family, friends and public institutions.

Barriers

General barriers

Eusterfeldhaus & Barton (2011) highlight the following general barriers to contribute to the EE gap: *risk, imperfect information, hidden costs, access to capital, split incentives* and *bounded rationality*. DellaValle & Sareen (2020) add that the "*ethical implications of an intervention can be evaluated in relation to the extent to which (i) people's goals are known (*information problem*), (ii) targeted people are initially endowed with cognitive skills and motivation (*multi-dimensional problem*), and (iii) policy designers are error-prone and benevolent (*political economy problem*)*." These general barriers were all mentioned in the literature, both on vulnerable households and in other HTR audiences (see **Chapters 4-7** below). There are several aspects that influence engagement with vulnerable households and can make them difficult to provide relevant support: *cultural diversity* or *different languages* spoken in the same home; *lack of energy knowledge* and *low self-efficacy* and *competence*; *language barriers* make it difficult for vulnerable groups to interact with the 'energy system'; *behaviour*; and/or *lack of trust* in the 'energy system', making vulnerable households more unlikely to change providers (Russell-Bennett et al, 2017). We will discuss some general barriers before going into sub-audience specific ones, below.

Neoliberalism in EE policy

Waitt (2017) points out that neo-liberal politics and (the associated) gendered discourse of science and knowledge dominate the energy policy realm and household energy knowledge. Concern about the distributional and structural injustices of neoliberalism and austerity have driven a greater need for understanding the underlying vulnerabilities highlighted by energy poverty (Robinson, 2019; Lacey-Barnacle, 2020). All of our participating countries govern under neoliberal doctrine (i.e. favouring free-market capitalism, deregulation and downsizing 'big government'), to one extent or another. The right of the market and the individual over the right of groups is particularly pronounced in the U.S., and much less so in the more socially-liberal (i.e. accepting of relatively high levels of state intervention in the economy for societal or environmental benefit) Sweden or Aotearoa. Neoliberal reforms, scaled up internationally in the 1980s, have caused significant impact on social, ecological and energy systems (especially via *deregulation*; e.g. Eusterfeldhaus & Barton, 2011; Hess, 2011). Because the changes resulting from neoliberal policies often had negative distributional impacts on the *working class*, the *poor*, the *small-business* sector (and the environment, see Hess, 2011), neoliberalism is worth mentioning as an overarching barrier to servicing their needs, here.

Deregulation of the energy markets has put the decision-making and price-setting into the hands of 'the market' (which comprises, globally, a small group of powerful and wealthy energy companies), and turned energy users into mere passive consumers (Platform, 2014). Britain's fuel poverty rates, for example, are thus now among the highest in Europe, yet the 'Big Six' energy companies take £1 billion per year in premiums that are charged predominantly to disadvantaged users (Boardman, 2011). This glaring inequality has become more public, as even a study commissioned by the Oil & Gas UK lobby group admitted: "*the market has not delivered the most efficient outcome for UK gas consumers*" (see Boué & Wright, 2011). One of the largest and 'cleanest' electricity producers in NZ was recently fined for manipulating the power market, costing consumers $80 million[50]. Brosemer et al (2020) describe the many *structural injustices* and *lack of energy sovereignty* that particularly Indigenous people suffer. A main issue is that access to energy services is regarded as a consumer good in the neoliberal system, meaning people can usually only access the energy they can pay for.

It is important to assess HTR audiences through the lens of why service providers exclude, or provide inadequate services to, certain groups of consumers. This trend has become much more pronounced with the shift in many countries, but particularly the U.S. (Hess, 2011) and the UK (Platform, 2014), to privatisation and liberalisation of many services. There is a substantial body of literature that explores why service provision based on maximising profit inevitably leads to exclusion of certain groups. An ethos of universal service provision is seen as leading to fewer opportunities for making profits or offering follow-up services for which to charge. In fact, there is often an underlying tension in privately-owned utilities' mandates, where maximising shareholder profits may be in direct conflict with (usually government or regulator-imposed) energy efficiency and conservation targets. Unless the government intervenes, it makes little sense from a profit-seeking perspective to design and roll out programmes targeting vulnerable energy users, who often are HTR by definition of their vulnerability (e.g. *non-English speaking; remote; disabled*), but also generally low energy users.

As an example, Aotearoa's policy climate is, according to Eusterfeldhaus & Barton (2011) "*a permissive, non-interventionist one, influenced by neoliberal thinking about the role of the state*." Neoliberalism has had a strong impact in NZ, particularly in energy policy and led to widespread deregulation of the electricity system (ibid). In relation to EE, neoliberal thinking challenged the assumption that the state should intervene in the energy choices that individuals or companies make. While this kind of thinking has receded from its high-tide mark in policy-making in the 80s, it continues to be strong in Aotearoa compared with elsewhere, in terms of resistance to forms of regulation and other collective action around EE. The authors (ibid) applaud the country's strong EE legislation, however, they also point out that NZ has a greater need than most developed countries to improve poor housing stock and energy efficiency. At the same time, like in other developed countries, there is a difficult balance between a need to improve energy use, a need to reduce carbon dioxide emissions, and a need to find legal and policy measures that are both effective and politically acceptable under a neoliberal governance system that inherently favours the wealthy (and energy companies).

One major breakthrough policy in Aotearoa in 2009 was putting a large amount of government funding into grants or subsidies for home insulation and clean heating for low-income and middle-income households (Telfar-Barnard et al, 2011). *National Energy Efficiency and Conservation Strategies* (NEECS) have been implemented since 2001. However, Eusterfeldhaus & Barton (2011) point out some shortcomings in Aotearoa's design and implementation of EE strategies: NEECS usually provide goals but are vague about the policy actions that will be undertaken in order to achieve said goals. The strategies also fail to provide sectoral action plans, to disaggregate the high-level economy-wide target into its constituent parts, including *specifying and segmenting target audiences*. In addition, the targets in the different NEECS differ in character and are sometimes obscurely stated. Sometimes,

[50] https://www.rnz.co.nz/news/business/420160/meridian-spilled-water-to-hike-electricity-prices-authority-ruling

targets are expressed in energy intensity, not energy savings; these key measures and how data and statistics were derived are unexplained, as are valid monitoring and evaluation efforts. The influence of neoliberal political thinking on EE policy has been particularly strong in Aotearoa, as well as the UK (Platform, 2014) - in contrast to e.g. California, Germany (Eusterfeldhaus & Barton, 2011) and Sweden (Isenhour, 2011).

Prepayment as a barrier

As energy markets have developed as user-pays models for what is an essential service for modern living, different strategies emerged for managing low-value customers, with prepayment providing a solution for industry - where consumers must credit their electricity or gas account in advance of receiving service. Older technologies included the use of coin-fed meters, and key-pad meters, but smart prepayment meters are becoming more widely available. In wealthy European countries, including Sweden, prepaid solutions, especially ones based on smart metering technology, are advertised as "*the ideal solution for those 'modern, nomadic employees' working remotely for months at a time*", or the many Scandinavian households who have remote holiday cabins (Pathway, 2013). Similarly, prepayment is useful for student housing and any kind of environment in which tenants change frequently. However, it has also led to increased legal complaints against some Scandinavian utilities[51]. Outside of the European context, different reasons for prepayment emerge: On the African continent, for example, prepaid metering has been the technology of choice for the electrification of households (ibid): "*While prepayment metering is offered to a broad spectrum of consumers, many customers living in remote, rural places might not have stable incomes or even a postal address to send the electricity bill to. The prepayment solution allows them to purchase prepayment tokens within their budget and only pay for what they use*."

While often preferred by both retailers and consumers as they avoid the accrual of debt and provide some additional control of energy service use, prepayment meters have been criticised as problematic in the UK (Mummery & Reilly, 2010), Australia, and Aotearoa (O'Sullivan et al 2013). Key concerns are that prepayment has offered fewer consumer protections to the most vulnerable energy users; disconnection statistics are typically not collected by regulators, making the problem of disconnection invisible; and the price per kWh, once all fees have been included, has often been more expensive. Due to differing regulations across states, the use of prepayment in the United States has been limited, but has begun to be explored more recently. When adequate consumer protections are in place, prepayment does have the critical EE outcome of reducing energy use (Sussman et al, 2018). Prepayment systems have also been introduced to varying degrees and success in an increasing number of countries worldwide; including across Africa (Mwaura, 2012) - sometimes combined with the provision of *Free Basic Electricity* as in South Africa (Ruiters, 2007) - as well as Asia (Amin & Rahman, 2019), the Middle East (AbuBaker, 2019), and South America (Telles Esteves, 2016; Fernando & Atehortúa, 2017). Once the prepayment system is in place, often there is little further contact with consumers, making prepayment meter users hard-to-reach.

Stigmatising the most vulnerable in our society

Reid et al (2015) wrote how *social pressures* may prevent the effective implementation of energy efficiency strategies in the housing sector in a way that technical approaches to EE may be unable to overcome. They also suggest that the underexplored relationship between *stigma* and EE could explain the low uptake of EE programmes: "*Common explanations for installation rates relate to finances, information and decision making, yet these have been critiqued for representing only a narrow set of explanations missing the wider, socially embedded nature of everyday practices, including the role of stigma*."

[51] https://www.nordicenergyregulators.org/wp-content/uploads/2017/04/Status-Report-Retail-Markets-Annex.pdf

With regards to both *homelessness* and *mental health issues*, stigmatisation is also a very serious concern: Ramanuj (2019) writes that "*these are the people that have been failed by society, but they are also the people that society chooses to typecast as 'failures'. The tragedy is that homeless people have the additional perverse burden of bearing the blame for their own exclusion*." People with mental illness expected discrimination and stigmatisation, due to prior negative experiences of such (Quinn et al, 2015). Belcher & DeForge (2012) described similar pathways to internalised stigma in homeless people. Ramanuj (2019) describes stigma as "*meaning a 'mark', and the more visible the mark, the stronger the stigmatisation*". 20–35% of homeless people in the U.S. were found to have a diagnosable mental illness and the prevalence of psychotic illness and substance dependence is several magnitudes higher than in the general population (Rees, 2009).

Lacking a coordinated federal strategy for energy poverty

Recent research by Bednar & Reames (2020) points to the challenge of the U.S. government's (non)acknowledgement (or 'pseudo recognition', ibid) of energy poverty on a federal level: "*In the absence of federal energy poverty recognition, states have implemented low-income energy assistance programmes. Consequently, 51% of all funding to address high energy burdens is from utility ratepayer-funded bills and EE assistance. Despite the absence of federal statutes to characterise, measure and evaluate the landscape of and responses to energy poverty, the essence of this phenomenon has generally been recognised in the US as evidenced by two federally-funded energy assistance programmes: the* Low Income Home Energy Assistance Program *(LIHEAP) and the* Weatherization Assistance Program *(WAP)*." These programmes were created by two different agencies (DHHS and DOE, respectively) to combat rising energy costs and promote household energy sufficiency following the 1973 oil crisis. However, despite almost half a century of federal energy assistance, one in three U.S. households still experience energy poverty (ibid). In contrast, both the UK and Aotearoa formally recognise households in *fuel poverty* (UK) or *energy hardship* (NZ; see Ofgem, 2013; Statistics NZ, 2017; Bednar & Reames, 2020).

Lack of data and understanding

Segmentation of households is a complex and costly process, which commonly involves identifying groups with differing attitudes, behaviours, demographics and psychographics. Only using socio-economic demographic data, for example, is not enough as there is an imperfect relationship between behaviour and demographics (e.g. Kleinschafer & Morrison, 2016). Household life cycle research demonstrates the usefulness of using a combination of demographic characteristics to predict household electricity consumption and efficiency, yet it is also not without limitations (ibid). Statistics NZ (2017), in their in-depth report looking at indicators for energy hardship, discuss the difficulty of collecting the data and how hard energy hardship is to measure directly. Instead, it is usually measured through consensual (self-reported, subjective) and objective measures (including information on the proportion of household income spent on energy). The European Commission (2008) when investigating issues with rural poverty, found that the *political irrelevance* of the rural poor was partly linked to the *lack of adequate data and analysis* - even in Europe, the rural poor are often invisible in official statistics. They are also *less organised* compared with the urban poor, partly because of their *geographical dispersion* and partly because of the *remoteness from the political and economic centres*. There is also the *existence of rural stereotypes*: e.g., that family and community support are stronger than in urban areas, therefore making public support for the rural poor less necessary.

Ignoring the non-energy impacts of low-income EE interventions

The International Energy Agency (IEA, 2011; 2014) recognises that "*the energy-saving benefits alone [of e.g. low income* Weatherization Assistance Programs*, WAPs] provide a relatively modest return for the energy-efficiency investment required, suggesting a weak return on government spending*." In order to address this barrier and to complete the picture of non-energy benefits (NEBs) of such programmes, the IEA (2011 and 2014) investigated the various co-benefits for property owners,

energy providers, programme participants, local communities and society as a whole. Income supplements and social tariffs are expensive, and EE improvements may not be practical or economical as a substitute for income supplements, especially for hard-to-treat residences (IEA, 2011). However, despite the significant health, environmental and poverty reduction benefits that arise from EE subsidies, they are not utilised in many countries to their fullest extent - especially when they are evaluated only based on household energy savings (ibid). Examples for NEBs include higher property values, improved appearance of the community, local job creation, lower school and work absenteeism, and potentially lower outlays on government or utility energy subsidies. Table 2 in IEA (2011) outlines the various benefits and beneficiaries of low income WAPs and EE subsidies. Reasons why NEBs are rarely measured were summarised by IEA (2011) as follows: they are hard to measure and quantify; persistence or retention of co-benefits may be short-lived; care must be taken to avoid double-counting; harmonising valorised results from different approaches is difficult; co-benefits may actually be negative ("co-costs"); some regulatory tests, (e.g. utility cost or participant cost test), will necessarily exclude some co-benefits.

Poor and inadequate housing leading to major health issues

Jessels et al (2019: Figure 2), in their review on energy insecurity and health, show the complex and extensive interconnections between the two, with inefficient housing being a major determinant. NZ's *Household Energy End-Use Project* (HEEP) found that houses have very low indoor temperatures owing to persistent under-heating; commonly, only in living rooms on winter evenings does the temperature even come close to WHO's healthy indoor temperature range of 18 – 24°C / 64-75°F (Isaacs et al, 2010). Bedrooms are typically colder; central heating is uncommon, and often only a few rooms in the house are heated. Cold rooms and houses are also likely to be damp, leading to the growth of moulds and associated poor health and excess winter mortality, especially for people who are vulnerable owing to illness, disability or age (Davie et al, 2007; Howden-Chapman et al, 2007). The HEEP study showed that cold houses are found across the income spectrum, but dwellings with mean winter evening living room temperatures below 16°C / 61°F are over-represented in those dwellings occupied by households in two lowest-income quartiles (Eusterfeldhaus & Barton, 2011).

In Dunedin, NZ, participants reported the *poor conditions of the house* and *energy inefficient appliances* to be the main barrier to a warm and dry house, becoming vulnerable to fall into energy poverty (Povey et al, 2014; McKague et al, 2016). Similarly, Sharpe et al (2019) highlight a possibility that some interventions can have a detrimental effect on *health* (Maidment et al, 2014; Sharpe et al, 2015a) in some populations. The resultant impact of health may be a result of *overall poverty and low socioeconomic status*, which is compounded by an inability to adequately heat and ventilate the home. Due to the *cost of living*, EE improvements may not eliminate the risk of cold on the lowest-income households (Anderson et al, 2012), nor take full account of *resident behaviours, risk perception* and *choices* when heating and ventilating the home (Critchley et al, 2007). Therefore, the potential benefits of fuel poverty alleviation programmes could be overshadowed by *rising energy prices* (Howden-Chapman et al, 2012; Povey et al, 2014). Consequently, some households may continue to *ration their heating*, despite home improvements (Lomax & Wedderburn, 2009). This means that some home improvements may not help the most fuel poor avoid the potential negative impacts of living in cold and damp homes. Homes receiving EE interventions may continue to experience problems with *mould contamination* (Richardson et al, 2005), regardless of occupant *risk perception of the potential health impacts*, heating and ventilation practices and EE levels (Sharpe et al, 2015b). Finally, Povey et al (2014), in their contrasting surveys of Dunedin housing stock in 2004 and 2013, found that almost half of the houses in the survey still didn't fulfil the 80% pass for safety (i.e. free of hazards) and less than a quarter met the 80% pass for soundness (i.e. providing shelter in nearly all weather conditions).

'Heat or eat' or 'The rent eats first'

Several researchers have investigated the impact of energy poverty on life choices, such as deciding if a household should 'heat or eat' (see Bhattacharya et al, 2003; Frank et al, 2006; Pro-Housing Alliance, 2012; McKague et al, 2016) or pay the rent before buying food. In a recent article entitled "*The rent eats first, even during a pandemic*"[52] Matthew Desmond describes the devastating stressors that "*rent - the greediest of bills*" has on people impacted by COVID-19, either due to layoffs and/or medical bills. Worse, once utility shut-off moratoriums expire in the U.S. (by October 1, 2020 in 36 states), 76 million households will lose their utility shutoff protections. About 10 million of those households are currently below the federal poverty line, and 9.5 million people in those states are unemployed (Thomas, 2020). Black families are twice as likely as white families to have their power shut off. As Thomas (2020) says: "*Utility shut-offs cost lives, people's health, and their dignity. Every year brings stories of people killed after their power is shut off (often due to fires and heat stroke)*." A tragic story in Aotearoa in 2007 made international news[53], when a 44-year old Pasifika woman on an electric oxygen pump died within 2h of her utility's power shut-off for a NZ$168.40 (US$110) overdue bill. The *Electricity Commission* (now the *Electricity Authority*) issued new guidelines in July 2007 stating consumers who are dependent on electricity for critical medical support should state so to their electricity retailer and are not to be disconnected for non-payment[54].

Whereas Bhattacharya et al (2003) found that poor and rich households increased their fuel bills during cold weather in the U.S., only the poor households reduced their food expenditures by roughly the same amount, leading to worse nutritional outcomes (see also McKague et al, 2016 for similar accounts from Aotearoa). Worse, the choices between food, medical bills, rent or heating, also leads to argument over bills; a reduced ability to maintain social relations; feelings of shame and guilt; social isolation, including due to children being unable to engage in extracurricular activities; and time poverty spent on e.g. foraging for firewood (McKague et al, 2016).

'Smart' technologies vs 'smart' users

There is an adage that engineers often design for engineers, not so much the people that are meant to utilise their technologies. Obvious examples of a mismatch in the 'smartness' of energy-efficiency technology and its users can be found in the smart meter (e.g. Darby, 2010; Wigan, 2014), and smart home (e.g. Hargreaves & Wilson, 2014; Wilson et al, 2017) literature. Johnson (2020) also describes how smart technology relates to ingrained *gender* roles and how this should affect the design and use of flexibility products, as part of the *Energywise* utility-led demand response project in the UK. This project - even though it had a successful recruitment strategy - had quite high attrition and disengagement rates of over 50%, which were attributable to several barriers. The main ones were related to the smart meter (SM) technology, including *issues with installation* (e.g. refusing access to installers), *difficulty accessing and using it*, the *way it looked*, as well as other *eligibility* criteria including switching providers (UK Power Networks, 2017). There are known issues where SMs turn 'dumb' when switching electricity suppliers, with 3 out of 5 surveyed UK energy users saying they have encountered problems[55]. Chen et al (2020) summarise some of the main barriers to uptake of home energy management systems (HEMS) as being *due to the associated costs; perceived lack of usefulness of the technology; renters being unable to make decisions on home improvements; and technology anxiety.* Grünewald & Reisch (2020) further delve into concerns of *privacy* and the issue of *(mis)trust* to various organisations collecting and utilising smart home data.

A major barrier limiting the success of SMs for young and old age groups studied by Brown & Markusson (2019), was how the *comfort and convenience* of using some electrical appliances takes

[52] https://www.nytimes.com/2020/08/29/opinion/sunday/coronavirus-evictions-superspreader.html
[53] https://www.theguardian.com/world/2007/may/30/1
[54] https://web.archive.org/web/20110811093543/http://www.ea.govt.nz/consumer/mdvc/
[55] https://eandt.theiet.org/content/articles/2019/03/over-50-per-cent-of-smart-meter-users-face-problems-when-switching-supplier/

priority over the desire to conserve energy. There appeared to be a *threshold of minimal energy use* where participants refused to engage in further energy-saving behaviours. Many older adult participants also *struggled with how to use and set up the feedback monitor*, despite having instructions available to them. This is well-aligned with findings from previous research (Marquie et al, 2002) about older adults' *negative experiences with technology*. When combined with smartphones or tablets, SM technology also competes with a variety of services and applications that users have access to, which in turn can reduce its effectiveness (Tedenvall & Mundaca, 2016). A somewhat surprising theme to emerge from Brown & Markusson's (2019) study was the *negative emotional responses* participants had to the SM, often resulting in participants not wanting to use the SM anymore, and dissociating themselves from it. Wilson et al (2017), in their national UK survey of SM users, found risks associated with SMs were: *increasing dependence on technology, electricity networks, as well as outside experts; monitoring private activities; making householders 'lazy'; being intrusive and an invasion of privacy, leading to a loss of control; disrupting daily routines;* and *making households worry more*.

Designing interventions without understanding audience needs

Similarly to the issues related to smart technology, it is important to design interventions for the target audience they have in mind. For example, from the analysis of two electric utility pricing studies in the U.S. (Cappers et al, 2018), the *chronically ill* had *less capacity* to manage their electricity consumption in response to a critical peak pricing rate design and were also *more sensitive* to comparable proportional bill effects. This led to them leaving the pilot in higher numbers. It is imperative to include increased education and outreach for such vulnerable customers to ensure they sufficiently understand the risks (e.g., more volatile and higher bills during certain times) and rewards (e.g. opportunity for lower bills during non-event season) associated with taking service under time-of-use rates. Nicholls & Strengers (2015a and b) and Anderson (2016) both showed that the *competing life priorities* of work and children (and especially much higher participation of *females in the labour market*) mean that many HTR households are unlikely to respond to *Time of Use* tariffs and signals.

General issues of distrust and difficulties accessing government or utility support

Whilst government interventions or subsidies, such as additional winter energy payments in Aotearoa, will help many resolve some immediate impacts from COVID-19 (see Mastropietro et al, 2020 for an overview of global emergency measures), the most-indebted customers are often reluctant to get in touch with their supplier (or a government agency providing welfare, see e.g. Royston et al, 2014) to ask for assistance (NEA, 2020). Long delays getting through to suppliers on the phone or suppliers limiting their interaction with customers on the phone, with some saying they are only taking 'emergency calls', have been reported in the UK (NEA, 2020). Not all utility suppliers are providing adequate support for indebted customers and there is a low level of awareness that these options exist, especially for newly-vulnerable energy users.

Structural inequalities and racism, vividly exposed by COVID-19

Finally, the COVID-19 crisis has also laid bare some important inequalities, particularly in *People of Colour*, which negatively impact on their physical and mental health and make them more likely to feel *overwhelmed* (*competing life priorities* were already some of the highest barriers to EE for vulnerable households prior to the pandemic). For example, Fawcett et al (2020) showed that, of those UK workers who were now working from home, a higher proportion of *BAME* people (41%) reported *working more* than they did before the pandemic, compared to white people (29%). Nearly half of *BAME women* (46%) said they were *struggling to cope* with all the different demands on their time at the moment, compared to 35% of white women and 30% of white men. Over twice as many BAME women and men reported that they had *recently lost suppor*t from the UK government (43% and 48%) than white women and men (13% and 21%). Over half of BAME women said that they were *"not sure where to turn for help"* as a result of the coronavirus pandemic, compared to 18.7% of white respondents.

Audience-specific barriers

Low-income households

Definition issues

An economic ratio, represented as 'Low Household Income / High Energy Expenditures' is generally used to estimate energy burden in the U.S. and energy poverty in Europe (Residential Energy Consumption Survey, 2012; Power, 2008). According to this, both energy burden and energy poverty occur when energy expenditures exceed 10% of a household's income. Recent data shows that most U.S. households at or near the federal poverty line are significantly burdened by energy costs (Hernández et al, 2014; 2016). However, this economic ratio captures only one dimension of energy-related hardship and otherwise fails to account for additional factors that contribute to energy burden, such as housing conditions and energy behaviour (Hernández, 2016). For example, one UK study showed that different definitions of fuel poverty influenced the comparative rates of fuel poverty between urban and rural areas - it was higher in rural areas under the 'full income' definition but the reverse was the case under the 'basic' and 'basic equivalised' definitions (see Baker et al, 2008). It is important to understand the wider contexts, barriers and needs of low-income households, beyond simple income considerations.

Design and deployment issues

UKERC et al (2018) found that many low-income households are *highly risk-averse and suspicious* about offers of measures, especially if these come through the *private sector* (including energy companies). Some households that UKERC et al (2018) interviewed noted that they are unable to negotiate the *'information minefield'*, whilst others noted that they were r*eluctant, or unable, to share personal information* with scheme providers. Whilst the health and social care sectors have some insight into the location of vulnerable households, and are best-placed to make referrals into EE schemes (see, e.g. NZ's *Warm Up NZ* and *Healthy Homes Initiatives*), their time and resources are restricted and they often have nowhere to make referrals to. UKERC et al's (2018) evidence shows that where such trusted intermediaries were absent or under-resourced, schemes struggled to reach vulnerable households. Such trusted intermediaries are therefore essential for facilitating access to energy poverty support schemes (see also **Appendix A**).

Rural households

The rural EE gap

Rural residents face several *geographic, financial,* and *awareness* barriers that could stop them from investing in EE. Shoemaker et al (2018) describe them in detail under the following headings:

- *Low population density*
- *Lack of broadband access*
- *Customers with limited exposure*
- *Shortage of local energy efficiency workers and lack of expertise*
- *Financial constraints*
- *High costs*
- *Insufficient outcome data.*

Winner et al (2018) and MacDonald et al (2020) say that the combined impact of these barriers create a market failure that they call the 'rural energy efficiency gap.' Perhaps the most obvious barrier we expect rural households to suffer from is *geographic isolation*, and thus, access to clean energy initiatives, EE programmes, and EE experts and installers (due to a lack of economies of scale and skilled [installer] workforce availability, according to Winner et al, 2018). *Remoteness* causes further difficulty to groups already at risk of social exclusion as a concentration of the main services in urban areas can impact on their quality of life (e.g. Snell et al, 2015): e.g. health services for the *elderly* or

disabled; child care facilities for *single female* workers; accessibility of schools for *children* living remotely etc. (European Commission, 2008). In addition, *access to credit* and *debt aversion* and *alternative financing mechanisms* such as on-bill financing, which are often not available in rural areas; as well as *lack of access to traditional marketing channels* due to factors such as *limited access to reliable broadband internet*[56]; and *lack of awareness or skepticism* of existing resources due to limited experience within a rural resident's social network, and a preference to *"do it yourself",* were found to limit rural residents' knowledge of, and interest in accessing EE programmes (Winner et al, 2018; MacDonald et al, 2020). However, at least one study that specifically-researched rural households found that they were no harder-to-reach for energy behaviour research than suburban or eco home groups (Murtagh et al (2014). Rural customers in an Oregon utility survey also appeared to participate in EE programmes at similar rates as urban customers, and for some utilities, they participated at greater rates than non-rural customers (NPCC, 2018).

Hard-to-treat rural housing

The 'quantifying rural fuel poverty' research project in the UK (Baker et al, 2008) suggests that *'hard-to-treat' housing* (see HTR definitions in the **Methodology Chapter 2** above) problems are much more extensive in rural areas, with the problem increasing as settlements become more dispersed. *Lack of access to gas* is an important predictor of 'hard-to-treat' housing, as it results in higher fuel costs because gas is the cheapest mainstream heating fuel. Although heating systems with lower heating running costs are available in off-gas areas, the installation costs for these technologies are prohibitively expensive. *Properties built with solid wall construction* is another predictor of HtT in that those buildings, on average, have lower EE values than those built with cavities. While insulation options are available for solid walls, they are much less cost-effective than that available for properties built with cavities (see Baker et al, 2008; BRE, 2008; Center for Sustainable Energy, 2012). Solid-wall buildings are much more common in a rural setting (e.g. Gilchrist & Craig, 2014), with the one urban exception being London (Baker et al, 2008). In the UK's flagship *Warm Front* programme, it was found that *lack of information*, *few appropriate measures* within the *Warm Front* package, and the possibility that *'high fuel costs'* represent a more significant contributor to energy poverty than 'low income' in remote rural areas, was the reason for lower uptake (Baker et al, 2008).

Vicious cycles

In addition to *housing conditions* in rural areas, which are often worse than those in urban areas, so is *access to (public or active) transport modes* and increased *commuting distances* (see e.g. Titheridge et al, 2014), and the *digital gap*, i.e. access to broadband and ICT (European Commission, 2008; Winner et al, 2018). In the agricultural sector, *low incomes* and *seasonality* of work also represent important risks of poverty and social exclusion; moreover they can be important elements of *intergenerational transmission of poverty*, especially among farmers and agricultural workers (ibid). Finally, early research by PHE and van Dorn et al (both published in April 2020) found that people living in urban areas versus rural areas also had *increased odds of testing positive for COVID-19*. This pattern often changed after the initial impact on cities, especially in the rural U.S. due to several existing underlying issues[57]. The European Commission (2008) describes four categories of problems of rural areas (*demography, remoteness, education* and *labour market*) and warn that they often interact and generate 'vicious cycles', which may reproduce and amplify the phenomenon of poverty of rural areas: Demographically, rural areas are usually *older* which affects the economic performance, in turn affecting low birthrates and migration. The remoteness generates *infrastructure issues*, further leading to lower economic performance and *urban migration*. *Low education levels* and *less access to*

[56] https://www.americanprogress.org/issues/green/reports/2013/07/15/69249/the-electrical-divide-new-energy-technologies-and-avoiding-an-electric-service-gap/

[57] https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/other-at-risk-populations/rural-communities.html

higher education affects employment and income. This is further compounded by a labour market often focusing on agricultural work, which tends to be hard and low-paid.

Indigenous rural communities

Many Indigenous communities live rurally and these communities are often off-grid and rely on imported diesel fuel to power generators (e.g. Crane, 2017; Mercer et al, 2020). Diesel generation poses substantial challenges for off-grid communities, which Mercer et al (2020) describe as follows: "*From an* economic perspective*, diesel-generation is expensive, requires significant governmental subsidies, poses energy security challenges, and local load restrictions may hinder economic growth, social development, and poverty alleviation efforts. From an* environmental perspective*, diesel generation poses a risk of fuel spills and leaks, and diesel plant emissions are a contributor to global climate change. From a* societal perspective*, diesel generation may contribute to local health problems, reliability challenges, and can be disruptive, due to noise pollution. Furthermore, government-controlled electrical utilities may be perceived as an imposition on the autonomy of Indigenous communities*."

Even if they are connected to the power grid, Canadian Indigenous rural communities often have to pay higher delivery fees to receive power from the same provincial hydro organisations that have originally displaced them from their ancestral land (ibid). The issue of distrust by those communities towards government programmes such as Canada's *Indigenous Off-Diesel Initiative* is based on the practice of altering community energy systems without necessarily gaining prior and informed consent from the affected communities (Mercer et al, 2020). The authors highlight that, due to vastly different understanding of the world between Indigenous and Western societies, Western conceptualisations of the social acceptance of renewable energies cannot simply be imposed upon Indigenous communities - as it could be seen as a form of 'cognitive imperialism' (see also Lieu et al, 2020).

Similar issues were recently reported with clean energy wind developments in Scandinavia, displacing the Indigenous Saami people[58]. Normann (2020) labels this 'Green Colonialism'. The energy system is thus inherently bound up in uneven power relations between settler colonial corporations and Indigenous peoples, making something as seemingly 'benign' as EE a *very political* and potentially highly contentious issue (Crane, 2017; Normann, 2020). Crane (2017) also discusses how Indigenous reservations in North America also have *unique laws and legislations*, which communities have to navigate in order to fund EE programmes. In Canada (ibid), as in Aotearoa (e.g. Isaacs, 2010), there are questions around installing certain EE measures, when especially rural Indigenous *housing is completely inadequate* and there are *no funds* for building new housing.

Rural Māori communities also have specific issues in their access to energy and its use, such as the *lack of local energy infrastructure constraining Māori business development* in many rural areas, thus contributing to the *inefficient use of energy resources* and *general poor health* of these communities (Penny, 2005). Brosemer et al (2020) describes the inequality suffered by Navajo Nation, who still largely lack access to water and electricity even though coal power generation occurs on 27,000 square miles of their reservation: "*The lack of energy sovereignty – the inability of people from poor and marginalised groups to make decisions about the energy systems they use and the impacts of energy systems they are willing to accept – is precipitated by a lack of social justice or social power*."

Women

Women are more disadvantaged than men in our society, including in the clean energy sector (e.g. Pachauri & Rao, 2013) and energy discourse is a "*stereotypically masculine one*", according to Waitt (2017): "*Dominant responses to energy efficiency often display a masculine focus towards supply side-driven technological solutions*." Listo (2018) argues that women are often co-opted to justify EE

[58] https://www.aljazeera.com/indepth/opinion/colonialism-ruining-indigenous-lives-norway-200703135059280.html

interventions at the expense of gender equality. This is supported by Grünewald & Diakonova's (2020) finding that women are widely believed to be more responsible for greater household energy consumption and thus targeted with demand response programmes. However, despite finding that women do indeed report doing more household chores, they actually used less energy in a lot of cases than men (ibid). Johnson (2020), in a utility-led demand response study of low income households in London, also showed that ignoring *gender* (or the assumed 'gender neutrality of energy policy') could undermine the transition to a sustainable energy system and possibly exacerbate underlying inequalities.

Waitt (2017) espouses a feminist retrofit framework which advises that researchers refrain from viewing the domestic energy sector through an overly-masculine lens, and acknowledge that knowledge is always underpinned by *unequal social power relationships* and *value judgements*. Johnson (2020) describes the risk of the smart energy future as serving the 'Resource Man' (utilising feminised AI assistants to do household chores) and ignoring the burdens and opportunities of 'Flexibility Woman' (bringing the actual realities of domestic [division of] labour into focus). Women also generally endure a greater proportion of the harmful consequences of energy poverty, than men (Petrova & Simcock, 2019; Robinson, 2019).

Robinson (2019) highlights five dimensions of gendered, socio-spatial energy vulnerability: *exclusion from the economy; time-consuming and unpaid reproductive, caring or domestic roles; exposure to physiological and mental health impacts; a lack of social protection during a life course; and coping and helping others to cope* (see also Figure 6, above). These underlying gender inequalities and gendered solutions to energy vulnerabilities are further highlighted and compounded by the global COVID-19 pandemic. Some of the key issues mentioned by WBG (2020) with regards to impacts from COVID-19 further highlight the *intersectionalities* of gender-based inequalities and vulnerabilities. (Re)designing policies and programmes targeting the various HTR sub-audiences described above will be most effective when there is acknowledgement of the following:

- Women are the majority of healthcare workers struggling with adequate personal protective equipment (PPE) and testing. There are compounded effects for *other areas of health* particularly affecting women.
- Women are the majority of care workers trying to deal with this crisis in an already decimated sector, without adequate PPE. The Government's relaxation of social care standards is cause for concern for many *elderly* and *disabled* women.
- There are huge gaps in the Government's salary retention schemes for employees and self-employed, which particularly affect women. *Pregnant women* are at risk of discrimination and millions will fall through the net or be made redundant anyway.
- The social security system still has huge holes in it, disproportionately affecting women including inadequate provisions for *renters*.
- With schools and nurseries closed, the huge increase in responsibility for *unpaid care work* is falling to women, often without the resources or equipment to cope.
- *Violence* Against Women and Girls (VAWG), including trans women and sex workers, is already increasing in 'lockdown,' while funding for organisations plummets.
- *Migrant women* still have no recourse to public funds, leaving them exceptionally vulnerable to poverty and destitution.
- *Undocumented migrants* may fear using the health service due to links with immigration enforcement and maintaining social distancing in detention centres – as in *prisons* - is near impossible, putting both staff and detainees at high risk.
- Travel restrictions lead to significant financial challenges and uncertainty for mostly female *foreign domestic workers*, many of whom travel in southeast Asia between the Philippines, Indonesia, Hong Kong, and Singapore (Wenham et al, 2020).

Women and men also occupy different positions in the economy. They are concentrated in different sectors, in different hierarchical positions and have different career patterns. For example, the clean energy industry has a massive gender inequality, including in some of the countries (with the exception of Sweden) participating in this research (see Baruah, 2016; Waitt, 2017). In fact, Baruah (2016) claims that "*grounded interventions to promote gender equality in clean energy employment – especially within the context of increasing access to energy services for underserved communities – are more prevalent and better-established in some non-OECD countries*". As we also discuss in the **Gap Analysis Chapter 9** and further in **Appendix D**, one big issue is the lack of sex-disaggregated data in the field (ibid; and see Pachauri & Rao, 2013 and Criado Perez, 2019). As Pachauri & Rao (2013) note, "*empirical studies that explicitly evaluate gender relevant factors are scarce. Causal mechanisms by which modern energy services impact women are not well understood. Additionally, issues related to intra-household decision-making and how these influence energy choices and behaviours are largely unexplored in the literature*."

The economic crisis created by the COVID-19 pandemic will also have different impacts on women and men and different groups of women as a result of these disparities (WBG, 2020). Worldwide, the majority of *part-time workers* comprises women, who were also more likely to lose their employment following lockdown. For example, of the 11,000 newly-unemployed due to the lockdown in Aotearoa, a full 90% of them were women[59]. Black, Asian and Minority Ethnic (*BAME*), *disabled, low-income* women and *single mothers* will be particularly affected by a gender-insensitive response to this crisis, including some of the behaviour changes which may have positive environmental benefits (e.g. reduction in air pollution), but at great social costs (e.g. *increased loneliness and mental health issues; overburdened by unpaid care work and schooling; increased infection risk from essential, low-paid work; increased utility bills*).

Black, Hispanic, Asian minorities

Several studies (e.g. Bayer et al, 2018; Rothstein 2017) have documented that racial gaps in liquid assets have roots in the long-lasting effects of *structural racism* embedded within government and institutional policies and practices, particularly in the U.S. These structural forces may also drive differences in the key determinants of *wealth disparities* over time and across generations, such as the intergenerational transfer of wealth (e.g. Shapiro, 2017), neighbourhood conditions such as *poverty rates, home values, delinquency rates*, and *access to banking* (Keys et al, 2020), *geographic and financial barriers* to human capital accumulation (Addo et al, 2016), and *racial segregation and discrimination in the labour market* (e.g. Bertrand & Mullainathan, 2004). 'Redlining' (see Wilson, 2020), where Black neighbourhoods were segregated, among other problems has created neighbourhoods with limited green infrastructure that now suffer from *extreme heat waves*[60], between 5-12 degree Fahrenheit hotter than adjacent white neighbourhoods.

Structural racism, and all its negative consequences, has also been found to negatively impact non-white ethnic groups in terms of EE programmes (e.g. VEIC, 2019) and their susceptibility to, and fatality rates from, COVID-19 (e.g. Platt & Warwick, 2020). Furthermore, there is a massive gap in understanding the size of the wealth gap and inequality between white and Black America: The bicameral U.S. *Joint Economic Committee* (2020) quoted survey results demonstrating that over 97% of respondents vastly underestimated (by 80 percentage points) the huge gap between the median wealth held by Black families ($17,000) and white families ($171,000). In addition to the *huge asset wealth gap*, when contrasting Black Americans with white Americans, the former take home less income (just 59 cents for every dollar), have twice the unemployment rate of white Americans, are far less likely to own their homes (42% vs 73%), more than twice as likely to live in poverty, are

[59] https://thespinoff.co.nz/business/05-08-2020/11000-new-zealanders-have-lost-their-jobs-and-10000-of-them-were-women/
[60] https://www.nytimes.com/interactive/2020/08/24/climate/racism-redlining-cities-global-warming.html

incarcerated at more than 6 times the rate, and live shorter lives (3.6 years shorter) than white Americans (ibid).

In the UK, similar inequality issues between white British and BAME groups were highlighted by the *Equality and Human Rights Commission* (2018): Ethnic minorities are twice as likely to live in poverty as white people in Britain, and they are four times as likely to live in overcrowded households. In addition, Black British women are four times more likely to be detained under the mental health legislation than white British women, and mixed ethnicity women almost seven times more likely (ibid). There is also a lack of robust data on race inequality hampering policy efforts to reduce it. In Aotearoa, where more than 25% of people were born overseas, and 2 in 5 people in the largest city, Auckland, are first-generation immigrants (Statistics NZ, 2014), there is less obvious inequality in living standards (but see sections on Māori and Pasifika, who suffer significantly detrimental health and socio-economic outcomes compared with Pākehā New Zealanders). Sweden, with its strong social welfare system, has fewer issues with socio-economic inequality, but does have significant and concerning incidence of racist 'hate crimes' and discrimination based on ethnicity (UN, 2017).

Migrants and refugees

For migrants and refugees, adaptation to a new country is already a difficult process that is associated with specific *cultural and language needs* and *attitudes toward resources, institutions or technologies* (Horakova, 2013). For example, Mehrsa et al (2018) highlighted Muslim immigrant women as HTR: "*Due to their socio-economic characteristics, religious affiliation, limited engagement with American society, suspicion of outsiders fostered by encounters with prejudice, and adherence to traditional gender ideologies, Muslim immigrant women in the U.S. are a hard-to-reach population*." WBG (2020) found that undocumented migrants in the UK may fear seeking COVID-19 treatment from the NHS due to connections with immigration enforcement and fear of being charged. PHE (2020) found that people of BAME background are also more likely than people of white British ethnicity to be *born abroad*, which means they may face additional barriers in accessing services that are created by, for example, *cultural and language differences*. Migrants also have to often overcome *uncertainty, loneliness* and *culture shock* (Horokova, 2013), leading to (sometimes chronic) mental health problems. Statistics NZ (2014) found that immigrants to Aotearoa are significantly *older* (the median age for people born overseas was 41.8 years, compared with 36.2 years for people born in Aotearoa), more likely to be *multilingual* (especially *females*, with 19.3% compared to 17.8% of males), and 2.2% of people *did not speak any English*. They are generally regarded as harder-to-reach, due to cultural differences (see Ashby et al, 2020b).

Disabled households

Some of the many barriers that households with at least one disabled person face were discussed in more depth in the Audience demographics section, above. UKERC et al (2018) has shown that disabled people and families often live in the *poorest-quality houses*. They also have *additional needs that require support* throughout the retrofit process which can make it more expensive for scheme providers and installers to reach these households and treat their homes. At the same time, Snell et al (2014) showed that their circumstances often *escape official statistics*, which do not take into account higher energy needs related to disabilities. Incentives to deliver targets at least cost have resulted in these households being side-lined (UKERC et al, 2018). In Sweden, complaints about discrimination against disabled people have recently overtaken those based on ethnicity (UN, 2017). In NZ, official data from the *Ministry of Social Development* has shown "*persistent inequity in median disability allowance payment amounts between Pākehā (white people), and Māori and Pasifika, dating back 10 years*" - with Pasifika being paid out less than half of Pākehā[61]. Brosemer et al (2020) highlight the added vulnerabilities of people with *chronic health issues* during a pandemic. Their survival often

[61] https://www.rnz.co.nz/news/national/425491/government-urged-to-provide-flat-fair-disability-allowance-for-all

depends on their ability to control the temperature in their homes, use an air conditioner to ease respiratory stress, refrigerate medicine, store and prepare food, and operate medical equipment.

Homeless

One of the major barriers that the homeless face is that they are *'invisible'* to the wider public; and that they are frequently *blamed* for their own fate (see Povey et al, 2014). According to Corak (2006), the U.S. has the least socially-mobile economy of the high-income countries of the world, closely followed by the UK. Toro et al (2007) also found that the U.S. and the UK had the *greatest lifetime prevalence* of homelessness; spending the *least on social welfare*; and having the *least compassionate public attitudes* to homeless people. American respondents to Toro et al's (2007) survey contrasting homelessness between Europe and the U.S., were most likely to "*endorse personal failings as an important cause of homelessness and the least likely to support increased federal spending to help homeless people*". This is a structural inequality issue, linked to the notion of self-interested individualism and neoliberalism that is supported in many parts of the U.S. (see also the preceding paragraph above; and ibid). According to Ramanuj (2019) "*how we respond to homeless people can be seen as a reflection of how we respond to injustice generally*". The current multiple crises (COVID-19, unemployment, evictions of tenants, climate emergency) have raised the suffering of the (chronically, but also, newly) homeless. For example, smoke exposure from the wildfires in the western U.S. is causing respiratory damage to the millions of homeless[62], which will further increase their susceptibility to COVID-19 (and they are already often unable to pay for medical expenses).

Children and young people

Royston et al (2014) highlight several barriers for families with children in energy poverty: *eligibility criteria* may not be designed to include families, and families may *miss out on automatic enrolment*, as in the case of the *Warm Home Discount*. Additional barriers that may prevent families from engaging with available help, include *time, cost, hassle, stigma* and *negative perceptions of the help offered* (see also Jessels et al, 2019). Wilson & Snell (2010) highlighted one challenge associated with socially-disadvantaged young people and the participatory process - it was heavily dependent upon existing relationships built up over a long period of time. In addition to the individual challenges associated with engaging poor young people, dependency upon adult engagement provided an added barrier (Kimberlee, 2008), making it unsurprising that there is a lack of data and a disconnection with policy (Burningham & Thrush 2001; Lucas et al, 2003). A recent literature review on energy poverty in young children by O'Sullivan et al (2016) showed that *very little research* has focused on this highly-vulnerable (particularly, to cold and damp housing) group. They describe three typical coping strategies of energy-poor households, all of which are leading to *negative health outcomes*, especially for young children:

1. Self-rationing of energy consumption
2. Financial redistribution through restricting other spending
3. Debt or disconnection from energy or other services.

Jessels et al (2019) found that *single mothers* are also more at risk of experiencing energy insecurity compared to other groups, and describe issues children in energy insecure households face, such as *noise pollution, inadequate lighting, crowding* and *homework distractions* leading to lower educational outcomes (see also Howden-Chapman, 2004). Finally, COVID-19 has, once again, highlighted the additional vulnerabilities especially of children of colour, leading to family instability via *sustained poverty; disproportionate experience of learning loss due to the pandemic; and housing insecurity causing long-term negative effects*[63].

[62] https://www.theguardian.com/us-news/2020/sep/07/homeless-wildfire-smoke-breathing-california?
[63] https://www.urban.org/urban-wire/covid-19s-disproportionate-effects-children-color-will-challenge-next-generation

Elderly

Even though many general recommendations aimed at the elderly to save energy reinforce individual responsibility, the reality can look quite different. For example, Willand et al (2017) found that "t*he material and technical conditions of homes may inhibit the applicability of the advice, that already established restrictive heating practices may hinder their effectiveness, and that householder susceptibility to cold and potentially harmful technical responses may call into question the soundness of the advice*". Even in Sweden, the systems of housing allowance and income support for older persons have their limitations: *not all eligible persons apply* for them and the *information on assets* has to be reported by applicants, who have clear incentives to underreport (Gustafsson et al, 2017). Waitt (2017) actually calls for a change in how researchers approach elderly energy users, and use narratives and storytelling instead (see also Rotmann, 2017a; Moezzie et al, 2017): "*No longer are older low-income households pre-configured as vulnerable, but instead they are repositioned as specialists in their everyday domestic energy use*." We have described several barriers the elderly face in the demographic and psychographic sections, above. In summary, they are:

- Lone person households (often, widowed females)
- Disparity in asset wealth in over 65s
- Asset 'rich', yet income poor
- Substandard housing with poor thermal performance
- Socio-economic inequalities leading to poorer health outcomes
- Greater susceptibility to cold and damp
- Unlikely to complain and live in 'voluntary hypothermia'
- Chronic illness, frailty and disability
- Less mobility, lower technological capability and access, leading to social isolation
- Much greater susceptibility to COVID-19 infection and fatality.

Needs

As we found with all literature outlining audience characteristics (see **Chapters 3-7**), there is a lot more emphasis on barriers they face, rather than in-depth needs-based analysis. It seems many Behaviour Changers think that identifying and addressing barriers automatically produces outcomes audiences need, but we do not believe this to be that simple. Undertaking in-depth social science research on audience barriers and what they believe *they* need to address them, would, undoubtedly be a more fruitful endeavour. We provide some examples where audience needs are specifically mentioned, below.

From a case study in Spain (Scarpellini et al, 2019), examining the perception of social service and NGO professionals, it was found that the concept of a vulnerable household needs to be *defined more precisely* and that a wider range of measures need to be *implemented at local level.* Based on the knowledge about the causes of household energy poverty, these new measures should focus on *prevention* rather than on *mitigation*. Social workers play a key role in household energy poverty mitigation at the regional level, assessing a household's (in)ability to meet a minimum energy service and the effectiveness of social-mitigation mechanisms (Scarpellini et al, 2017). In this respect, to improve energy poverty intervention at the *regional level*, main measures should *facilitate communication and cooperation* between agents by creating cooperation units; define *different levels of subsidies* depending on the households' situation; define a *participative national model*; increase the number of *social housing units*; and provide social workers *training and tools* with which they can make their work more effective.

Children and young people (i.e. students) are especially affected by energy poverty (O'Sullivan et al, 2016); however, they have been under-represented in research. This gap must be addressed by research programmes in order to support policy actions which would reduce the risk of energy poverty

impacts in vulnerable children and young people (Kousis et al, 2020). Aguirre-Bielschowsky et al (2018), focusing on nine to ten-year-old children from Aotearoa, discuss the *need for a more structured approach*, through *developing energy literacy*, in order for children to use their agency, surpass their parents' level of energy-saving practices, and stabilise energy saving behaviours throughout life. In addition, recommendations on how parents, schools, the media and product developers can help in this process, need to be developed. School clearly acts as a key information source, highlighting a route for local consultation, and the concern expressed for animals has great potential as a communication tool (Littledyke, 2004).

Humpage (2005) showed that in attempting to address the relative disadvantage of Indigenous New Zealanders, government policy has traditionally applied a *needs-based discourse* to Māori. This conceptualises Māori as just one of many disadvantaged groups whose 'needs' can be met by *activating equal citizenship rights*. This needs-based discourse, which conceives Indigenous culture as a major explanation for Indigenous poverty and disparity, has legitimised state intervention into Māori communities under the pretence of 'helping' Māori peoples gain access to the kind of socio-economic status their non-Māori counterparts enjoy. Along with 'Māori well-being', 'tino rangatiratanga' was the top outcome area mentioned by interview participants (ibid). Although literally meaning absolute chieftainship or full chiefly authority, *tino rangatiratanga* can be more broadly defined as the power to be self-determining.

Humpage (2005) warns that Māori values and input should never be regarded as 'add-ons'. Rather, appropriate Māori involvement should be sought right from the initial stages of planning through to the implementation stages of any government initiative for Māori. Mercer et al (2020) similarly highlight the following themes (which can be interpreted as 'needs') that underlie Indigenous support of sustainable energy projects in Canada:

1. Community familiarity and understanding
2. Association with previous projects
3. Relationships with culture and sustenance
4. Endogeneity of resources (e.g. community support for wind energy development)
5. Energy security impacts.

They warn that these needs should be viewed as "*a framework for understanding community support, not a definitive recipe for reaching consent*."

Rural communities consist of an array of energy end users, including small towns with older homes, energy-intensive manufacturing facilities, and family farms and ranches of varying size (Shoemaker et al, 2018). The energy, economic, and societal needs of rural and small-town communities are often unique to their geography, and there are many differences between rural areas across large countries like the U.S. and Canada, e.g., demographics, utility model and rate structures, energy sources, and consumption patterns (MacDonald et al, 2020). Rural households need *'bridging models'* including community-based approaches that help close the 'rural EE gap', according to Winner et al (2018) and MacDonald et al (2020). In addition to *geographically-equitable programme design*, local residents should be *hired and trained* as part of the EE workforce (also overcoming work shortages outside of the low-paid farming sector) and community-based organisations should be *educated and included* in EE partnerships [ibid; see also Penny, 2005; and Crane, 2017]).

Without this hands-on *'learning-by-doing'* approach, Penny (2005) found that many of the benefits of retrofitting are not realised because residents are not aware of how to optimise their system through simple behaviours. Penny (2005) studied energy needs of Māori communities specifically and found that several houses were in need of hot-water systems and that communal showers with inefficient technologies were common. Similar to Crane's (2017) research with Canada's First Nation

communities, the Māori communities also wanted to be as *energy-independent* as they could be (Penny, 2005). Crane (2017) highlighted, from interviews with First Nation people who were aware of their power companies' EE programmes, the "*importance of building capacity from within the community so that people can build their own houses, heat their own homes, generate their own electricity, and remove the dependence on federal and provincial governments for funding. There is an overwhelming desire to be independent and get out of the 'grips' of the system*."

Dimensions

Hernández (2016) examined the various dimensions affecting energy-insecure households in Massachusetts, U.S. Three primary dimensions of energy insecurity emerged: economic, physical and behavioural. She coded them as follows (see Table 1: ibid):

Economic energy insecurity

Definition: Financial hardship associated with the cost of energy relative to income and other expenses. This includes:

- Poverty, material hardship and tenuous employment
- Energy-specific financial hardship
- Priorities and trade-offs
- Seasonal variations
- Billing issues
- Landlord improprieties
- Discontinued service due to non-payment.

Physical energy insecurity

Definition: Deficiencies in the physical infrastructure of the home environment that impact thermal comfort, induce harmful indoor exposures and increase energy costs. This includes:

- Poor overall housing quality
- Faulty building infrastructure
- Changes in building energy systems.

Behavioral energy insecurity

Definition: Behavioural strategies used to cope, improvise and counteract the impacts of economic and structural energy insecurity. This includes:

- Energy conservation
- Seeking thermal comfort
- Lump sum and partial bill payments
- Fuel assistance
- Leveraging medical vulnerability
- Faith, hope and despair.

It seems obvious that the *economic dimensions* act most acutely on low-income households. Many participants in Hernández' (2016) study attributed low-household incomes to unstable employment, low wages and the 'cliff effect' which occurs when households become ineligible for safety net benefits, despite not experiencing full economic self-sufficiency through employment (a circumstance that is common across the U.S. more broadly, and is often described as a 'Catch-22'). In comparison to other household expenses such as housing and food, utilities were often considered a *lower priority* (but see "Rent or Eat" barrier discussion above), and were handled with more flexibility because service interruptions take time to issue and can be avoided. The economic hardships associated with

unaffordable utility bills resulted in thousands of dollars of *debt* to utility companies, and brought consequences which included *limits to energy access* as well as restrictions on the *ability to change residences.*

In response to various challenges, study participants often devised a variety of *behavioural strategies* to manage the physical and economic facets of energy insecurity (ibid). However, behavioural energy insecurity is defined by strategies used to cope, improvise and counteract the impacts of economic and physical energy insecurity. This dimension is marked by both positive and negative behavioural approaches. Positive strategies had environmental and economic benefits and demonstrated resourcefulness; negative strategies presented risks to health, safety and residential stability. *Environmental* (hazardous exposures, heat and cold stress), *health* (asthma, chronic stress, mental issues), and *social* (parental fear and stigma, family disruption, residential instability) consequences all follow on from energy insecurity. However, not all vulnerable households face economic challenges, first and foremost. For example, rural households and often Indigenous populations suffer from *geographic isolation*; the elderly and disabled can suffer from *social and technological isolation*; and otherwise-stigmatised minorities suffer from a form of *societal and political isolation*.

Approximate size of this audience

As we have discussed earlier, the issue of various intersectionalities between different factors impacting energy poverty and other vulnerabilities is complex. This also makes it hard to estimate audience sizes, as they will invariably overlap, except where very specific indices were used (e.g. Gustafsson, 2017 specifically studying *low-income, elderly, non-labour migrants* to Sweden). We nonetheless attempt to provide some estimates of audience sizes of the various subgroups, below.

Energy poverty / burden / hardship

In Aotearoa, there are around 682,500 people living in poverty (or one in seven households), including around 220,000 children. Some groups are more likely than others to be in poverty: Beneficiaries, children, Māori and Pacific peoples, and sole parents[64]. One-quarter of Aotearoa's low-income households spend more than 10% of their monthly income on energy (Eusterfeldhaus & Barton, 2011). The recent *Household Economic Survey* shows that, depending on which measure is used, between 1 in 4 and 1 in 22 Aotearoa households experienced at least one energy hardship indicator in 2015/16[65]. Having an energy hardship indicator was, however, much higher for low-income (defined as "*households in the lowest equivalised income quintile [when household income was adjusted by the number and ages of people in the household]*") households, who were approximately twice as likely to experience difficulty paying a utility bill on time and to experience cold and/or damp housing conditions.

Bird et al (2010) estimated that there are 150 million people in energy poverty in the European Union alone. Only half of these households receive fuel-poverty assistance, e.g. fuel aid or subsidised tariffs (IEA, 2011). Long-term incidence of energy poverty held steady at around 20% in most IEA countries, but in some, like Northern Ireland, it spiked to 44% following the *Global Financial Crisis* (ibid). In the UK, the proportion of households in England in fuel poverty was estimated to have decreased by 0.7 percentage points from 2017 to 10.3% in 2018 (approximately 2.4 million households, according to BEIS, 2020). Robinson & Mattioli (2020) have recently estimated that 6% of UK neighbourhoods (accounting for 3 million residents) have a high propensity towards *double energy vulnerability* (domestic energy and transport vulnerability), typically concentrating in i*solated, rural* neighbourhoods.

[64] https://nzccss.org.nz/work/poverty/facts-about-poverty/

[65] http://archive.stats.govt.nz/browse_for_stats/people_and_communities/Households/energy-hardship-report/measuring-energy.aspx#gsc.tab=0

Sweden ranks first (i.e. lowest) in the *European Domestic Energy Poverty Index* (EDEPI) and 7th in the *European Transport Poverty Index* (EEPI, 2019). However, the EDEPI scoring points to the need for Sweden to consider tackling summer domestic energy poverty given that almost 10% of the first income quintile population lives in dwellings not comfortably cool in summer (ibid). In addition, Gustafsson (2017) highlighted around 250,000 *low income, elderly, non-labour migrants* as being highly vulnerable.

Out of a total of 118.2 million U.S. households, the *Energy Information Administration* (EIA, 2018) estimated that 17 million households received an energy disconnect / delivery stop notice and 25 million households had to forgo food and medicine to pay energy bills in 2015. 31% of households reported trouble paying their energy bills (ibid) and a recent ACEEE report (Drehobl et al, 2020) claims 25% of U.S. households (30.6m) faced a high energy burden in terms of paying more than 6% of their income on bills (cf. with the average U.S. household spending 3.1%). The median energy burden for *Black* households was found to be 43% higher than for white households, and the median energy burden for *Hispanic* households was found to be 20% higher than that for white households (ibid). In the U.S., next to domestic violence, not being able to afford utility bills is the #2 reason for *homelessness*[66]. In January 2018, 552,830 people were counted as homeless in the U.S. (The Whitehouse, 2019). Of those, 194,467 (35%) were unsheltered, and 358,363 (65%) were sheltered. The overall homeless population on a single night represents 0.2% of the U.S. population. 70% of homeless are individuals, and 60% of those are males[67]. Pacific Islanders and Native Americans are most likely to be homeless in America when compared to all other racial/ethnic groups. The Federal *Low Income Home Energy Assistance Program* delivered over $3 billion of relief in 2015, but funds only reached 22% of families that needed assistance.

Energy insecure

Energy insecurity is a source of hardship that affects an estimated 16-17 million low-income households in the U.S. (Power, 2006). For this segment of the population, the struggle to meet basic household energy needs is a common thread that remains hidden in plain sight.

Rural households

One in every five Americans lives in a rural area (US Census Bureau, 2017). In the U.S., the energy burden (which Winner et al, 2018 call the "*percentage of household income spent on energy bills"*), is 33% higher in rural areas and participation in residential EE programmes can be significantly lower. Shoemaker et al (2018) claim that about 41% of U.S. households in rural communities have incomes below 200% of the federal poverty level (FPL) compared to 33% of households in urban areas. In Aotearoa, on the other hand, people living in *rural areas* with high urban influence had the highest median incomes and highest household expenditure of any profile area (Statistics NZ, 2002). They were thus consistently among the least-deprived areas in every region, at the time of the 2001 Census. In the UK, the percentage of people living in relative and absolute low income is also lower in rural areas (14% after housing costs) than in urban areas (19%), but nevertheless many thousands of individuals living in rural areas are in households below average income (DEFRA, 2019). According to DEFRA (2013) 9.8 million people, or 18.9% of the population, live in rural areas with most living in less-sparse rural areas and only 1.2% living in sparse rural areas.

It is hard, due to lack of data, to undertake a systematic and complete analysis on *rural* / urban patterns in income poverty (European Commission, 2008). In Western Europe, it was found that between 20% and 33% of rural areas suffer from income poverty (ibid). There are great differences in *gender* in the rural labour market, with females having significantly lower employment than in urban areas. The European Commission (2008) showed that there are specific differences between the

[66] http://solargaines.com/10-stats-about-energy-poverty-in-the-u-s-that-will-shock-you/
[67] https://endhomelessness.org/homelessness-in-america/homelessness-statistics/state-of-homelessness-2020/

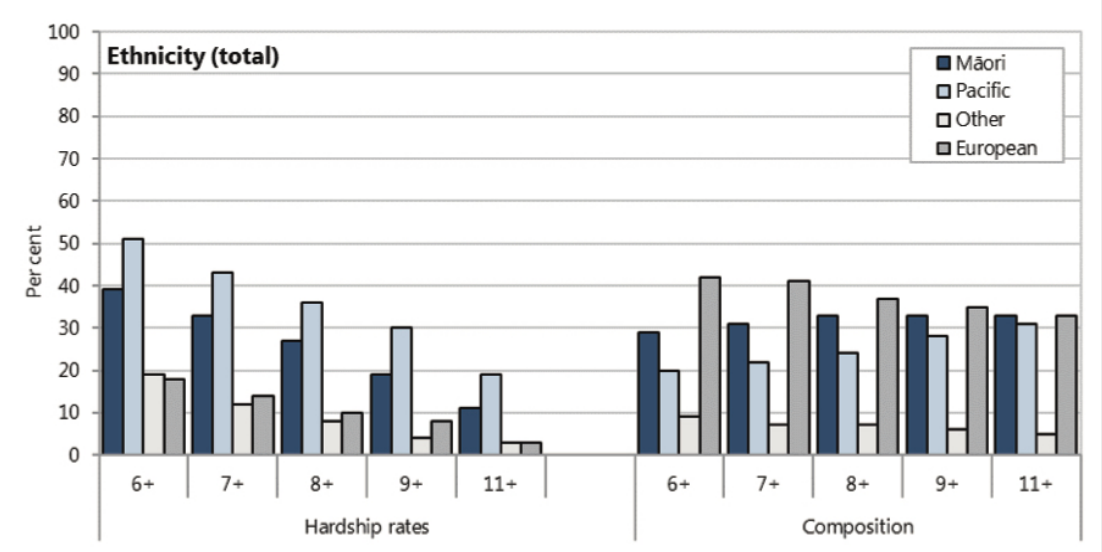
general status of women and the status of *rural women*. Some is due to general disparities, e.g. in *educational* level*, employment* opportunities, and sources of *income*. Rural women have a greater vulnerability to long-term poverty than men, largely because they are over-represented among *elderly single people*. There is little difference in urban vs rural *youth* and *elderly* employment.

Minorities

13% of UK households with someone with a *long-term illness or disability* also live in energy poverty (UKERC et al, 2018) - although Snell & Bevan (2015) highlight that energy poverty amongst disabled people is arguably under-reported due to the inclusion of some disability benefits as disposable income and the lack of consideration of elevated energy needs.

It is estimated that over 214 million people worldwide are *migrants* (this number is expected to increase to 405 million in 2050) and around 32 million are *illegal immigrants* (Horakova, 2013).

The estimated population of *Indigenous people* in the world is at about 302 million, most of whom live in India and China (Anderson et al, 2016). Cornell (2005) found that, at the turn of the 20th century, Indigenous peoples made up approximately 1.5% of the overall U.S. population, just over 2% of that of Australia, >4% of that of Canada, but close to 15% of the NZ population. Their study (ibid) shows that about 24% of Aotearoa's Māori households had a disposable income of less than 60% of the median (Aotearoa's measure of wealth) compared with 12% of its non-Indigenous population (i.e. a 50% income gap). Figure 7 shows the clear distinction between ethnicities in hardship rates in NZ.



Source: NZ 2008 Living Standards Survey from Perry, 2016; Note: left side of graph 'hardship rates' answers "what percentage of the selected group of children are in hardship?" and right side of graph 'composition' answers "what percentage of all children in hardship are in this group?"

Figure 7: Number of NZ children in hardship by ethnicity (Source: McGuinness Institute, 2017).

Brosemer et al (2020) showed that, in the U.S., some 100,000 people - a third of the Navajo Nation - still have no running water, and 15,000 of their 50,000 households live without electricity. This is even more problematic seeing many of these homes suffer from health impacts of coal power generation occuring on their land. As of May 12th, the Navajo Nation also had more COVID-19 cases per capita than any state in the U.S., with just four hospitals serving 175,000 residents.

Elderly and single parents

Recent statistics from the *English Housing Survey* (2016) highlight that 15% of family households are in energy poverty, a figure that increases to 25% for *single parents*. Stated otherwise, Royston et al

(2014) claim that families with children make up over 45% of UK households in fuel poverty. According to Statistics New Zealand, between 2001 and 2021, *single parent families* are projected to increase from 31 to 38% of all families with dependent children. The *child poverty* rate in Aotearoa is already high by OECD standards at 16.3%, but for children in single parent households this figure increases to 47% (Todd, 2008). Half of all single parent families rely on the *Sole Parent Support* as their only source of income - and the level of this income is set below the income poverty threshold. For *single mothers*, therefore, neither current benefit levels nor low wage work necessarily provides enough income to cover basic expenses or to raise their families out of poverty (ibid). 33.6% of households that reported using no heating had dependent children (O'Sullivan et al, 2016).

Statistics NZ (2017) found that around ⅓ of NZ households experienced one or more energy hardship indicators. Pew Research Center (2019) showed that the U.S. had the highest rates of children living in a single-parent household - almost a quarter (23%), more than three times the share of children around the world who do so (7%). According to Lu et al (2019), 21 million children, or 28% of all children in the U.S., lived with one parent. Among the 11.6 million single parents living with their children in 2009, 9.9 million were *single mothers,* who were more likely to live in poverty than the 1.7 million *single fathers*.

Older adults in the U.S. are also more likely than those around the world to age alone: More than a quarter of Americans ages 60 and older live alone (27%), compared with a global average of 16% (Pew Research Center, 2019). Over 25 million Americans aged 60+ are economically insecure—living at or below 250% of the federal poverty level[68]. *Older women* earned significantly less than older men in terms of Social Security benefits (older women of *colour* were far worse off, according to the U.S. *Social Security Administration*). Old age poverty in NZ is now below the OECD average, but they are still above the general population level (OECD, 2013). Figure 8 below shows that the elderly, children and Māori were more likely than the general population of NZ to experience poverty at least once (McGuinness Institute, 2017). Gustafsson et al (2017) showed that, despite having the lowest energy poverty levels on the planet (<2%, see also Thomson et al, 2017b), there was one audience group that fell through the Swedish welfare state cracks: *non-Swedish born over 65s*, which make up 12% of the population of that age group. The latest statistics show that 20% of Swedes are in the over 65 age group, thus the highly-vulnerable *migrant elderly* population is around 250,000 people[69]. It is highly likely that the number of older migrants in the developed world will grow substantially during the next 50 years and we already know that older migrants face special disadvantages which have attracted little research or policy attention to date (ibid).

[68] https://www.ncoa.org/news/resources-for-reporters/get-the-facts/economic-security-facts/

[69] https://www.statista.com/statistics/525637/sweden-elderly-share-of-the-total-population-by-age-group/#:~:text=The%20population%20in%20Sweden%20increased,were%2090%20years%20or%20older.

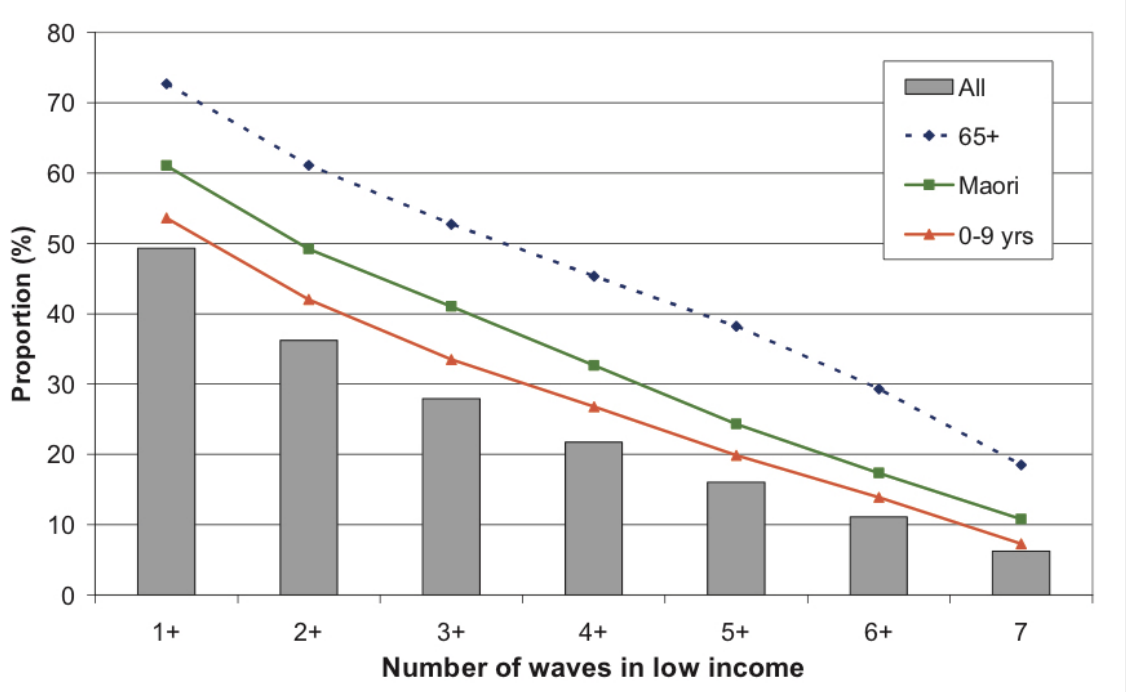


Figure 8: The proportion of the population experiencing low income at least once (Source: NZ Treasury, 2012)

Homeless

It is estimated that over 100 million people (11 million children) around the world are *living without shelter* (Horakova, 2013). 78 million homeless people are living in India, and around 3 million in the European Union (UN, 2005). It is estimated that 1% of Aotearoa's population is homeless, yet it is 6.2% in the U.S. and 7.7% in the UK[70]. A 2013 Statistics NZ census concluded that around 41,000 New Zealanders are homeless, with 70% of the homeless population living in overcrowded conditions, and 80% of them being *transitionally homeless*, with a further 15% being *episodically homeless* (leaving only 5% who are *chronically homeless* and sleeping rough or in shelters)[71]. 1.4 million people use a homeless shelter or transitional housing in the U.S. each year, according to the CDC. This is a rapidly-growing population (one model shows a 45% increase in homelessness in the U.S. thanks to unemployment and rental evictions) as unemployment soars and prisons release people to ease crowding[72]. In the UK, one in 200 Brits was homeless (pre-pandemic), an increase of 4% between 2018-19 and no accounting for the 'hidden homeless' who are transitionally homeless and not known to authorities[73]. Even in Sweden, where the government provides universal health care, family support and financial support for the elderly and retired, there were 34,000 homeless counted in 2011 (4,500 were classified as 'acute homeless')[74].

COVID-19 and its impact on vulnerable households

The SARS-CoV-2 virus has exposed some of the most glaring existing inequalities in our societies. For example, in the UK, the mortality rates from COVID-19 in the most deprived areas were more than double the least deprived areas, for both males and females during the first 3 months of the emergence of the virus (PHE, 2020). After accounting for the effect of sex, age, deprivation and

[70] https://ourworldindata.org/homelessness
[71] https://www.equaljusticeproject.co.nz/articles/b8s1du24t0rkezrzortvxioxispe8d2020
[72] https://community.solutions/analysis-on-unemployment-projects-40-45-increase-in-homelessness-this-year/
[73] https://www.bigissue.com/latest/social-activism/how-many-people-are-homeless-in-the-uk-and-what-can-you-do-about-it/#:~:text=An%20estimated%20320%2C000%20people%20are,on%20the%20previous%20year's%20number.
[74] https://www.thelocal.se/20150115/a-portrait-of-sweden-in-ten-statistics

region, people of *Bangladeshi* ethnicity had around twice the risk of death when compared to people of white British ethnicity. People of *Chinese, Indian, Pakistani, Other Asian, Caribbean* and *Other Black* ethnicity had between 10 and 50% higher risk of death when compared to white British. Survival among confirmed cases, after adjusting for sex, age group, ethnicity and region was lower in the most *deprived* areas, particularly among those of *working age* where the risk of death was almost double the least deprived areas (ibid). Similar findings came from the U.S. in April 2020, with a disproportionate early impact of COVID-19 on *African American, Latino, Pasifika* and *Native American* populations, particularly those living in *segregated* areas and working in *low-paid essential jobs*; as well as the *elderly*; and *poor rural* populations which suffer from significant comorbidities such as opioid addiction and obesity (van Dorn et al, 2020)[75]. However, as Platt & Warwick (2020) warn, the impacts of the COVID-19 crisis are not uniform across ethnic groups, and aggregating all minorities together misses important differences. Larger shares of many minority groups are also of *working age*, which means that these populations are more exposed to labour market conditions as a whole and nearly 60% of them do not have enough savings to cover even one month's income (ibid).

The COVID-19 lockdown has had two significant impacts on energy and water consumers: *increased usage due to lockdown, and reductions in income* (Chen et al, 2020). The UK's *Ofgem* has recently shown that over half of surveyed consumers said that they were using more energy than normal for the time of year, rising to 75% in households with children (NEA, 2020). Households with teleworkers have seen energy usage increase by 32%, compared with those households not working from home - the only households that have not seen significant bill increases are those with retirees, those who always have one household member working from home, and those of essential workers who continue to go to work in person[76]. These results are backed up by Chen et al (2020), who found that the group of New York households that showed no change in energy usage after COVID-19 lockdowns were imposed contained significantly more *elderly, lower-income* people, and *females* than the increasing-and decreasing energy use groups.

In the UK, 14 million households are also heading for a significant bill shock as meter readers have not been able to visit their homes (NEA, 2020). In addition, in countries where the lockdown happened during autumn and winter (e.g. Aotearoa), or if lockdowns were continued into Northern Hemisphere winter months, those houses without proper insulation would be hit with significantly higher energy bills than those living in energy-efficient housing (ibid). This would also have obvious negative health outcomes, including greater susceptibility to, and suffering severity of the coronavirus[77]. Many governments have reacted by introducing emergency consumer protection measures, such as disconnection bans, payment deferral and extension plans, enhancing energy assistance programmes, or even energy bill reduction or cancellation for all in some jurisdictions (Mastropietro et al, 2020). That said, the enforceability and duration of these protective measures is still somewhat unclear, and as mentioned earlier above, an astonishing 76 million Americans will soon suffer from expiration of utility shut-off moratoriums (Thomas, 2020).

Even before COVID-19, energy poverty was already a significant issue in the UK, U.S. and NZ (but not Sweden, see EEPI, 2019): For example, in 2019, *Ofgem* reported that 1.3 million UK electricity customers and 1 million gas customers were repaying debts to their energy supplier, figures that had risen from the preceding year. The energy burden is also greatest among the very poor in the U.S., who are likely to spend upwards of 20% on their household income on utility bills (Hernández & Bird, 2010). It is also known that low-income homes are disproportionately less energy-efficient, particularly

[75] https://theconversation.com/energy-is-a-basic-need-and-many-americans-are-struggling-to-afford-it-in-the-covid-19-recession-140416?platform=hootsuite

[76] https://octopus.energy/blog/domestic-energy-usage-patterns-during-social-distancing/

[77] https://www.rnz.co.nz/news/national/414591/lockdown-highlights-risks-of-poor-accommodation-housing-group-says

in urban areas where the housing stock is older (ibid). The U.S. government's official poverty rate has been increasing, although some argue that U.S. poverty rates are systematically underestimated (e.g. Glennerster, 2002). Some schemes to help the most vulnerable and low income households are in place, for example, the UK's *Warm Home Discount* (which, according to Royston et al, 2014 only reached 2.9% of fuel poor households) and also its previous *Fuel Poverty Strategy* obligations, (following which UK fuel poverty ironically increased significantly, see Rosenow, 2012) or NZ's *Winter Energy Payment* scheme, which was doubled in response to COVID-19[78] (see also Mastropietro et al, 2020 for other global examples).

In addition, the extreme vulnerability of *small businesses* from COVID-19 (Bartik et al, 2020) will extend into small business owners' and employees' households. It is therefore a significant concern that, thanks to the global pandemic, already high rates of household vulnerability and energy poverty, and the inability to afford utility bills (with all its associated potential *mental health* and *Excess Winter Death* consequences, e.g. Davie et al, 2007; Howden-Chapman, 2015; NEA, 2020) will continue to worsen. Of course, energy bill debts also negatively impact energy suppliers and if significant utility debt and liquidity problems persist, they will negatively affect the whole economy, with global implications. This is particularly true when emergency measures, such as disconnection bans, bill reductions or cancellations lead to inclusion errors, as there is no time to carry out the extensive administrative process needed to identify vulnerable customers (Mastropietro et al, 2020).

Target behaviours

Despite substantial literature on energy poverty and vulnerable households, very little of it describes in detail specific energy-saving behaviours (ESBs) in which these households are, or should be, engaging. The ESBs of vulnerable households do not only influence the effectiveness of EE interventions but also the risk of suffering energy poverty. A utility client study by Ehret et al (2019), building on data by Boudet et al (2016) among others, collated 390 direct residential ESBs into a spreadsheet with 26 specific coding characteristics (grouped under *Home & Household; Action & Decision Types; Monetary;* and *Non-Monetary Impact* variables). When filtering out only no- or low-cost (under $20) behaviours with no additional financial costs, over 200 ESBs remained. Despite this broad range of energy conservation behaviours applicable to many vulnerable and low-income households, most of the literature focuses on *heating behaviours* (see also Simcock & Walker, 2016), and *engagement with smart meters* or related technology (e.g. in-home display or *Time of Use* tariffs, see Johnson, 2020).

Interactions with family members, friends and neighbours were found to be an important source of practical, emotional and financial advice and support, which may help people cope with energy poverty and influence behaviours such as *heating regimes, money management, and use of the home* (Kearns et al, 2019). Emotional practices (e.g. seeing energy as a pressing and worrying concern) influence people's (energy) behaviour and, consequently, (energy) vulnerability (ibid) and even self-esteem. That is, these individuals limit their performance of practices to cut back on energy use in order to save money, such as: *spatial and temporal rationing of heating; using cold or only minimal hot water; heating water with a kettle rather than boilers or immersion heaters; making do with light from televisions; wearing additional layers; wrapping up in duvets; visiting friends to warm up, etc. pressing and worrying concern* (Longhurst & Hargreaves, 2019). Meanwhile, low-income family households described the additional energy need associated with having children, such as *increased washing, drying and cooking*, and strict *heating regimes* based around the presence of children in the home (UKERC et al, 2018).

[78] https://www.workandincome.govt.nz/products/a-z-benefits/winter-energy-payment.html

General no-cost behavioural energy-saving activities encouraged by state and local governments include the temporal and spatial restrictions of *heating and the layering of clothes* in winter (Willand et al, 2017) - something that especially the *elderly* often already practice (e.g. Cupples et al, 2007). Researchers who investigate the daily lives of energy-poor households often do so on the premise that achieving warm homes should be a public health goal. Their descriptions of such energy conservation behaviours are thus often judged as regrettable coping and adaptation responses to unsatisfactory situations (as opposed to positive energy-saving behaviours, see Willand et al, 2017) - Collins (1993) going as far as calling it a state of 'voluntary hypothermia'. Waitt et al (2016) highlighted the issue of the 'tyrannies of thrift' in low-income and often elderly households, particularly related to inefficient appliances, lighting and heating behaviours.

Walker (2013) argued that the value judgment of energy practices should rely on the capability of householders to enact them and to function to their optimal potential. Willand et al (2017) state it thus: "*To enable the interpretation of 'behavioural' no-cost energy-saving advice in terms of applicability, soundness and equity, research is needed on how such practices are shaped, how they may influence health as an integral part of daily functioning, and how these practices may shift (or not) after low-cost technical retrofits."* Their paper focused on four such recommended practices: *turning off the heater overnight, keeping the thermostat setting between 18-20°C, heating only occupied rooms, and putting on extra layers of clothing*. In most homes, the heating practices were determined by the requirements of the least-healthy person (often, the older husbands). Low-cost retrofits did not eliminate underheating and had little effect on householder adaptation practices for keeping warm, as households continued to engage in their energy-saving routines (ibid).

In contrast to relatively well-researched heating behaviours, the issue of the need for *air conditioning* and *summer cooling* (including to prevent excess heat mortality; Robine, 2008; Guo et al, 2018), is coming up more commonly in the literature (e.g. IEA, 2018; Osunmuyiwa et al, 2020; Zhang et al, 2020), with Black and poor households in the U.S. suffering disproportionately[79]. Osunmuyiwa et al (2020) found that 'hedonic factors', such as comfort and sleep overrode the pro-environmental attitudes of environmentally-conscious communities in India. This led to an *increased use of air conditioners*, especially at night. They also found that cost and functionality overrode biospheric concern when *purchasing energy-efficient air conditioners*. Further, in some participants, their self-reported 'know-how' on *efficient use of air conditioners* led to an increased willingness to *purchase more* of them (a direct rebound effect, ibid).

Zhang et al (2020) found that increasing temperatures led to increased purchase and use of air conditioners, including in rural, low-income households in China. Even though there is a subsidy called *Benefit People from Energy-saving Products*, 93% of air conditioning units in Chinese households are below the energy-saving standards (ibid). This will become an important energy supply issue seeing that projections show that air conditioners are likely to grow from the current 1.6 billion units to 5.6 billion by 2050, largely driven by global heating and energy users in the Global South (ibid; IEA, 2018). NZ Government support for 'efficient' heating appliances such as heat pumps has led to an unexpected rebound when they are being used for cooling in summer, especially in the more populous sub-tropical North of the country[80],[81].

Recent research by Pachauri & Rao (2013), Waitt (2017), Listo (2018), Petrova & Simcock (2019) and Robinson (2019) focused specifically on *gender* differences in low-income households' energy practices. Even though many men acknowledged being the bill payers and responsible for installing EE measures such as insulation, it was largely the women who changed their everyday chores around

[79] https://onezero.medium.com/why-record-heatwaves-are-especially-dangerous-when-youre-black-and-poor-44f632469228
[80] https://www.nzcompare.com/n/power/how-much-electricity-homes-summer-winter
[81] http://www.stuff.co.nz/the-press/2518913/Heat-pump-sales-spark-fears

the home, e.g. *limiting vacuuming to only once a week* and *using a broom* the rest of the time; *being careful with lights*, sometimes *hand-washing clothes* rather than using a washing machine; taking care to ensure the *home's radiators were correctly adjusted* throughout the day; and *changing the timing* of their energy-using chores (especially if they had time-of-use tariffs, see Petrova & Simcock, 2019). Petrova & Simcock (2019) speculate that "*it appears that energy-saving measures that involve everyday behavioural adaptations are often considered a form of home 'reproduction' and so legitimately 'feminine' undertakings, whilst energy efficiency retrofits fall into the male realm of home 'maintenance.'*" However, in some mixed-gender households it was actually the females who were more interested in EE measures (ibid), including undertaking DIY repairs and upgrades.

One issue highlighted by Petrova & Simcock (2019) and Robinson (2019) is that women are more likely to stay at home caring for *young children*, and are thus more exposed to the negative emotional and physical consequences of inefficient housing and inadequate heating or cooling. COVID-19 has had a disproportionate impact on women, being more likely to lose their employment (the so-called 'fatherhood premium'[82]), or being forced to stay at home caring for, and schooling the children. Grünewald & Diakonova (2020) also showed that women not only undertake more energy-using (and saving) behaviours than men, they are also more likely to report them. The authors report gender differences in 37 energy-using activities (or appliances), but not specific behaviours.

Brown & Markusson (2019) studied smart meter (SM) feedback and its effectiveness on changing energy-saving behaviours (ESBs) in different age groups. Overall, both age groups did very little to act upon the feedback being provided to them by the SM, changing only minor aspects of their behaviour to reduce energy consumption. *Older* adults were generally already largely partaking in many ESBs prior to having the SM installed, thus it was mainly the *younger* adults that changed their behaviour at all. Older adults were found to be rather set in fixed routines and habits and as a result less likely to adapt their general day-to-day behaviours (ibid). In an Australian *Time of Use* tariffs study, Nicholls & Strengers (2015a and b) found that there was considerable disagreement in family households about *heating and cooling.* Children often *turned heaters on or up* themselves in 30% of the surveyed households (this increased with teenage children to 52%). Similarly, children turned the *air conditioner on (or up)* themselves in 20% of households (42% in households with teenage children, ibid).

Finally, Titheridge et al (2014) released a report into *transport* and poverty in the UK, outlining how different vulnerable audiences changed their transport behaviours: For example, people on *low incomes* travel significantly less than those on *high incomes*, with the highest-income group making trips over twice as long as the lowest-income one. The lowest-income group also makes a quarter more trips on foot than other income groups. In the U.S., on the other hand, those on low incomes *spend a greater share of income* on transport than the non-poor, and only the very poor were unlikely to own at least one car (Giuliano, 2005). Low-income households in *rural* areas in the UK suffer from access problems more than those in urban areas (Titheridge et al, 2014). Car availability also tended to be lower in *BAME* groups in the UK (ibid), with *Muslim women*, for example, often being afraid of using public transport and thus staying at home. *Lack of cultural awareness* by transport providers and *language issues* further compounded these travel behaviours. *Unemployed people* without a car found it significantly harder to seek work, especially *low-income* and *immigrant* groups (ibid). The *elderly in rural areas* felt social isolation and lack of access especially strongly. *Low-income women* in the U.S. found having access to a car a stronger correlation with successful transition from welfare to work than education or training (Wachs, 2010).

Conclusions

[82] https://www.thelily.com/dads-are-less-likely-than-moms-and-people-without-kids-to-be-laid-off-during-the-pandemic-new-research-shows/

The research reviewed here highlights how a combination of low incomes and higher energy bills (not to mention the impact of COVID-19) can increase energy poverty among some groups (e.g. Snell et al, 2014; PHE, 2020), such as *disabled people* that are reliant on benefits, *Indigenous* households, and *single-parent families*. Jessels et al (2019) summarise their extensive review on energy insecurity as follows: "*Energy insecurity is a complex problem, and it does not occur in a vacuum. The hardship of energy insecurity intersects with other hardships, such that each compounds the severity of the others and contributes to detrimental health consequences. Competing needs and hardships, such as food insecurity, water insecurity, and housing insecurity, result in tradeoffs where basic needs are prioritised and sometimes foregone. The stress from having to make trade-offs between basic needs for food, water, housing, and energy profoundly affects adult and child mental health, which can exacerbate many kinds of physical health and social issues*."

Despite many efforts to better target and define the energy poor (e.g. Hills, 2012; MBIE, 2019a), much government assistance continues to be focused on *older* people. This ignores the many important intersectionalities compounding energy hardship in many other population groups, especially *women of colour,* and *stigmatised minorities*. In addition, energy poverty is not necessarily the same as suffering from other vulnerabilities, which may make certain groups much harder-to-reach than those known (e.g. by authorities or utilities) to live in poverty. We also need to reiterate the need to consider energy vulnerability as extending beyond *heating or cooling* to other essential energy uses and services, such as *lighting, mobility, communication, or travel* (Mattioli, 2015; Simcock et al, 2016; Walker et al, 2016). Actual ESBs that can help vulnerable households reduce their energy bills, based on their audience characteristics, barriers and needs have been under-researched to date. Some findings of note in the literature reviewed here include:

- There are *many definitions and methods* of measuring energy / fuel poverty; energy hardship / burden, and they often vary with geography and research discipline. Energy poverty and vulnerability, while related, are two distinct issues which are context-dependent.
- It is important to differentiate between the general vs academic usage of the term 'minority': Common usage of the term indicates a *statistical minority*; however, we refer to *power differences* among groups rather than differences in population size among groups. We focused on minorities based on *race / ethnicity, gender* and *disabilities*. Other vulnerable groups were based on *age* (the old and the young, including solo parents), *geographic isolation,* and *socially stigmatised and criminalised* groups, as well as *low-income* households.
- The underexplored relationship between *stigma* and EE could explain the low uptake of EE programmes.
- *Women* are the majority (67%) of people living in *homelessness*, with *single parents* leading two-thirds of homeless families with children. They also suffer from many structural inequalities which are further compounded by COVID-19.
- Within policy, *disabled* people are typically treated as a single group with homogenous needs, despite highly varied needs and eligibility for energy poverty support. They usually also spend more time in the home, and can suffer from isolation and unhealthy housing. Their energy use may be increased by energy-intensive apparatus needed to help them breathe or move.
- Even once access is gained, studying vulnerable populations can be particularly difficult because members of these populations often have *low literacy levels* (complicating the typical process of obtaining written informed consent), and their ability and/or *willingness to participate* which is often contingent on factors out of the researchers' control.
- Particularly with *immigrants / refugees* and *indigenous populations*, *cultural differences* can cause mistrust and lack of engagement.
- *Trusted intermediaries* are therefore essential for facilitating access to energy poverty support schemes.

- In addition to *geographically-equitable programme design*, local (rural) residents should be *hired and trained* as part of the EE workforce, and community-based organisations should be educated and included in EE partnerships - the importance being particularly high for *Indigenous rural communities*.
- As we found with all literature outlining audience characteristics (see **Chapters 3-7**), there is a lot more emphasis on the *barriers* they face, rather than in-depth *needs-based analysis* that collected audience feedback.
- Only a few specific *target energy-saving behaviours* are outlined in the literature, most papers focus on technologies, rather than defining specific behaviours.
- Even though the main dimension affecting low-income and energy-poor households is *economic*, there are many others (e.g. *geographic* for rural (Indigenous); *psychological* for disabled or stigmatised people; *technological* for the elderly) that play important roles.
- The *intersectionality* of vulnerabilities cause additional complexities which have been underexplored in the literature to date.

Chapter 4 - High-Income Households

Background

The literature clearly shows that income, and related affluence, lifestyles and consumption patterns play a very important role in large energy-use disparities. In turn, the topic is intrinsically associated with income inequality, which generates unambiguous differences in both direct and indirect energy use between the rich and poor segments of the population. Energy use per capita often increases as a function of income or level of expenditure (Sovacool, 2011; Khan & Heinecker, 2018; Oswald et al, 2020; Castaño-García et al, 2020), and there is strong evidence for a positive relationship between growth in household demand for modern energy carriers and growth in per capita income (Chakravarty et al, 2009; Grubler et al, 2012). The situation is not static given the dynamic nature of household economic structures (Kooreman & Wunderink, 1996). Thus, as income inequality keeps rising (Alvaredo et al, 2018), one can infer that energy disparities will remain or increase. Importantly, and in the context of the *Users TCP HTR Task*, income-driven energy use disparities are observed across *and* within countries (Spreng, 2005; Galvin & Sunikka-Blank, 2018; Oswald et al, 2020).

Disparities in energy use associated with income *across* countries often mirror the level of economic activity (production and consumption), development, and wealth of nations (Yeager et al, 2012). Studies showing data for 2010 (Grubler et al, 2012; Oswald et al, 2020) reveal major differences between rich and poor regions of the world. For example, whereas the upper bound of per capita final energy use in high-income countries is in the range of 200—300 GJ yr-1, the lower bound of per capita final energy use in poor countries is in the range of 10—30 GJ yr-1. More recent figures (for 2014-2015) show similar trends (see Figure 9). When comparing specific countries, even larger disparities are identified. According to the World Bank (2019), Qatar shows the highest energy use per capita in 2014 (750 GJ yr-1). This needs to be compared, for example, with South Sudan (2.7 GJ yr-1). Energy-use disparities are also accompanied and further augmented by variations in terms of energy carriers and access to them (e.g. electricity being the dominant carrier in OECD countries versus unprocessed biomass used in least-developed countries; Johansson et al, 2012). Irrespective of specific geographical boundaries, stark differences in energy use globally still hold if only top and bottom income deciles are compared: whereas the lowest-income decile uses 2% of total final energy, the top-income decile uses 39% (Oswald et al, 2020).

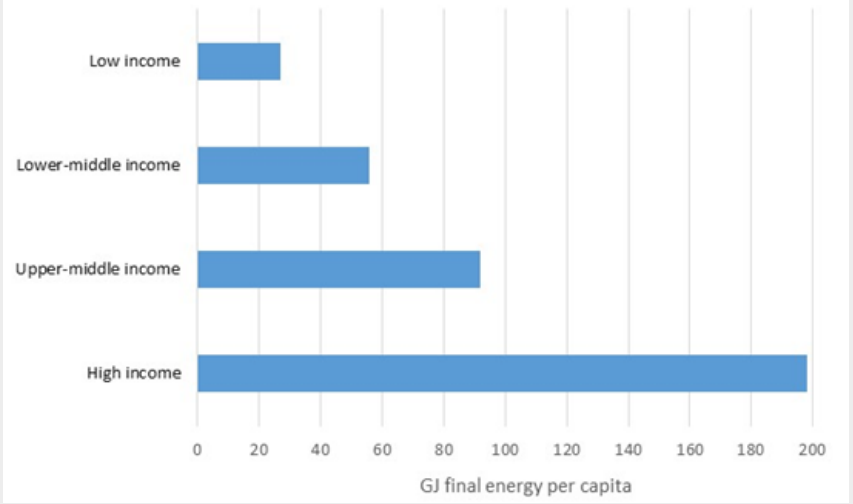


Figure 9: Average final energy use (GJ) per capita across different income-level groups of countries in 2014. Data source: World Bank (2019). Low income = gross national income (GNI) per capita ≤ US$1,025; Lower-middle income = GNI per capita of US$1,026—US$3,995; Upper-middle income = GNI per capita of US$3,996—US$12,375; High income: GNI per capita ≥ US$12,376 (World Bank, 2020b).

When it comes to disparities of energy use related to income *within* countries, similar or even larger inequalities are observed. For instance, Spreng (2005) shows energy use per capita for the highest and lowest income deciles across 73 countries. According to the data, some of the largest disparities are found in the U.S., Canada, the Russian Federation, Australia, Aotearoa, and South Africa (see Figure 10). Whereas the lowest 10% uses ~2—5 kW per capita, the top decile uses ~10—30 kW per capita (Spreng, 2005). In the Netherlands, estimates show that the top 10% use more than four times the amount of energy than the lowest 10% (Vringer & Blok, 1995), and subsequent studies continue showing that high-income households use more energy than low-income households (Abrahamse & Steg, 2011). In the UK, energy use in high-income segments is estimated to be ~20% higher than the annual mean (Druckman & Jackson, 2008). Jacobson et al (2005) and Schaffrin & Reibling (2015) show similar disparities for the U.S. and European countries, respectively. Energy use inequalities have also grown in Mexico (Rosas et al, 2010). Within nations, energy use inequalities are further exacerbated by income inequality (Karekezi et al, 2012; Yeager et al, 2012, Castaño-García et al, 2020); e.g. in certain countries, the top decile concentrates 30%—60% of the national income (WID, 2020), and by the urban and rural divide, as in the case of India and China, for example (Pachauri, 2007; Pachauri & Jiang, 2008; Feng et al, 2011)[83]. The reviewed material highlights that increasing income disparities within rich countries are having negative impacts on four energy-related areas: *home-ownership, energy poverty, carbon emissions,* and *gender inequality* (Galvin & Sunikka-Blank, 2018; Otto et al, 2019). The literature also shows weak or modest levels of decoupling at higher levels of income (i.e. energy consumption increases at a lower rate than income; see Roy et al, 2012; Oswald et al, 2020).

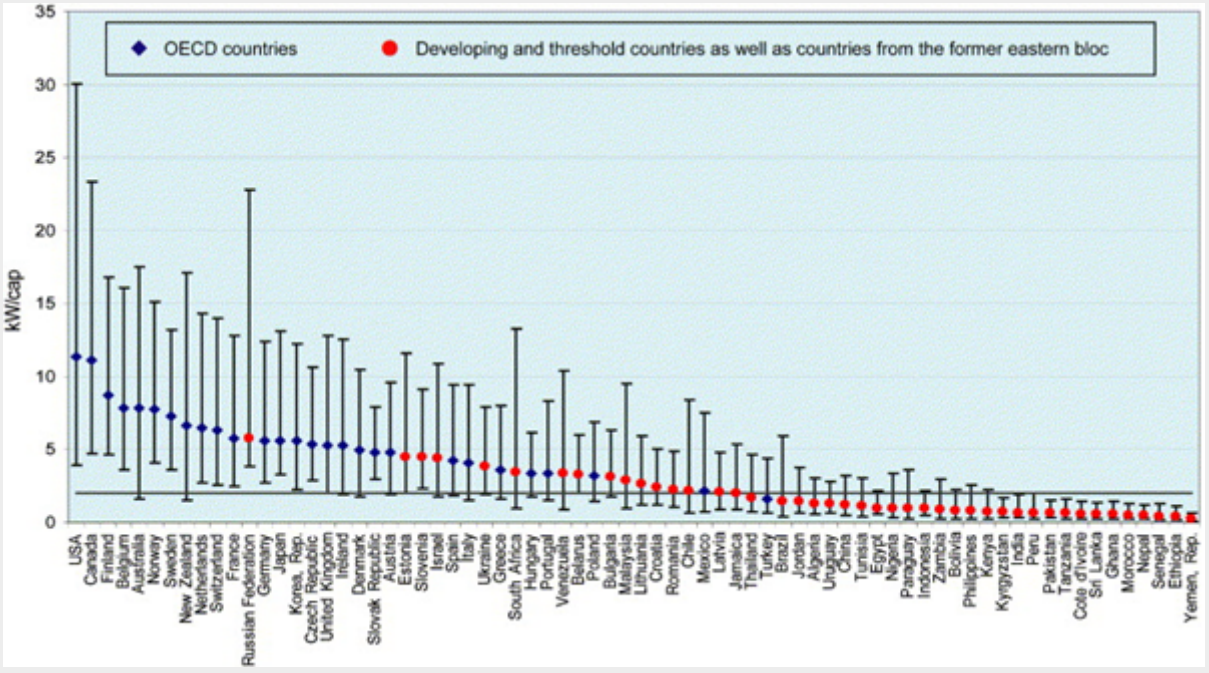


Figure 10: Disparities in per capita energy use within countries; including the highest and lowest income deciles. The continuous line indicates 2000W per capita. Source: Spreng (2005).

Definitions

The reviewed literature does not provide any specific definitions of high-income (households) in the context of energy use or hard-to-reach energy users. In fact, and from a general perspective, the

[83] From a broader economic perspective, the literature suggests that the urban-rural difference is lower at higher levels of economic development (Easterlin et al, 2011).

designation of high-income households entails the specification of arbitrary values (e.g. based on a given GNI per capita figure, as shown in Figure 9) or the use measures based on a reference level (e.g. twice the median income; Törmäletho, 2017). However, as the previous section suggests, the bulk of the studies addressing income (household) and energy-use disparities based their estimates or analyses on various terms associated with income statistics, economics and inequality. Within the context of this specific section, some key terms are briefly presented in **Appendix C**.

Audience characteristics

Demographics and Psychographics

The literature that explicitly addresses the psychographics and demographics of high-income segments is limited and lacks details. This is despite the fact that income and material growth are important elements to consider when analysing *attitudes, values and norms* associated with energy use (Brandon & Lewis, 1999; Poortinga et al, 2004; Steg, 2008). For example, and with due exceptions, studies addressing *values, attitudes, interests and/or behaviours* of top deciles or quintiles are fragmented and mostly done when preferences or the rich and poor divide are explored (e.g. Poortinga et al, 2003; Leiserowitz et al, 2006). Specific linkages to energy use or high income are omitted and data collection (often aggregated and presented from a national / global perspective) is also a challenge. On the contrary, there seems to be growing interest in understanding the psychographics and demographics of the 'super-rich' (e.g. top 1%), albeit not necessarily from an energy-use perspective (e.g. Beaverstock et al, 2004; Neumayer, 2004; Freund & Oliver, 2016). In addition, and given different market, policy and economic conditions across (and within) countries, findings are also highly context-specific. Acknowledging these limitations, the following aspects can be elaborated in the context of HTR energy users.

Studies that address beliefs and attitudes towards the environment and energy use provide various insights. For example, people in high-income nations seem to be *less optimistic* about the capability of technological advances to resolve environmental problems compared to people located in poor countries (Leiserowitz et al, 2006). People in high-income countries are also relatively *more sceptica*l about environmental problems than those in lower-income countries (Anker-Nilssen, 2003; Ameli & Brandt, 2014). Differences also appear across high-income countries, for example, whereas Swedish households are inclined to make *sacrifices to their lifestyle* to solve environmental problems, Dutch households are less likely to do so (Ameli & Brandt, 2014). On the other hand, Martisson et al (2011) show that *environmental attitudes* (e.g. in relation to environmental problems) are relevant in high-income households. At the same time, high-income segments living in detached houses or multifamily buildings exhibit the lowest probability of saving energy compared to middle- or low-income segments (Martinsson et al, 2011). *Perceived behavioural control* and *moral responsibility* can also play a positive role among middle-upper income households to use energy more efficiently (Tedenvall & Mundaca, 2016). However, energy use is strongly correlated with income and household size rather than environmental attitudes (Gatersleben et al, 2002).

The literature stresses that not all high-income households are inefficient energy users (e.g. Baxter et al, 1986; van den Brom et al, 2018). High-income households are shown to be *more likely to invest* in energy-efficiency measures than renters and low-income households (see e.g. Ameli & Brandt, 2014; Miller et al, 2014; Hatvani-Kovacs et al, 2016; Ramos et al, 2016; NPCC, 2018); with home ownership or tenure playing an important role in amount of energy use (Druckman & Jackson, 2008; Galvin & Sunikka-Blank, 2018). Similar findings are found in China, where high income positively moderates the relationship between EE technologies and *purchase attitudes* (Yang & Zhao, 2015).

There is also a growing body of literature exploring the linkages between *income, lifestyles, well-being* and energy use. Here, there seems to be a positive correlation between relatively high subjective

well-being and increased gross national product (GNP) per capita (Stevenson & Wolfers, 2008; Ortiz & Roser, 2017), with the level peaking at approximately U$14,000-15,000 (Leiserowitz et al, 2006; Tella & MacCulloch, 2008). Despite the complex relationship between subjective well-being and economic growth (Graham, 2011), the literature acknowledges that living standards and lifestyles within or across countries can have a more influential impact on subjective well-being and energy use than absolute levels of wealth or income (Leiserowitz et al, 2006; Roy et al, 2012; Sanquist et al, 2012).

The literature also acknowledges that demographic factors do affect the likelihoods and limitations that households face in terms of energy use (Brandon & Lewis, 1999; Abrahamse & Steg, 2011; Karekezi et al, 2012; Galvin & Sunikka-Blank, 2018). Generally speaking, high-income households are characterised as follows: to be in the range of *25—65 years old* (Poortinga et al, 2003; Druckman & Jackson, 2008; Hatvani-Kovacs et al, 2016), *highly educated* (Poortinga et al, 2003; Tedenvall & Mundaca, 2016)[84], in which *marriage or long-term relationships* are common (Miller et al, 2014), and with *male-dominated income earners* and energy users (e.g. Räty & Carlsson-Kanyama, 2009; Abrahamse & Steg, 2011). In addition, the type / size of dwelling, household compositions, and geographical location are also important (Poortinga et al, 2004; Druckman & Jackson, 2008). It is shown that *urbanisation* intensifies energy use among high-income segments (Poumanyvong & Kaneko, 2010), and Khan & Heinecker (2018) show that energy use increases in an urban context due to income disparities.

Esmaeilimoakher et al (2016), in a literature review on social housing tenants, reported a positive relationship by a number of researchers between the household income and the energy used in dwellings (Wilson & Dowlatabati, 2007; Wei et al, 2014; Jones et al, 2015). Yohanis et al (2008) showed that higher-income households can pay for *larger dwellings*, which subsequently results in higher electricity usage. However, when annual electricity cost per person was considered, lower-income people were found to pay nearly 67% more on electricity per person. A similar result was found by van den Brom et al (2018), where Dutch low-income households consumed more gas per m^2 (space heating and hot water) than households with a high income for all types of housing. Furthermore, the performance gap found was caused not only by the occupant but also by the assumed *building characteristics*. One speculation was that higher-income households had larger homes and they did not heat all rooms all the time. However, when *floor area* was accounted for, another possible explanation was that households with a high income may *spend less time at home* than households with a low income and, therefore, consume less gas (ibid). The opposite trend was found for electricity consumption, where occupants with a high income occurred more frequently in the higher electricity-consuming groups. Vassileva et al (2012) showed that low-income households used less electricity than high-income ones in Sweden. They suggest it was because low-income consumers are more aware about their consumption and strive to reduce it, whereas the high-income consumers lack the economic pressure.

The high-income segment also appears to be highly heterogeneous even from a pure income distribution perspective. Within the top decile, the differences are noticeable in terms of both level and composition of income (Piketty & Saez, 2003; Roine & Waldenström, 2008). For example, whereas the top 1% in Sweden makes its fortune from both capital and labour income, the income from the rest of the top decile comes mostly from labour income (Roine & Waldenström, 2008). However, at least in the U.S., high-income earners seem to share common features: *opportunistic, strategic, disciplined*, and *long-term thinkers* (Bank of America, 2016). In any event, this specific body of literature does not provide explicit links to energy use. An exception is found in Anker-Nilssen (2003), who found that high-income households heavily *value gains in time and comfort*.

[84] Research shows that a higher level of education also leads to higher levels of energy use in wealthy countries (e.g. Anker-Nilssen, 2003).

Finally, and with due limitations, links between *partisanship* and high income in the context of energy use or cleaner technologies can to some extent also be identified in the literature. In the U.S., for example, it was found that the possibility of becoming a Democrat diminishes as marginal income grows[85], and that conservatives are less likely to adopt efficient technologies (Gromet et al, 2013). Analysing similar partisanship aspects, Sintov et al (2020) identify that positive perceptions (or 'impressions') about electric vehicle (EV) attributes negatively correlate with higher income, and that Democrats are more likely to adopt EVs than Republicans. In any case, it needs to be acknowledged that not all high-income earners are more politically conservative.

Barriers

Consistent with the limited and fragmented literature on high-income households and energy use, specific barriers to EE improvements or conservation behaviour appear to be scarce. However, and in the context of this *Users TCP HTR Task*, various aspects deserve our attention. For example, some studies show that, as incomes rises, households or energy users are less sensitive to price increases (Brons et al, 2002; Labandeira et al 2017; Schulte & Heindl, 2017), which means that *price mechanisms are inadequate* in sending the right incentives and promote EE among this segment of the population. It is argued that, unlike poor households, high-income segments are less vulnerable to energy-price hikes (Anker-Nilssen, 2003), and unwilling to reduce energy use (Frederiks et al, 2015).

As mentioned earlier, the literature shows that high income motivates or correlates well with investments in EE or energy-saving behaviour (e.g. Lutzenhiser, 1993; Herring et al, 2007; Sardianou, 2007; Nair et al, 2010; Ameli & Brandt, 2014). Webster et al (2008) show that as income rises, households show *preferences for less energy-intensive* homes and appliances. Hatvani-Kovacs et al (2016) also identify *better roof insulation* among high-income households. However, the reviewed material also shows weak or no relationship between income and investment in energy-efficiency or conservation behaviour (e.g. Ürge-Vorsatz & Hauff, 2001; Barr et al, 2005; Ek & Söderholm, 2010; Wang et al, 2011; Malama et al, 2015). These aspects suggest, for example, that high purchasing power or income may not automatically lead to energy-efficient behaviours. In turn, this simply confirms that we need to increase our knowledge about non-economic barriers and conditions (potentially) hindering the engagement of high-income households in EE initiatives.

There is an added complexity in that *self-perceived 'high income' status* can be related to spending on energy and utility costs. Murtagh et al (2014) undertook a qualitative study on impact of in-home-devices (IHDs) on energy behaviour. In it, they found that some 'non-engaged' participant households were not 'rich' in terms of net household income. Nevertheless, they felt they "*have enough money to not bother*". Murtagh et al (2014) stated that it was likely that attempts to engage this group through economic incentives (still one of the most common forms of policy interventions, e.g. Mourik & Rotmann, 2013) will be ineffective.

When it comes to policy interventions, some studies show high-income households being less motivated to participate or engage. For instance, resistance towards transport measures among high-income households has been identified (Poortinga et al., 2003). In the UK, high-income households are less likely to engage with smart meters and report behaviour change (BEIS, 2018). Low levels of participation (~2%) among high-income households are also shown for a variety of energy-efficiency activities in Oregon, U.S. (NPCC, 2018). Analysing the effectiveness of real-time feedback, a significant negative correlation between middle-upper income and *attitudes and social norms towards less energy use* is found in Sweden (e.g. the higher the income the less important for people it is to reduce energy use; Tedenvall & Mundaca, 2016). It is also identified that high-income

[85] https://www.debt.org/faqs/americans-in-debt/economic-demographics-democrats/

households reject the idea of increasing electricity prices to encourage energy conservation (Mah et al, 2012), and they are less likely to be motivated with economic incentives (Murtagh et al, 2014).

At the same time, it is argued that households that participate in (field) experiments addressing energy-use behaviour tend to have higher than average income (Abrahamse et al, 2005). However, this does not mean that participation inevitably leads to improved EE or conservation. An exception is found in Yang & Zhao (2015), who found that high-income households are more likely to purchase efficient technologies as a result of a subsidy scheme. Likewise, NPCC (2018) also found that interest in high-cost efficient measures increases with higher income. Interestingly, during energy-price hikes, high-income households maintain their energy consumption and apply for tax credits or incentive programmes to implement efficient technologies (Dillman et al, 1983). Setting aside moral or ethical aspects related to the use of subsidies by wealthy households, note that the results by Yang & Zhao (2015) are mediated by knowledge about the subsidy programme.

Knowledge, perceptions and cognitive processes also seem to pose a barrier. For example, Lutzenhiser (1993) notes systematic reporting biases affecting high-income energy users (e.g. about fuel use) when energy-related surveys are carried out. Murtagh et al (2014) suggest that the *perception of disposable income* (or notion of affluence) and corresponding levels of wealth among middle-income households may also drive them to use energy unsustainably and replicate patterns of high-income households. Without explicit links to income segments, it is also argued that people's (mis)perception of their own energy behaviours (and related costs and consequences of their actions) deserves much more analytical attention (Attari et al, 2010; Allcott, 2011; Steg et al, 2015).

Needs

There is no explicit literature addressing the needs of high-income households in the context of energy use[86]. To a limited extent, most studies focus on 'wants' (e.g. appliances, cars, travel). Using Maslow's expanded hierarchy of needs (Maslow, 1970), one can infer some conceptual aspects from the reviewed literature, though. For example, excessive energy use may be attached to (unsustainable) necessities of warmer or cooler shelters. This may or not be driven by (distorted) *safety needs* (e.g. protection from the elements). However, the *type of dwelling* matters (Druckman & Jackson, 2008; Martinsson et al, 2011; Esmaeilimoakher et al, 2016), and wealthy households can be characterised in terms of *large living areas* (Abrahamse & Steg, 2011; Tedenvall & Mundaca, 2016) and relatively *poorly insulated* houses (Satterthwaite, 2008). Expectedly, *(energy) prices* play a relatively low level of importance among high-income households (Anker-Nilssen, 2003), and basic energy-related needs (e.g. food, home energy services) are always satisfied (Sovacool, 2011). The literature also shows that high-income households exhibit *increasing appliance ownership* (Bittman, 2000; Rosas et al, 2010), and devote more consumption to *leisure and entertainment* (Sovacool, 2011; Oswald et al, 2020). Conspicuous consumption or *social signalling* (Sovacool, 2011) resulting in the accumulation of energy-intensive devices or technologies can also be taken as a need for belongingness to a certain group, or desire for reputation from others (e.g. car as status symbol; c.f. Roy et al, 2012; Haustein & Hunecke, 2013; Nässén, 2014). *Cognitive needs* (e.g. curiosity about and predictability of new technologies) may also drive or explain this pattern (c.f. Ameli & Brandt, 2014; Steg, 2016; Zoepf & Keith, 2016).

Dimensions

For high-income households, the obvious dimension that applies is the *economic* one. The literature generally acknowledges that demand for energy use and transport correlate positively with income (and household size; see e.g. Lutzenhiser, 1993; Poortinga et al, 2004; Hunecke et al, 2007;

[86] Even the social marketing literature acknowledges the lack of studies addressing the needs of the rich (Smith, 2007).

Abrahamse & Steg, 2009, 2011; Sovacool, 2011). However, the review also indicates that a *geographical* dimension is relevant, particularly when analysing income and energy-use disparities in urban versus rural settings (c.f. Druckman & Jackson, 2008; Pachauri & Jiang, 2008; Khan & Heinecker, 2018).

In addition, and given the lack of understanding of values, attitudes, motivations and behaviours among high-income households in relation to energy use, one could also claim that *psychological* and *behavioural* dimensions are of utmost importance (c.f. Steg & Vlek, 2009; Steg et al, 2015). After all, the literature also shows that habits, cognitive processes, lifestyles and behaviours do have an impact on, and are a major source of variation in energy use and demand of energy services regardless the level of income (Lenzen et al, 2006; Roy et al, 2012; Ürge-Vorsatz et al, 2012; Steg et al, 2015). In addition, the psychological and behavioural dimensions are relevant, for example, to identify critical enabling factors for behaviour change and corresponding behavioural-oriented policy interventions that can enrich traditional policy portfolios (Steg et al, 2015; Mundaca et al, 2019).

Approximate size of this audience

If we take per capita income or decile as metrics, the potential size of this audience is substantial. For example, and from a global perspective, the World Bank (2020b) estimates that the high-income population segment reached 1.21 billion in 2018. In their global energy inequality study, Oswald et al (2020) consider approximately 550 million people in each income decile (e.g. roughly equivalent to the combined population of the U.S., Germany and Russia), and its top decile uses 39% of total final energy. From a country perspective, note that top income deciles concentrate between 30% and 60% of total national income (Alvaredo et al, 2018).

Target behaviours

The reviewed literature suggests that high-income household behaviours that greatly affect energy use are mostly related to *mobility, appliances, communication,* and *recreation*. However, specific details about behaviours *per se* (e.g. [ir]rational use of *thermostat settings*) are limited and mostly confined to consumption categories (e.g. home energy use, travel). Overall, this situation seems to be consistent with the need to increase the knowledge and characterisation of energy behaviours and related energy-saving potentials (Dietz et al, 2009; Ek & Söderholm, 2010; Lopes et al, 2012; Steg et al, 2015; Boudet et al, 2016). Within the context of this *Users TCP HTR Task*, calls for a better understanding of motivations, habits and values among high-income households are growing (see e.g. Otto et al, 2019). Despite these limitations, consumption categories and related figures provide indications of target areas for behaviour change.

When it comes to *direct* energy use, Oswald et al (2020) estimate that *home energy use* (heat and electricity) in the top decile is 13 times higher than in the bottom decile. When addressing the same consumption category, we observe that data from Anker-Nilssen (2003) reveals a top-to-bottom decile ratio in the range of two for the case of Norway. Van Hoa (1985) reports that high / middle-income households use four times more the amount of energy carriers than low-income households in Australia. In relation to home energy use, appliance ownership increases with rising income levels (McNeil & Letschert, 2005; Rosas et al, 2010; Rao & Ummel, 2017); however, it is much less understood how high-income households use respective appliances (Matsumoto, 2016). This is particularly important for the case of electricity, as it is argued that heat consumption is much more dependent on building characteristics than electricity use (Gram-Hanssen, 2011). Thus, the *adoption and use of energy-efficient appliances* among high-income households seems an obvious target for behaviour change (Ameli & Brandt, 2014; Yang & Zhao, 2015; Ramos et al, 2016).

However, and considering the linkages between high-income and the type / size of dwellings (Druckman & Jackson, 2008; Satterthwaite, 2008; Schaffrin & Reibling, 2015), the *optimal adjustment of thermostat settings* and *better home insulation* also seem rather relevant areas to promote behaviour changes —more so, when extremely wasteful energy use behaviour among high-income households is identified (e.g. *outdoor swimming pools being heated all year around* [Sovacool, 2011]). Furthermore, and considering relatively high capital costs but also greater purchasing power, the *adoption of micro-scale renewable* energy technologies (e.g. solar PV, wind) or *subscription to premium green energy tariffs* represent another target behaviour areas across high-income households (c.f. Miranda et al, 2015; Barbose et al, 2018; Otto et al, 2019).

For the particular case of personal transport, *vehicle fuel and operation* also represent a significant area for targeting behaviour change (Bin & Dowlatabadi, 2005; Roy et al, 2012; Oswald et al, 2020). For example, data from the *Global Consumption Database* (World Bank, 2018) reveals that high-income segments consume nearly five times more in transport (direct and indirect energy use) than low-income segments (see also Titheridge et al, 2014). In Norway, a top-to-bottom decile ratio in the range of three for private car use was identified (Anker-Nilssen, 2003). Oswald et al (2020) estimates vehicle fuel operation in the top decile to be 187 times higher than in the bottom decile. Petrol consumption also increases with higher income disparity (Khan & Heinecker, 2018). These findings are consistent with strong correlations between per capita income and per capita transport emissions in high-income countries (Blanco et al, 2014). As a whole, the figures and trends suggest that *personal travel behaviour* and *modal choice* represent another area for targeted behaviour change in high-income households (c.f. De Vos et al, 2012; Gallego et al, 2013; Li & Zhao, 2017).

Regarding *indirect* energy use, areas for targeted behaviour are mostly represented by *(air) travelling, recreation / holidays* and *vehicle ownership / purchase*. For example, according to Oswald et al (2020), the top decile monopolises energy use for recreational items, vehicle purchase and travel holidays, with Gini coefficients in the range of 0.77—0.82[87]. Otto et al (2019) show that *air travel* is the highest consumption category among high-income segments (3.5x more than home energy use[88]). These patterns have of course changed, at least in the short-term, thanks to COVID-19. In (remote) countries like Aotearoa, who enacted very strict lock-down measures very successfully, it is likely that much more emphasis will be put on domestic tourism and travel, particularly seeing that 2-week forced quarantines for all overseas travellers (including returning New Zealanders) will remain for the foreseeable time (i.e. until a global vaccine has been developed and distributed).

Druckman & Jackson (2008) and Gallego et al (2013) identify that high-income households also have a high proportion of vehicles (*owning two or more cars*). It is also argued that once basic needs are satisfied, high-income households devote more consumption to *leisure and entertainment* (Sovacool, 2011), with high-income *single men* consuming more energy for transport and recreation purposes than high-income single women (Räty & Carlsson-Kanyama, 2009). For these specific consumption categories, the literature has already put forward behaviour changes via, for example, the adoption of alternatives to frequent air travel (e.g. *virtual meetings*, now proven to be a useful and workable solution), *efficient public transportation systems, personal carbon allowances, frequent flyer surcharge* and *a climate levy* (e.g. Parag & Eyre, 2010; Titheridge et al, 2014; de Coninck et al, 2018; Sonnenschein & Mundaca, 2019).

Communication and *food consumption* also appear to be areas for behaviour change in indirect energy use. For example, consumption of communication services and technologies shows a top-to-bottom decile ratio of 580 and a Gini coefficient of 0.73 (Oswald et al, 2020). This seems

[87] Note that the bottom decile is completely excluded from these consumption categories so top-to-bottom decile ratios are nil (Oswald et al., 2020).
[88] Bin & Dowlatabadi (2005) also estimate relatively high indirect energy use across US households; however, no direct links to income segments are presented.

consistent with the literature that shows, for instance, increasing levels of electronic waste in high-income countries (e.g. Widmer et al, 2005; Hossain et al, 2015; Veit & Bernardes, 2015). In turn, behaviours that can be promoted relate to the *adoption of waste prevention, reuse and recycling* (Herat, 2007; Kaya, 2019). For food consumption, Oswald et al (2020) estimate a top-to-bottom decile ratio of 13. This is consistent with the literature that shows strong correlations between per capita income and *dietary choices* (e.g. Worsley et al, 2003; Lin et al, 2004; Gale, 2006), including food waste generation (Roy et al, 2012; Thi et al, 2015). The promotion of *healthy / plant-based diets* (Inglis et al, 2009; de Coninck et al, 2018), *adoption of local / urban farming* (De Bon et al, 2010), and consumption of *locally-produced food* (Cranfield et al, 2012) offer areas for behaviour change which will have large effects on energy use, but also during COVID-19 response and recovery efforts (e.g. due to the high rate of COVID-19 infections in U.S. meat packing plants, there is a meat shortage in certain areas[89]). Russell et al (2017) argue that habits, emotions, and norms are also critical to consider in behaviours that aim to reduce food waste[90].

Based on the literature addressing energy use behaviours in general, we can infer that a better understanding of energy behaviours among high-income households is highly dependent on utility and (subjective) well-being, and thus corresponding *lifestyles, norms, beliefs, moral concerns and motivations* in relation to both indirect and direct energy use (c.f. Sovacool, 2011; Lopes et al, 2012; Sanquist et al, 2012; Galvin & Sunikka-Blank, 2018; Khan & Heinecker, 2018; Otto et al, 2019). The picture is indeed complex and Roy et al (2012) argue that it is not the absolute level of energy service provided by consumption categories that is important in shaping energy behaviours, but the generation of utility and well-being that comes out of energy use. In addition, there is a need to understand cognitive processes and contextual factors that inhibit or promote more sustainable energy behaviours among high-income households (c.f. Lutzenhiser, 1993; Maréchal, 2010; Nair et al, 2010; Steg et al, 2015; Atkinson et al, 2017). It is argued that to better understand household energy behaviours, much more research needs to be devoted to ‘day-to-day situations’ that bring together “*physical, economic and moral-based contexts (and their interaction)*” (Ek & Söderholm, 2010).

Conclusions

The reviewed material clearly shows that income, and related affluence, lifestyles, and consumption patterns play a critical role in large energy use disparities. Income-driven energy use inequalities are identified across and within countries. From a conceptual point, the majority of the studies based their estimates on various terms associated with income statistics, economics and inequality. Depending on the metrics, the potential size of this audience is likely substantial. However, the literature that explicitly addresses the psychographics, demographics and needs of high-income households in relation to energy use is extremely limited. Consistent with this, knowledge about specific barriers to EE improvements or conservation behaviour within this segment is still insufficient, and different views exist about the role of price mechanisms in sending the right incentives to promote efficient energy use among this segment. Acknowledging these caveats, the reviewed material suggests that behaviours that greatly affect energy use among high-income households are mostly related to mobility, appliances and recreation. In any case, much more research is needed to better understand high-income energy behaviours and related (response to) policy interventions aiming at EE and conservation in this specific HTR segment.

[89] https://www.nationalgeographic.com/science/2020/05/covid-19-disrupts-complex-food-chains-beef-milk-eggs-produce/
[90] Modelling studies show that a reduction in residential segregation can lower income inequalities in food consumption (Blok et al., 2015).

Chapter 5 - Landlords and tenants (residential & commercial)

Background

The residential rental market

The residential housing sector has a large carbon footprint, accounting for about 22% of U.S. national energy consumption and a similar share of domestic CO_2 emissions (Joint Center for Housing Studies, 2015). According to the most recent *Residential Energy Consumption Survey* (RECS), renters were responsible for nearly a quarter of all residential energy use in 2009. On a per-household basis, renters living in single-family homes consumed 19% less energy than owner-occupants, while renters living in multifamily units consumed 29% less energy than owner-occupants. Lower energy use among renters reflects in part the smaller average size of rentals relative to owned units, and could also be borne from the fact that tenant households have significantly lower income and net wealth than homeowners (Coleman, 2011; see discussion in **High Income Chapter 4**, above). The differences in income and wealth between homeowners and tenants; the spatial concentration of rental properties; and the historic challenge to provide energy efficiency (EE) services to rental and multifamily buildings highlight social inequalities and discrepancies in our society (ibid). Coleman quotes a prominent public official in Massachusetts who works extensively on EE programmes: "*Energy efficiency programmes seem to be designed for suburban, upper-middle class, single-family homes with sophisticated owners who ... understand risk and loans and repayments*."

In addition, a recent report by Kneeborne & Murray (2020) has shown that nearly 16.5 million renter households (totalling almost 50 million people) in the U.S. are likely to suffer loss of income from COVID-19 response. Children (27%) and young adults (16%) make up a disproportionate share of this vulnerable population, as are people of colour: while Hispanic and Black residents make up 18% and 12% of the U.S. population, they account for 28% and 18% of the impacted renter population, respectively (ibid). Among likely-impacted renter households, more than 7.1 million (roughly 43%) were already experiencing housing cost burdens and are likely to be especially vulnerable. Already financially-burdened renters have little (if any cushion) to weather the shutdown, putting them at greater risk of housing instability. Now that the eviction moratoriums ended in the U.S. as of July 31, 2020, barring new moratoriums on eviction one estimate suggests 23 million people will be subject to eviction by the end of September, more than 10 times the number for an entire year[91].

The commercial rental market

Commercial buildings represent about 40% of energy use in the U.S., and of those about 71,000 million square feet, comprising almost US$16 trillion worth in value, was commercial real estate, of which only 10% was owner-occupied[92]. Commercial buildings (which are not owner-occupied) can be single- or multi-tenanted buildings, with either the landlord or the tenant paying utilities.

Similarities between multifamily buildings and multi-tenant commercial space

According to Bell et al (2013), the following similarities between multi-family buildings and multi-tenant commercial spaces can be observed:

[91] https://www.resilience.org/stories/2020-08-02/evictions-tenants-and-the-fragility-of-a-correlated-world/
[92] https://www.reit.com/data-research/research/nareit-research/estimating-size-commercial-real-estate-market-us

- Both are segmented into *various building classes* based on location and aesthetics. There are fewer financing options available to support EE retrofits of lower-class buildings than higher-class buildings.
- Both encounter the *split-incentives barriers* between the tenant and owner, which *green leases and green leasing* (see Janda et al, 2017) can potentially reduce.
- When tenants pay utilities, they look for the *payback period* from upgrades to be less than the lease term in order to achieve a positive return on investment.
- Owners can make upgrades to *common areas* without invading tenant spaces, benefitting the owner if he pays utilities.

There are currently more financing opportunities available for commercial leased space, specifically the creditworthy *Municipalities, Universities, Schools, and Hospitals* (MUSH) market.

Differences between multifamily buildings and multi-tenant commercial space

Bell et al (2013) also describe the following differences between multi-family buildings and multi-tenant commercial spaces:

- Multifamily buildings can be *leased or owned* (cooperatives or condominiums), whereas multi-tenant commercial space is typically leased[93].
- Multifamily-owned spaces have an *elected board* that determines common area system upgrades, but this board has no control over in-unit appliances or HVAC equipment. Multi-tenant commercial space rarely has an elected board.
- Multifamily buildings typically have *1-year leases*, while multi-tenant commercial buildings have lease terms of *3, 5 or 10+ years*[94], depending on the size of the space. This means that tenants in commercial buildings would be more likely to invest in deeper EE upgrades with longer payback periods since they have a longer time to see a return on investment.

Motivation for programmes addressing rentals

Residential rentals - motivations

In the U.S., most of the efforts to promote EE for rental housing have taken place in the context of utility-run EE programmes (Williams, 2008; Coleman, 2011). Generally speaking, the programmes have not made major breakthroughs in the rental sector, which is classified in the industry as 'hard-to-reach' with its own, commonly-used HTR acronym (Williams, 2008; Coleman, 2011; Ross et al, 2016). Historically, most of these programmes have focused on owner-occupied homes because these buildings face smaller barriers to efficiency than rental housing (see also Ramsay & Pett's (2003) comments on most energy utilities focusing on the 'easy-to-reach / heat' customers / homes). The multifamily sector is often underserved by EE programmes due to the sector's diversity, complexity, and unique set of challenges that relate to EE investments (Coleman, 2011; Cook, 2013; Johnson & Mackres, 2013; Ross et al, 2016; Samarripas et al, 2017). One problem Cook (2013) and Coleman (2011) call to be addressed is that traditional (U.S.) utility programmes are designed primarily to overcome financial barriers to EE, but that the most problematic barriers in the multifamily sector are instead social and structural in nature.

[93] The situation in Sweden is slightly more complicated: there is a tenant-ownership, which means that the home 'owner' is a member of a tenant-owner association. This association owns the physical property, while the 'owner' owns the right to live in the physical property. Every member has their 'own' apartment. The 'owner' can sell the tenant-owned apartment (i.e. right) on the housing market, but it is ultimately the association that approves the buyer. New legislation was introduced in 2009 so one can build new multi-dwelling buildings with owner-occupied apartments. An ownership-occupied building means that the person can actually own the physical property, not just the right to use the residence. The market operates more freely, so owners can sell apartments without permission from an association.

[94] In the U.S., it is not uncommon for businesses to have multi-decade leases, something of relevance now as these companies try to get out of these lengthy leases if they plan to have their employees work from home permanently due to COVID-19.

The relative dearth of targeted rental EE programmes (e.g. Cluett & Amann, 2015; Ross et al, 2016) has also been justified in the U.S. by the argument that owner-occupied buildings offer ample opportunity for energy savings (see Williams, 2008). The argument in favour of rental housing efficiency programmes turns these points around, however, by pointing to the high technical potential, especially in multi-family apartments (MFAs; Quantum Consulting, 2004). ACEEE estimated that if multifamily EE programmes were expanded nationwide, they could save owners and their residents up to $3.4 billion per year (McKibbin, 2013). There are also important equity considerations that renters, like all utility ratepayers, should enjoy equal access to EE services (Williams, 2008).

In the UK, there was a dramatic increase in the numbers of households renting privately by almost 50% from 2001 to 2011 (Hope & Booth, 2014). Privately-rented homes, defined in the UK as all rented dwellings not owned by local authorities or housing associations, continue to be the only tenure type that is increasing in England - the first time in 50 years that the number of people renting their homes from a private sector landlord has overtaken social, or public housing renters (DCLG, 2014). This is an issue as the energy performance of homes differs by tenure type (Hope & Booth, 2014). Of the housing tenures in the UK, public housing is the highest-performing tenure type in energy terms, and privately-rented homes represent the worst performing tenure type (ibid). Hope & Booth (2014) also argue that "*there is a clear need then to develop strategies to improve the energy efficiency performance of homes across all tenures, however, to date there have been few initiatives aimed primarily at the worst performing housing stock, that within the private rented sector.*"

In Aotearoa, "*a tenant is a person who rents a property from a landlord, and has a written tenancy agreement signed by both the landlord and the tenant. Tenants have rights and obligations under the Residential Tenancies Act (RTA) 1986.*" A 2019 update to this Act now requires all landlords to provide a statement in new tenancy agreements about the location, type and condition of insulation in the home, and requires minimum levels of insulation. *Kāinga Ora* (the government's social housing provider) is the country's largest residential landlord, owning or managing more than 60,000 properties. Currently, there are too many homes in provincial areas and not enough homes in urban areas where there is a higher level of social housing demand (Johnson et al, 2018). The issue in NZ is less a housing crisis (although the housing stock is shockingly inefficient, see White & Jones, 2017 *Housing Condition Report*; Johnson et al, 2018), but rather an accommodation crisis. Rental housing has been found to be significantly harder to heat, mouldy, damp and below the WHO recommended 18°C indoor temperatures, especially in winter (ibid). Substandard, insecure, and unaffordable housing affects health, contributing to the spread of infectious disease (a particular issue in light of COVID-19, see Baker et al 2020), susceptibility to respiratory illness, and stress and anxiety (Chisholm, 2016). People who rent in Aotearoa are most likely to experience health problems related to housing (e.g. Howden-Chapman et al, 2011). It should be noted that in NZ, MFAs are exceedingly rare, whereas they are a mature market segment in the U.S., Canada and Sweden, and, to a lesser extent, in the UK and Australia. "*The main challenges in the multifamily apartment sector's application to the NZ market include a lack of concept familiarity, a prohibitive cost of construction / compliance, and the high individual value of residential apartments, which incentivises developers to sell the units down individually*."[95]

In Sweden, "*unless otherwise indicated, a tenancy agreement (written or oral) applies for an indefinite period (or it can also be concluded for a fixed term). If the tenancy has lasted for more than nine consecutive months, notice of cancellation is always required for the agreement to cease to apply.*" Sweden differs from most EU states in that heating and water costs are usually included in the rent, thus the onus, at least in principle, sits on the property owners (i.e. building association) to improve efficiency of their building stock to curb heating costs. However, in multi-family homes apartment rent

[95] https://www.nzherald.co.nz/property/news/article.cfm?c_id=8&objectid=12000721

is regulated, with limitations on how much the rent can be increased after refurbishment, and housing associations are often unable to identify and afford loans for profitable EE refurbishment measures (Myrhen et al, 2018).

A large share of the building stock in Sweden was built about 50–60 years ago, during the '*Million Homes Programme*', a large public housing programme to construct one million dwellings for low-income families in urban areas (ibid). These buildings are often in need of significant energy improvements, and are therefore particularly important to address as refurbishment objects (Mangold, 2016). For municipal companies (or publicly-owned building associations), the main reason to refurbish is to prolong the lifespan of *Million Homes Programme* buildings in order to avoid value loss. A second important motivation behind refurbishing is the improvement of the indoor climate, of the buildings in poor condition, and 'unhappy tenants' (Myrhen et al, 2018). The energy operating costs are not necessarily considered to be a primary factor, although energy aspects are sometimes included through *Energy Performance Contracting* (EPC). Unlike most Swedish detached houses, and European multi-family buildings which most frequently have separate heating systems, 91% of the Swedish multi-family buildings are heated by district heating networks (Femenias & Lindén, 2010; Pyrko & Darby, 2011; Swedish Energy Agency, 2015). Studies have shown that Swedish seniors and homeowners are more aware of EE than tenants (Pyrko & Darby, 2011).

Landlord motivations

Elevate Energy (2014) surveyed U.S. landlords for their motivations to undertake EE improvements. Their rationales could be broken down as follows:

- *Building stability:* EE work was completed to increase the physical stability of the building.
- *Financial security:* upgrades were motivated by monetary benefit (this could be lower energy costs, increased capital, or lower operation and maintenance (O&M) costs).
- *Increased safety:* for the tenants provided by the energy efficiency upgrades.
- *Tenant comfort and reducing tenant turnover* were two of the items most cited by owners as a benefit of energy efficiency.
- *Rent increases* due to more energy-efficient, and thus comfortable and cheaper-to-heat / cool buildings.

The vast majority of landlords are private individuals, as opposed to companies, often holding only one rental property (Hope & Booth, 2014). The majority of private landlords consider themselves part-time landlords, given that it is not their primary source of income (DCLG, 2011). For the majority of these landlords, the rewards from refurbishment could be perceived as slim, versus the substantial effort of having work carried out. The results of the private landlord survey (DCLG, 2011) suggest that private landlords are less engaged in sustainability issues than social (public) landlords and homeowners. This highlights one of the biggest hurdles that must be overcome - individually, each of these landlords has relatively little impact on carbon emissions; however, as a whole they collectively contribute significantly to countries' carbon footprint.

Commercial rentals - motivations

The potential for energy savings in the U.S. commercial space is very large. According to an estimate by the *Environmental Protection Agency*, 30% of energy in buildings is used inefficiently or unnecessarily. Every year, $20 billion could be saved if the EE of commercial and industrial buildings improved by just 10% (Bell et al, 2013). In the commercial real estate market there is also evidence that 'green' or efficient buildings perform significantly better. ENERGY STAR reports 10-20% lower operating costs in ENERGY STAR-rated office buildings (ibid). Energy efficiency also offers less obvious co-benefits, e.g. that employees appreciate knowing they work in an environmentally-friendly office, and productivity thus increases (IEA, 2014). Bell et al (2013) state that it is not uncommon to

see EE projects self-financed through capital improvement budgets when owners are convinced of the project's value. However, they also state that "*split incentives remain a primary barrier to efficiency investment in leased spaces in the commercial office (and multifamily) markets*."

In the UK, changes to the non-residential tenant market are underway (BEIS, 2019). The Government set an ambition to support businesses to reduce their energy use by at least 20% by 2030, potentially saving businesses up to £6 billion per year. The assumption is that this will "*drive a more productive economic cycle of improvement, followed by return on investment to the landlord and lower energy bills to the tenant, as opposed to inertia, inactivity and inefficiency*" (ibid; see Table 1).

Table 1: UK stakeholders and attribution of costs and benefits of EE upgrades between them.

Stakeholders	Cost	Benefits
Landlords	• Capital expenditure, covering costs of technologies installed including equipment, hidden & installation costs • Operating expenditure of measures • Familiarisation costs associated with understanding new regulations (estimated as if undertaken by letting agency) • Compliance costs associated with time taken demonstrating exemptions and/or compliance with regulations • Opportunity Cost of Capital forgone from other business activity • Cost of forgone rent due to increased void periods during installation.	• Potential increase in rental value to reflect upfront investment in package of energy efficiency measures • Potential increase in property values • Increase in tenant satisfaction • Reduction in long-term property maintenance costs • Reduction in letting costs as property will be easier to let • Energy bill savings during non-rented periods.
Tenants	Capex, Opex and hidden costs (covered in the landlord section, but potentially financed through energy bills, rent or other contractual arrangement).	• Energy bill savings during lease periods (bills not in social CBA). • Comfort and productivity. • Improved health. • Increase in tenant satisfaction and reduced void periods.
Letting agents		No additional cost on top of landlord costs.
Society as a whole	As above	• As above plus: • Carbon emission savings • Air quality improvements • Social Value of Energy Savings • Increase in security of energy supply (not monetised) • Wider economic benefits e.g. economic growth, jobs in the green construction industry (not monetised).

Source: BEIS (2019)

Definitions

All audience definitions are outlined in **Appendix C**.

Audience characteristics

Boomsma et al (2019), in research on social housing tenants, make an important call to focus not just on the individual (households), but also on their wider contexts. According to Stephenson et al (2010), *cognitive factors* (e.g. beliefs and understandings), the *material culture* (e.g. technologies and

buildings), and *energy practices* (e.g. activities and processes) all underlie consumer energy behaviour, and are highly interactive, creating so-called 'energy cultures'. Studying these different components together in diverse contexts may open up opportunities to modify energy behaviours more effectively (ibid).

There are two distinct HTR audiences in the rental market, both with their separate characteristics, barriers and needs: *tenants* (commercial and residential), and *landlords* (commercial and residential, and we include *property managers* of multi-family apartments here). We aim to separately describe audience characteristics for both, below.

Williams (2008) outlines which characteristics of rental housing markets are important to keep in mind when analysing or developing policies and programmes:

- Amount and distribution of housing
- Structure type, age and condition
- Metering type (master-metered vs sub-metered)
- Rent control (where applicable)
- Investment decision criteria (debt service, taxes, operating costs)
- Ownership types (proprietorship, i.e. a single owner; a general partnership; a limited partnership; a corporation).

As important as dwelling characteristics and housing stock may be, Boomsma et al (2019), in a field study on social housing tenants' energy-saving behaviours (ESBs) found that even though there was tentative support that dwelling characteristics could add to explaining heating behaviours, they were unable to explain other ESBs beyond the variance explained by socio-demographics and psychological factors. Even though psychological factors were shown to have high influence over ESBs, Boomsma et al's 2019 study also showed that subjective norms may relate more strongly to such behaviours when people live in relatively energy-efficient homes. It is thus prudent to consider housing infrastructure, socio-demographics and psychographics together.

Housing infrastructure, Demographics and Psychographics

Tenants / renters

Housing-related infrastructure

In Sweden, the *housing stock* is generally very good and there are few deeply-impoverished areas. The problems can only be found on an area level (Femenias & Lindén, 2010). A study conducted by the OECD in the late 1990s, rated Sweden as one of the most segregated countries in Europe, not making use of the knowledge and potential of foreigners (SOU, 1998). This 'residential segregation', leading to inequality and impoverished neighbourhoods, is still a problem now (Andersson & Hedman, 2016). As a result *employment* has become the focal point of integration policy. The idea is that work should be a way for immigrants to enter a social framework and integrate into Swedish society (Femenias & Lindén, 2010; but see Gustafsson, 2017 and **Vulnerable Households Chapter 3** for a discussion on poverty in elderly non-labour migrants). However, employed immigrants want to move from their impoverished neighbourhoods; housing shortages mean that their place is often taken by new immigrants at the starting point of their integration process. New immigrants who often do not speak the native language, are frequently refugees fleeing significant hardship, struggle to find employment, often mistrust authorities and suffer from cultural misunderstanding (see **Vulnerable Households Chapter 3**), are unlikely to be able to invest in EE measures and their housing infrastructure. Therefore, the development of highly-impoverished neighbourhoods in Sweden is a

slow process - though it is tackled by large-scale neighbourhood initiatives, such as *Sustainable Järva* (described in Mourik & Rotmann, 2013).

In terms of energy use, among private persons / companies, cooperative organisations and public housing companies, energy use per square meter is highest in *public housing* companies (150kWh/m^2 just for heating; Femenias and Lindén, 2010). In addition, where many Swedish tenants in multi-dwelling housing have the heating included in the rent, the incentives should be higher for the owner (who still have to overcome other barriers to EE upgrades), but the incentives for the tenants to save energy are still low (ibid). Vassileva et al (2012) have shown that the consumption per m^2 and per person of Swedish houses was higher than that of apartments.

The U.S. *rental stock* is generally in good condition, with only 3% considered severely inadequate and another 6% categorised as moderately inadequate (Joint Center for Housing Studies, 2015). Utility costs can add significantly to housing costs. According to the 2014 *American Community Survey*, the median renter paying utilities separately from rent spent $130 per month, with utilities accounting for 4% of income, and 14% of housing costs. Given that the need for heating, cooling, lights, appliances, and other energy uses varies little across households, renters with incomes under $15,000 spent $120 per month on utility costs last year, while those earning $15,000–29,999 spent $130. By comparison, higher-income households earning $75,000 and over, spent about $150. As would be expected, as a share of income, utility payments are much more onerous for lower-income renters.

House size is also directly related to energy usage (see Esmaeilimoakher et al, 2016). In India, Pachauri (2004) demonstrated that larger areas require more electrical fittings and fixtures such as fans, lights, coolers, etc. Therefore, unsurprisingly, people living in larger dwellings would have higher total per capita energy requirements (MJ / capita / year). Similarly in the United States, Ewing & Rong (2008) compared energy consumption by two households living in 1000 and 2000 square foot buildings and showed that more energy is required for cooling, heating and all other usages by the household in the larger house.

Vacancy rates can have a critical impact on the balance of power between tenant and landlord and therefore upon tenants' ability to demand EE (Williams, 2008; Davis et al, 2018). Low vacancy rates force tenants to pay higher rent prices and/or to accept housing of inferior quality. Lower vacancy rates are also an important indicator for neighbourhood stabilisation and signal to lenders and developers that a community is a less-risky investment (Elevate Energy, 2014). When vacancy rates are high, in contrast (rates of up to 18% have been seen in some U.S. metropolitan areas, U.S. Census, 2007), renters have considerable choice of where to live. The large supply of rental housing helps to keep prices down and encourages owners to compete for the best tenants by offering a better product - for example, greater EE (ibid). If the housing market is too loose, however, owners may choose to sell their properties or convert them to condominiums due to the reduced profitability that comes with high vacancy rates (Levine & Raab, 1981). Therefore, housing markets with moderate vacancy rates may be the most amenable to increasing EE investment.

In theory, *government-subsidised low-income MFA* (social, or public housing) could be regarded as ‘low-hanging fruit’ for increasing EE in multifamily housing because the government has regulatory levers to require certain efficiency levels and can create new financing programmes targeting these properties (Reina & Kontokosta, 2017). In practice, these programmes present an important venue for understanding how regulations governing multi-family units can affect an owner's incentive to make energy-efficient investments, and a tenant's desire to reduce their own energy consumption levels. Reina & Kontokosta (2017) found that subsidised properties were associated with higher energy consumption than similar market-rate properties and, of the subsidised housing programmes, public housing tended to consume the most energy (similar to Sweden, see Femenias and Lindén, 2010).

Although not usually included in measures of housing cost burdens, *transportation costs* are another major draw on household budgets in the U.S. (Joint Center for Housing Studies, 2015), and elsewhere (Titheridge et al, 2014). On average, a renter family of four with two commuters earning the median income for the region and living in a large metro area (population of 5 million or more) spends about 26% of income on housing costs and 17% on transportation costs. Similar families living in a mid-sized metro (population between 250,000 and 1 million) spend 24% of income on housing costs and 23% on transportation. And in the country's smallest metro and micro areas (with populations under 100,000), these families spend 23% of income on housing and more than 28% on transportation. These results highlight how much transportation costs can significantly add to the affordability pressures facing U.S. renter households.

The difficult tradeoffs that many lower-income renter households have to make between housing affordability and *location* are evident in their spending choices. The 2014 U.S. *Consumer Expenditure Survey* indicates that severely cost-burdened renters in the bottom expenditure quartile (a proxy for low income) spent 60% less on transportation than otherwise similar households living in affordable rentals. This tradeoff between spending on housing and transportation may reflect in part the choice that some low-income renters make to live in units that are expensive but well located, rather than in units that are affordable but distant from work and other resources.

In countries like Aotearoa, the *housing stock* is amongst the poorest quality and hardest-to-heat in the developing world (e.g. Howden-Chapman et al, 2009; Johnson et al, 2018), and this particularly affects *private rentals* (Ambrose & McCarthy, 2019). A study examining the practicality of introducing a *Warrant of Fitness* (WoF) scheme for rental houses showed that 94% of sampled houses failed at least one of the 31 criteria, with many of the houses having numerous defects (Bennett et al, 2016). In addition, over 70% of the additional 150,000 households formed over the past decade have become tenants and recent strong population growth has increased demand for private rental accommodation (Johnson et al, 2018). Signs of stress within this market abound. For instance, rents have begun to rise faster than wages and salaries – perhaps twice as fast in some places – and tenant turnover has declined. Finally, there is also an increased risk of *Excess Winter Mortality*, most likely related to poor housing (leading to an additional 1,600 deaths every winter according to Howden-Chapman, 2015), in private rentals and particularly among low-income renters (Hales et al, 2010). In other countries, such as Australia, the South of Europe and even California, *Excess Summer Mortality* from global heating and the inability to cool homes (e.g. due to blackouts from wildfires) is becoming an increasingly worrying issue (e.g. Robine et al, 2008; Guo et al, 2018). In addition, poor air quality from wildfires necessitates the use of air conditioners[96], further exacerbating GHG emissions and increasing inequality for lower-income or vulnerable households who cannot afford them[97],[98].

Demographics

Energy consumption in dwellings is generally affected by *household demographics* (age, gender, household composition), *socio-economic level* (education level, income), and *lifestyle* (retirement, full-time work, unemployment; Guerra-Santin et al, 2018). These factors are known to influence energy consumption and are considered to be very important because of the great variation within and between types of households. For example, two single-person households could have very different energy consumption because of the age, background, employment status and health condition of tenants. The most commonly used socio-economic characteristics are the *household's size and composition,* and *householders' age, income, education level,* and *employment status* (Bhattacharjee & Reichard, 2011; Karatasoua et al, 2018). The household size, i.e. the number of persons in the

[96] https://airqualitynews.com/2020/09/10/california-faces-record-levels-of-air-pollution-due-to-wildfires/
[97] https://californiahealthline.org/news/low-income-californians-feel-twice-the-burn-from-wildfires/
[98] https://www.theguardian.com/environment/2020/sep/23/california-climate-crisis-wildfires-smoke-heat-health

household, is positively correlated with energy consumption and considered as one of the most influencing socio-demographic factors. As reported by Baker et al (1989), the presence of *children or elderly people* in the household is associated with increased occupancy and more time spent at home, and thus may increase energy consumption. Since the COVID-19 pandemic, there will now be an additional metric, namely *ability to work from home*, in addition to country-specific lockdown orders and e.g. school closures.

The UK Government released the *English Housing Survey* report in 2018, which highlights some key demographic issues for renters: About two thirds (68%) of UK households in the private rented sector had a *household age* (the age of the *household reference person*, i.e. the 'householder' in whose name the accommodation is owned or rented) under 45 years (UK Government, 2018). About one fifth (19%) of rented social housing had households of ages 16-34, with 16% aged 35-44 and 20% aged 45-54. The most prevalent group in the social-rented sector were households aged 65 or over (27%). While the under 35s have always been overrepresented in the private-rented sector, over the last decade or so the increase in the proportion of such households in the private-rented sector has been particularly pronounced. In 2007-08, 28% of those aged 25-34 lived in the private-rented sector. By 2017- 18 this had increased to 44%. A similar trend can be seen in Aotearoa (Johnson et al, 2018).

The UK social-rented sector had the highest proportion of *single person households* (UK Government, 2018). One in five (21%) social renters were lone females, 20% were lone males. About a third of private (35%) and social (33%) renters had *dependent children*. About three quarters (76%) of private renters were *working*, with 65% in full- time work, and 12% in part-time work. Smaller proportions of private renters were retired (8%), in full-time education (5%), or unemployed (3%). Among social renters, 41% were working, with 27% in full-time work and 14% in part-time work. Over a quarter (28%) of social renters were retired. A quarter (25%) were 'inactive', a group which includes those who have a *long-term illness or disability* and those *carers* who were looking after the family or home.

UK social renters were concentrated in the *lower-income quintiles* (46% were in the lowest-income quintile; 26% in the second-lowest) while mortgagors were concentrated in the highest-income quintiles (40% were in the top-income quintile; 28% in the second-highest). This is not surprising given the economic status of the two groups. Private renters and outright owners were fairly evenly spread across the quintiles. Rent payments (excluding utilities) were 28% of household income for social renters, and 33% of household income for private renters. Excluding *Housing Benefit*, the average *proportion of income spent on rent* was the same for social and private renters (37%). *Overcrowding* was also more prevalent in the rented sectors than for owner occupiers (also in Aotearoa, e.g. Baker et al, 2010). Average *life satisfaction* among outright owners was nearly a unit higher than for those living in the social-rented sector. *Risk and hazards*, including damp and mould, were also higher in rental than owner-occupied housing, although the percentages were decreasing thanks to newer housing and higher EE standards (UK Government, 2018). Social housing stock was *more energy efficient*, with full cavity insulation, than private rentals or owner-occupied housing.

In the U.S., the Joint Center for Housing Studies (2015) released some interesting demographic insights into the rental market:

- *Single persons* living alone, the most common renter household type, have accounted for 2.9 million new renters since 2005.
- Families with *children*, including those headed by both married couples and single parents, are the second-most common type of renter household.
- Groups of young unrelated adults living together (non-family households) make up a relatively small share of all renters and their numbers have grown only modestly in the past 10 years.

- Single-family share (including mobile homes) has increased dramatically since 2005, from 34% to 40%.
- In 2014, roughly half of all new rentals were in buildings with *50 or more units*, double the share a decade ago.
- Nearly six out of ten new apartments are in the principal cities of *metro areas*, nearly twice the share of the population in these areas.
- The number of *low-cost rental units* in the U.S. increased just 10% in 2003–2013 while the number of low-income renter households competing for that housing rose by 40%.
- Between 2001 and 2014, real rents rose 7% while *household incomes* fell by 9%.
- In combination, these trends pushed the number of cost-burdened renters (paying more than 30% of income for housing) up from 14.8 million to a new high of 21.3 million.
- The number of these households with severe burdens (paying more than half of income for housing) jumped from 7.5 million to 11.4 million. Overall, 49% of renters were burdened in 2014, including 26% with severe burdens.
- The households most likely to be severely cost-burdened have *dependent children* and/or rely on a *single income*, including 38% of single-parent families and 32% of persons living alone.
- By *age group*, renters aged 75 and over have the highest incidence of severe burdens, at 33%.
- Large shares of *minorities* are also severely burdened, including 33% of African Americans and 30% of Hispanics, compared with 23% of whites.

In Aotearoa, not only is there an increasingly high proportion of private-rental sector (PRS) with highly inefficient and costly housing (Johnson et al, 2019), 49% of those *under 65* and in *poverty* live in the PRS and they also have the least choice over the property they live in and the least agency to improve its conditions (Barton, 2012). *Rising housing costs* have contributed to declining home ownership rates, greater housing instability, and *Māori and Pacific* peoples living in poor quality housing. By 2013, Māori and Pacific homeownership rates had declined relatively rapidly to 28% for Māori and 19% for Pacific peoples, compared with 57% for Europeans (Johnson et al, 2018). Māori landowners have a range of spiritual, cultural and economic aspirations for their *whenua* (land), including housing. Despite the apparent availability of land owned by Māori, there are challenges related to achieving the right to build on land owned by multiple people, the provision of infrastructure, access to finance, and central and local planning rules. Reductions in the number of *state houses* have led to major shifts in tenure patterns for those on low incomes.

In the NZ renting population, between 1986 and 2013, the proportion of *Māori renting state housing* dropped by 29 percentage points compared to 16 points overall (Johnson et al, 2018). As state housing has become less available, *unaffordable rentals* in the private market have become the only option available for many families. Again in the renting population, the proportion renting in the private sector rose rapidly from 1986, but for Māori, the percentage increased from 41% to 77%. In 1986, around half of Māori *children* lived in an owner-occupied dwelling, but by 2013, the proportion was only 39%. These trends are also clear for Pasifika. Between 1986 and 2013, the proportion of *Pasifika renting state housing* dropped 27 percentage points and the proportion renting in the private sector increased from 27% to 56%. The proportion of Pacific *children* who lived in an owner-occupied dwelling dropped from around half in 1986 to 28% in 2013 (ibid).

Tenant households tend to have *higher housing costs* relative to their income and to suffer poorer *health* outcomes (e.g. Howden-Chapman et al, 2007). In addition, *children* from tenant households are more mobile and are at greater risk of not succeeding at school (Johnson et al, 2018). In the current market there are few incentives for landlords to have fixed-term tenancy agreements longer than 12 months, which precludes rent increases for the duration of the tenancy (unless otherwise agreed).

This leaves most tenants with little security of tenure and no effective protection against biannual rent increases.

In Sweden, 2 million apartments were in *single-dwelling* houses, almost 2.4 million in *multi-dwelling* buildings, slightly more than 230,000 are apartments in *special housing* (divided into residences for the *elderly*, people with a *functional impairment* and *student* housing) and 80,000 in other buildings (Boverket, 2015). *Youths* find it the most difficult now to obtain a residence, with more than half of the country's municipalities saying that they have too few residences for youths. An increasing number of *elderly* chose to continue living at home in Sweden, where they can receive home help service and other support. Therefore, the number of care facilities for the elderly is also declining[99]. There are fewer special forms of housing for people with a *functional impairment* than special forms of housing for the elderly, with roughly half of the municipalities saying that they have too few residences for such disabilities (ibid). People born in other countries do not have the same opportunities to get a residence as people who are born in Sweden. It is more common for *foreign-born people* to live in apartments with right of tenancy and less common for them to reside in private homes.

Psychographics

Research on tenants in MFAs showed a positive relationship between *pro-environmental attitudes* and responsible energy consumption behaviour (e.g. Mohazabieh et al, 2016). However, many renters face basic *financial and social challenges* that make it difficult for them to exert control over their housing situation (Williams, 2008). First, renters tend to earn lower incomes than homeowners, and are likely to have less access to the kinds of resources that would be helpful in negotiating with a landlord over EE upgrades. Second, renters are often *hesitant* to ask their landlord to make improvements for fear that the landlord will *seek revenge* by raising the rent or evicting them. Renters, whose utility bills make up a greater fraction of their monthly budget than the average consumer, are thus less able to obtain the EE services that would help them meet their monthly expenses.

Not only is it extremely difficult for renters to convince landlords to make EE improvements, but renters are often *restricted in their ability* to make such improvements themselves, per conditions of their lease (Williams, 2008). Because renters tend to earn relatively lower incomes, they may have difficulty obtaining enough up-front capital to pay for any but the cheapest efficiency measures. In addition, the *payback period* for most efficiency measures is three years or more, which is too long to make economic sense for tenants who may occupy an apartment for only a year. In short, EE programmes and incentives directed at tenants are often found to be unsuccessful (e.g. Philbrick et al, 2014; Pivo, 2014).

One thing renters and landlords tend to share, however, is a *mutual distrust* (Williams, 2008). Landlords often do not trust renters to take care of costly new equipment or to *use energy responsibly*, pointing to high thermostat settings and windows left open in the winter. Renters, on the other hand, complain of landlords' unresponsiveness, poor building maintenance, and erratic heating and cooling performance. Improving relationships between renters and landlords may be one of the most critical, and difficult, steps in facilitating EE for rental housing. Janda et al, 2017 and Rotmann & Bulut (2018) describe commercial renter / landlord distrust and how the process of *green leasing* could help overcome it.

Chisholm (2016) showed that when tenants were able to represent their interests, often with the assistance of a tenant advocate, they could improve their housing in Aotearoa. However, tenants often chose against representing their interests due to a *lack of knowledge of or confidence* in asserting

[99] Unfortunately, Sweden's COVID-19 response hit elderly in long-term care facilities particularly hard: http://www.xinhuanet.com/english/2020-06/16/c_139144239.htm

their rights, as well as the *high costs* of doing so in terms of time and effort, the experience that reporting housing problems does not lead to their resolution, and the *fear of risking their tenancy*.

Further, issues such as *competing priorities of work and family* might prevent the resident from acting on financial EE incentives (Fredman et al, 2018). There are also differences in how homeowners and renters consume energy; for example, owner-occupied units consume more total energy than renter-occupied units, but renter-occupied units consume more energy per square foot (Carliner, 2013). This suggests that homeowners gravitate toward living in larger homes, whereas renters *lack the capacity or ability* to be more efficient.

A recent U.S. study found a persistent, *strong desire for home ownership*, but most of the renter and homeowner respondents believed that buying had become less appealing while renting had become more appealing (Fredman et al, 2018). This shift, the study showed, related to *perceptions about the economy* (e.g., the housing crisis) and *lifestyle changes*; current renters and homeowners both believed that *renters can be as successful* as homeowners. A 2015 Joint Center for Housing Studies survey showed that, while such high-income households (>US$100,000 per year) still represent a relatively small share of renters, the rate of growth in this segment has far outpaced that of other income groups, and testifies to the growing appeal of renting among households with substantial financial means.

McKibben et al (2013) also found that tenants have begun *actively looking for EE* and green features when finding their next home, incorporating expected utility costs into their financial decisions when finding a new place to live and placing a high priority on comfort and their family's health (see also Bierre et al, 2014; Chisholm, 2016). As a number of U.S. cities enact building energy benchmarking and disclosure ordinances, tenants will increasingly be able to look for energy use disclosures and green building labeling to meaningfully compare buildings and incorporate their EE into the rental decision (McKibben et al, 2013).

Landlords

A major U.S. study in which landlords from cities across the U.S. were interviewed about energy efficiency identified three variables that seem to be especially influential in shaping their *attitudes* (Levine et al, 1982). First, the *building's metering type* is critical because it dictates the impact of the split incentive problem. Second, the *size of the landlord's holdings* is important because landlords with significant holdings tend to have better access to capital and information, and greater interest in participating in EE programmes. Finally, the *investment time horizon* has a major impact on the owner's motivations for investing in efficiency: those who hold on to their buildings for a long time pursue EE to increase annual cash flow, while those with more short-term interests seek to increase their properties' capital value. This fragmentation of the broad group of 'landlords' into subgroups with different motivations and barriers suggests that in order to be highly effective, interventions should be flexible enough to meet the needs of *different landlord types* (Williams, 2008).

Ambrose & McCarthy (2019) segmented private landlords in Dunedin, Aotearoa into four main categories:

1) **Non-joiners (10%)** provide accommodation to students and/or low-income groups. They aim to keep capital expenditure to a minimum and feel they are meeting a need for low cost accommodation and that EE increases rents.
2) **Passive actors (10%)** provide accommodation to students and low-income groups. They understand the importance of warm homes that are affordable to heat but cannot or will not invest in EE measures as they perceive that they cannot recoup costs through rent increases/ uplift in capital value.

3) **Active landlords (70%)** let to a variety of tenants. They feel that tenants expect insulation (ceiling and maybe under floor too) and air source heat pumps (ASHP) as standard and will provide them.
4) **Pro-active landlords (10%)** let to a variety of tenants, but tend to avoid low-income groups and younger students. They are interested in buildings and innovation, and will include a wider range of EE measures when renovating a property including ASHP, mechanical heat ventilation and double glazing, in addition to insulation.

Research both within and outside of Aotearoa has pointed to the *reluctance* amongst private landlords to reinvest profit into improving the thermal performance and EE of their properties where there is no legal or regulatory requirement to do so (Ambrose, 2015; Barton, 2012; ACE, 2014). Ambrose & McCarthy (2019) address the topic of "*taming the masculine pioneers*" in a paper that reveals a shift in attitudes amongst landlords over a period of about 5 years, with many becoming more amenable to investing in insulation and low-energy heat sources. This shift had ostensibly been driven by pressure from tenants who appeared to be *departing from established cultural norms* of under-heating ("*Put on another jacket you wuss*!", Cupples et al, 2007; Mourik & Rotmann, 2013) and instead were becoming intolerant of cold homes and high bills. The study highlighted how *socio-cultural factors*, such as growing expectations regarding warmth and comfort in the home, as those seen since the *Warm Up New Zealand* insulation subsidy programme started in 2007, can disrupt established cultural norms and economic rationales to bring about change (ibid).

Focus groups, surveys and interviews have provided a window into landlords' motivations, the barriers that make them reluctant to invest in EE, and their points of view regarding solutions to the problem (Levine et al, 1982; Nexus Market Research, 2005; 2007). Some general findings about landlords include the following (Williams, 2008):

- When the landlord pays for utilities, the major motivation for EE upgrades is *cost savings*.
- In contrast, when the tenant pays for utilities, the landlord's motivation is to *attract and keep what they regard as 'good' tenants*.

Barriers

The International Energy Agency (IEA, 2007) identified a range of market barriers and failures that inhibit energy-efficiency improvements in the rental sector. The lack of *information, fragmentation of housing and energy markets, lack of capital* and *misaligned incentives* challenge retrofits and a detailed understanding of the EE potential in rental and multifamily properties (Coleman, 2011). Especially in cities with concentrations of renters and a *relatively old housing stock*, historic challenges to reach the rental market have left significant potential for efficiency on the table.

Split incentives

Numerous market failures and barriers have been cited to explain the 'energy-efficiency gap' (Hirst & Brown, 1990), including *externalities, imperfect information, low energy prices,* and *inadequate access to capital* (Williams, 2008). Of all the obstacles to EE, however, the most stubborn has been the *split-incentive problem*. The consequences for rental housing are serious. Approximately 31% of homes in the United States are rented, and the vast majority of tenants pay for heating, meaning that almost all renters face the split-incentive problem (ibid). Split incentives therefore affect roughly a quarter of the U.S. population, as well as additional millions of renters worldwide.

Fredman et al (2018) also refer to split-incentive issues around EE appliance purchases: A property owner might be responsible for appliance or equipment choices, whereas the resident is responsible for paying for the electricity they consume. Owners thus have no incentive to upgrade to more EE

appliances as they do not see cost savings; residents might never recoup the cost savings of a more EE appliance while they live in the unit - so, no one purchases the appliance (Carliner, 2013).

Principal Agent Problem

The *transaction* or 'agency' costs involved in the principal finding a way to ensure that the agent overcomes his lack of incentive are often prohibitively high (Williams, 2008): "*Information asymmetry is also often a factor in PA problems, with the agent having the advantage. Examples of principal-agent relationships include a firm and its managers, client and lawyer, and patient and doctor; this is why we tend to select our doctors and lawyers carefully*."

Principal-agent problems surrounding EE differ in some important ways from the textbook economic model (Murtishaw & Sathaye, 2006): "*First, the* definition of agent and principal is more complex*: in the case where the tenant pays the energy bills, the landlord is generally the agent and the principal is the set of all possible renters, whereas when the landlord pays the bills, the landlord is more akin to a principal and the renter is the agent. Second,* information asymmetry *need not be present in order for a renter-landlord agency problem to exist; both renter and landlord may be fully aware of the improvements that need to be made, but the renter remains powerless to compel the landlord to act. Finally, the identity and qualifications of the landlord are generally a minor factor at best in a renter's decision to rent a particular unit; factors such as* location, rent price, and property condition *carry far more weight.* Professional licensing and certification *are often used to help overcome the principal's lack of information regarding the agent's skill, as in the case of doctors and lawyers; an analogous system does not exist to provide information about landlords and property managers*."

Where 'traditional' (neoclassical) economists assume both principals and agents to be *rational* and self-interested utility maximisers, other social science disciplines recognise the heterogeneity in *values and behaviour* among these actors. Coordination among principals and/or agents add layers of rich complexity, and the balance of power can be dynamic and influenced by third parties (Williams, 2008). The result is *adverse selection* and *moral hazard* (e.g. a renter choosing a poorly-insulated property [adverse selection], and a landlord acting opportunistically by purchasing the cheapest and inefficient appliances [moral hazard; IEA, 2007]). Sorrell et al (2004) also criticise the principals / agents (PA) theory as reductionist, arguing that it does not hold true in complex world scenarios.

Williams (2008) points out that there is no magic bullet - no single policy or programme element that will persuade landlords to invest in their properties' energy efficiency. Although the *split incentive* problem has taken most of the blame for the particularly low investment in EE for rental housing, other significant barriers are also fairly unique to this sector-for example, *power imbalances* between renters and landlords. We will outline barriers and failures (other than the split incentive and PA issues which were discussed at some length) that are important to landlords, tenants, or both, as well as those specific to the Behaviour Changers in government, utilities, CBOs or the service sector, below.

Landlord barriers

Williams (2008) outlines the general barriers faced by landlords as follows:

- The most frequently-cited *barriers to investment*, in decreasing order of importance, include:
    - Cost
    - Low return on investment (ROI is especially low when tenants pay for utilities)
    - Tax policies that discourage landlords from purchasing new equipment
    - Uncertainty and mistrust regarding new EE technologies (i.e., access to and trust in information)
    - Hassle and paperwork (i.e., transaction costs).
- Critical implicit barriers include the following:

- Individual metering removes the landlord's cost-saving incentive.
- Many landlords believe (or at least claim) that their properties are already efficient.
- Many lack awareness and/or have misconceptions about existing EE programmes.

Financial factors (for landlords)

Financial factors always present a significant barrier to EE investment because many measures require a *significant initial outlay of capital*. Landlords may have difficulty accessing sufficient capital to pay for measures outright. Those landlords with smaller holdings have greater difficulty accessing capital than those with large holdings, who also tend to have greater organisational and financial resources (Williams, 2008). Coleman (2011) asserts that lenders have historically been concerned that additional leverage adds risk to an asset, an issue he says can be especially acute in low- and moderate-income neighbourhoods.

Hiring an energy technician or a contractor to identify the EE potential of a larger building, like a MFA, can also be very expensive (Coleman, 2011). In addition, the large *implicit discount rate* that many individuals place on EE is a major obstacle. Studies have shown that owners require a 3-year payback period (PPP; roughly a 33% annual rate of return), to make the investment in EE equipment (Stern, 1986). With split incentives, where the landlord does not reap the financial benefits of monthly savings, the PPP is very difficult to quantify and bound to be greater than three years.

Landlords prefer to invest in improvements that are *visible* to renters, such as new windows, and/or equipment required to comply with the law, rather than investing in insulation or other 'invisible' EE measures (Nexus Market Research, 2005; Ambrose & McCarthy, 2019). There is also uncertainty associated with the *likely savings* of each measure due to future fuel price uncertainty, and skepticism about the technology and/or proper equipment use by the renters (Williams, 2008). Williams (2008) points out that, from a behavioural point of view, it implies that the observed *high implicit discount rates* for EE are primarily not a problem of *time discounting* but of *information processing*.

Taxes pose another financial obstacle to investment by landlords in EE (ibid). They are a key determinant of rental property profitability; tax policy can thus be a major help or hindrance in stimulating EE investment. For example, some EE measures count as capital improvements that increase property tax, thus discouraging the landlord from installing these options. However, tax policy can be used to encourage investment: e.g. tax credits and accelerated depreciation allowances could be extended, and EE improvements could be exempted from property tax. In a few countries, like NZ, lack of a *Capital Gains Tax* and a highly overpriced housing market means that property investment is seen as a major asset to those who can afford it[100].

An in-depth review of financing in the commercial rental market (Bell et al, 2013) also remarked that "*Financing is not a panacea for serving hard-to-reach markets, and driving energy efficiency investment requires overcoming many other barriers in the commercial buildings market*."

Financial factors (for tenants)

Most EE programmes in the rental sector focus only on financial barriers (Cook, 2013). However, research (Quantum Consulting, 2001) shows that renters are willing to share in the cost of EE improvements with their building owner when *payback periods* are less than or equal to the time remaining on their lease. There is thus a significant opportunity for utilities to work with both building owners and renters to cooperate and share in the costs and benefits of EE investments. In addition, Cook (2013) points out that *upfront costs* are rarely the only reason that potential participants might

[100] https://www.stuff.co.nz/business/industries/110432452/wealthiest-kiwis-would-pay-vast-majority-of-capital-gains-tax

hesitate. Residents may also be turned off by *high transaction costs*, e.g. the *time-intensive participation process,* but also may have *trust issues,* and *a lack of information* about benefits.

Information Barriers (landlords and tenants)

In order for landlords and tenants to make good decisions about EE, they must have relatively easy access to relevant information on equipment and housing efficiency and the potential for improvement (Williams, 2008; Fredman et al, 2018; Ambrose & McCarthy, 2019). In principle, BEIS (2019) argues that, in a well-functioning market, the split incentive would not exist because rent levels would reflect the differences in the EE of the property. Many EE measures pay back their up-front cost well before the end of their lifetime - something many landlords do not know or understand. Businesses may also not be aware of the numerous *additional benefits* that EE brings, including potentially increasing staff productivity, health, and wellbeing in the workplace (IEA, 2014).

Stern (1986) found that the *time and effort* required to search for information was often enough to discourage individuals and businesses from pursuing EE. It is extremely difficult to design an information campaign that actually reshapes individual behaviour, according to Williams (2008). Assessments of the effect of mass information campaigns on energy savings have had discouraging results (e.g. Collins et al, 1985), which is consistent with general social science findings that information alone is insufficient to change human behaviour (e.g. Mourik & Rotmann, 2013). This suggests that standard neoclassical economics is limited in this context, and that the perverse incentive response might be due to the split-incentive problems. That is, without information, renters feel powerless to make changes and might do the wrong things, without an effective way to understand the consequences (Fredman et al, 2018).

In addition, Cook (2013) and McKibben et al (2013) refer to the *complexity and ambiguity* of different EE programme offerings, especially in the MFA market. Some relate to the number of units, some to the income level of households and different programmes may serve to provide upgrades to residential units and whole-house systems, requiring coordination between multiple utility programmes to undertake a comprehensive whole-building energy upgrade (Cook, 2013). This level of complexity and ambiguity can cause frustration and confusion for tenants and landlords.

Another claim is that EE programmes have a low take-up rate because consumers *don't know about the programmes* or how to participate, thus driving down the expected benefits. To investigate this, Fowlie et al (2015) studied whether extensive outreach and assistance would boost the take-up rate of the *Weatherization Assistance Programs* (WAPs). Using a firm with extensive experience in managing outreach campaigns, the research team made almost 7,000 home visits, more than 32,000 phone calls, and 2,700 follow-up appointments. Yet, despite this aggressive outreach and personal assistance, only 6% of households in the treatment group participated in the programme, compared to 1% in the control group. In the end, it cost over $1,000 for each additional household encouraged to undertake these free EE investments.

Finally, a building owner's *confidence* in making EE investments can be undermined by fluctuations in fuel prices and uncertainty over whether savings will live up to engineering estimates (McKibben, 2013). In addition, MFA owners who have made comprehensive EE investments report that one of the biggest project benefits - reduced tenant turnover rates - was totally unexpected to them.

Trust Barriers (tenants)

It is not just the right kind of information, but also the *trust in information sources*, which has proven to be a critical factor for EE initiatives in many countries. Several studies have pointed to consumers' lack of trust in utility companies (Williams, 2008; Pyrko & Darby, 2011; Bailey & Hodgson, 2018; Grünewald & Reisch, 2020) or landlords (Wrigley & Crawford, 2017). Information must come from a credible

source if it is to have an impact. In some cases, the visible participation of a trusted governmental entity will aid in programme success (e.g. *Warm Up New Zealand* insulation case study, see Grimes et al, 2011); in other cases, it may be best to partner with a nonprofit organisation (e.g. Coleman, 2011; Cook, 2013), or a highly respected private company (e.g. Johnson et al, 2009). In Sweden, municipality energy advisors were found to be both highly-trusted and successful in getting homeowners of detached houses to implement their energy advice (Mahapatra et al, 2011). It is important not to politicise the housing crisis, in order not to undermine public trust. Fredman et al (2018), for example, describe that in Chicago, politicians played up the drama by referring to housing benchmarking as 'public shaming', instead of discussing the underlying equity issues causing structural inequalities.

Benchmarking and submetering requirements are less controversial in the commercial sector. A lot of work has been done on appliance ratings schemes such as ENERGY STAR or building ratings schemes such as *BREEAM* (UK), *LEED* (U.S.), *Homestar* (NZ), *GreenBuilding* (SWE) etc. It is widely acknowledged that they can help building owners and managers better understand how energy use affects an owner's bottom-line, or how building performance compares with others in the market (Bell et al, 2013). However, BEIS (2019) estimated that 18% of non-domestic properties in the UK were in the lowest two *Energy Performance Certificate* (EPC) bands, those rated F and G. Submetering and individually metering units within multi-tenant and multifamily buildings can both assist tenants in controlling their energy use, and drive potential demand for improvements. There is evidence to suggest that submetering may have advantages over individual energy audits in pinpointing potential energy savings measures because it can capture information over time (ibid). However, in NZ, for example, several attempts at residential and commercial benchmarking and rating schemes have largely failed, as landlords lobbied successive governments to keep them voluntary - with the onus of e.g. adequate heating and ventilation being firmly put on tenant behaviour, rather than the underlying housing infrastructure (Wareing, 2015).

Landlord perceptions and mistrust

Research conducted on the UK *Warm Front* programme showed that 45% of cancellations from the private-rented sector were from customers who had been *told to cancel their application* by their landlord (Williamson, 2011). Despite its success, *Warm Front* EE improvements were limited to the low-hanging fruit of improved insulation, focusing only on these small-scale improvements and failing to address hard-to-treat homes (Hope & Booth, 2014). The fact that 40% of landlord respondents in a survey stated they felt that there was *no personal benefit* to them from installing EE measures was illustrated by a comment by one responder who stated: "*It's just something that most landlords don't think about – the energy efficiency, even though we should. We just want the rent*" (ibid).

A large proportion of respondents stated that another deterrent was the fact that there is *no personal benefit* to them. Whilst tenants may 'reasonably request' that their homes undergo EE interventions such as double glazing or improved insulation there is no requirement for landlords to do so. Should a tenant be unhappy, a landlord can simply end the tenancy and install new tenants (see also Wareing, 2015). There is a need for greater and clearer powers for tenants to request such improvements and mechanisms to ensure that landlords follow through without prejudice (Hope & Booth, 2014). In addition, Ambrose & McCarthy (2019) mention landlord distrust of government-led EE efforts, regarding them cynically as 'pro-tenant', in both the UK and NZ.

Coleman (2011) also mentions that landlords of properties with existing code violations or poor housing conditions, which are more likely in multifamily housing than in single-family, are often *reluctant to open their properties* for inspection or review by third parties, such as EE auditors or public agencies tasked with improving building EE. In Sweden, it was found that the current business models

in energy supply and current government regulations limit the development of mutually-beneficial cases between the energy and buildings sectors (Bulut et al, 2016).

Myrhen et al (2018) stated that it is very important to have *expertise* on EE and refurbishment within individual companies, according to almost all the housing owners questioned in their Swedish study. More than 90% expressed the view that it was vital to *recycle knowledge* from one refurbishment project to the next. Most of them said they do *not fully trust consultants* and/or do not believe in energy performance contracting services because they know their own buildings best and thus thought it was risky to leave the refurbishment process to an external partner. One danger that might be introduced because of this way of thinking, is that new ideas and concepts are not implemented if the 'wrong knowledge' is recycled from earlier projects (Myrhen et al, 2018).

Finally, Australian studies found the strongest evidence of split incentives to be found between *renter and agent* (Wrigley & Crawford, 2017). Two thirds of rental properties in Australia are managed by a real estate agent. Strempel et al (2010) found that properties managed by agents had significantly less EE upgrading. They speculated this was because agents "*acted as 'gatekeepers', deciding which types of requests and complaints would be passed onto landlords and sometimes actively discouraging landlords from undertaking what they consider to be unnecessary works e.g. those that are not required by law*" (ibid). It was also found that agents had very low levels of EE knowledge.

MFA-related barriers

Multifamily buildings are difficult to reach because they combine the more challenging aspects of single-family homes and commercial buildings (Quantum Consulting, 2004). As an aggregation of single-family homes, such buildings are occupied by *multiple decision-makers* who are apt to make diverse choices about how to live in their space, making it difficult to achieve consensus on whether and how to improve the building (Williams, 2008). In addition to the individual residents of each housing unit, a *separate entity* such as a landlord or condominium association is generally present and responsible for whole-building decisions (Cook, 2013). While a single resident may make some energy improvements autonomously, most EE upgrades must be implemented at the building scale. Defining the *actual audience to target* in an MFA can itself be a challenge (York et al, 2015). In some cases this is the owner of a property, in others it may be a property manager or management company, it may be an individual owner, or it could be a corporation or other organisation, and it may also be individual occupants of units, whether owners or renters.

As commercial buildings, multifamily buildings also often have *technically-complex heating, ventilation and cooling (HVAC) systems*. This physical complexity can result in relatively *high uncertainty regarding predicted energy savings* resulting from specific measures, exacerbating owners' and tenants' reluctance to make costly investments. Ross et al (2016) found that while some programme administrators have improved their programmes to reach more of their multifamily customers, some sectors remain underserved. This was especially true for the harder-to-reach segments of the market, like *affordable multifamily buildings for low-income households*.

Because many programmes do not track participation by segment (but see York et al, 2015), it is hard to know how well a programme reaches the affordable multifamily segment (ibid). Johnson & Mackres (2013) undertook an in-depth investigation into the U.S. MFA market and found that, in most areas, multifamily programmes account for only a *small share of overall spending* on EE interventions (although this changed somewhat in the follow-up study by Samarripas et al, 2017). Only one of these programmes, by *Hawaii Energy*, also explicitly targeted landlords, property managers and rental tenants for all their residential programmes as HTR customers (ibid; Johnson et al, 2009).

Lack of Individual Outreach and Support (MFA)

Cook (2013) points out that another limitation results from the largely passive role that traditional EE programmes take in *soliciting participation*. Multifamily residents interested in EE face a difficult task in recruiting neighbours and building owners. This creates both a need and an opportunity for an aggressive programme implementer that is able to encourage residents to take on this task, and can provide resources in communicating with other building-level stakeholders.

In Sweden, housing cooperatives, where the building is owned by an association and people can buy a share in the apartments (and then rent them out), are common. The board, which is often made up of volunteers has been found to often *lack EE qualifications,* and also has high turnover (Samuelson, 2018). Samuelson (2018) highlighted the difficulty in making decisions in such housing cooperatives, with some changes like retrofits taking up to 45 years! On the flip side, Hauge et al (2013) found that the board of a housing cooperative often has a tough task of *engaging the residents*. It is crucial that the residents get informed early in the process, to have a dialogue with the residents, letting the decisions mature and seek external expert advice early in the process. Important decisions are sometimes made in advance, decreasing the motivation to participate in such meetings. Thus, the basic challenge seemed to be to get the residents to show up at the meetings in the first place (ibid). This was even more pronounced when they were renters and the apartment owners lived elsewhere.

Additional vulnerabilities (Community Housing tenants)

Esmaeilimoakher et al (2016) undertook a study into identifying the determinants of energy consumption by community housing tenants in Western Australia. Other than low levels of income, tenants in community housing may also have *other vulnerabilities,* including suffering from mental illnesses, disability, substance abuse, or domestic violence. Hence, such tenants are more likely to spend a longer time at home and as a result, have higher energy consumption than other households, which makes them highly-vulnerable to increasing energy prices (ibid). These issues are further described in the **Vulnerable Household Chapter 3**, above.

Rebound / Jevons Paradox and 'Prebound' effects

The UK *Warm Front* programme was designed to assist vulnerable private sector homes (owner-occupied or privately rented) in improving EE (Hope & Booth, 2014). It was reported that the scheme improved over 2 million homes. Whilst occupants did gain from increased thermal comfort, few experienced any significant reduction in their energy bills (ibid). Hope & Booth (2014) attributed this to the *Jevons Paradox* or *rebound*, where recipients of energy improvements do not save on their energy costs; instead they use the potential savings to increase thermal comfort within the home at no extra cost (see also Gillingham et al, 2009; and Boomsma et al, 2019 for a similar effect in social housing). On the other hand, Greening et al (2000) conducted a review of studies into the rebound effect and concluded it was not significant enough to undermine the importance of EE to mitigating climate change. Van den Brom et al (2018) on the other hand claimed that tenants have a higher rebound effect than homeowners (tenants 31–49% and homeowners 12–14%).

An added complexity is in countries where the housing stock is extremely poor (like the UK, but even more so, NZ; see e.g. Bierre et al, 2014; Chisholm, 2016). Even though the *Warm Up New Zealand: Heat Smart* programme was initially aimed at reducing kWh and GHGs, among other metrics like creating an insulation market, it quickly became clear that the link between respiratory diseases, poor housing and insulation was more important than EE improvements *per se* (Grimes et al, 2011). When the programme, which has been running for over a decade (now in new versions, which are focused on the most vulnerable populations - *Warmer Kiwi Homes* and the *Healthy Homes Initiative*), undertook its evaluation, it found that in some of the most inefficient properties, the emphasis on improving comfort and warmth to WHO-level standards meant there was an increase in electricity consumption (especially when e.g. inefficient open fireplaces or unflued gas heaters - the energy consumption of which was not accounted for previously - were replaced with EE heat pumps).

However, the massive pay-off (each dollar spent on the insulation subsidy meant over $5 were saved on macroeconomic health benefits), more than made up for the relatively minor increases in energy usage (Grimes et al, 2011).

On the other hand, in countries with better housing stock, like the U.S., Fowlie et al (2015) showed in the largest randomised control trial (RCT) on *Weatherization Assistance Programs* (WAPs) in Michigan, that the model-projected savings of WAPs were roughly 2.5 times the actual savings. While this might be attributed to the 'rebound' effect, their paper failed to find evidence of significantly higher indoor temperatures at weatherised homes. This could be a significant issue, seeing that the average rate of return outweighed the costs by -9.5% annually, and that low-income households still did not gain the promised health and comfort outcomes.

In the Netherlands, Guerra-Santin et al (2018) discuss a potential '*prebound*' effect (see **Glossary of Terms Chapter 2** or Sunnika-Blank & Galvin, 2012; van den Brom et al, 2018; DellaValle & Sareen, 2020) if occupant behaviours are not accounted for following net-zero energy MFA retrofits: Their research showed large, statistically-significant differences on energy consumption between the different household types, which could contribute to prebound effects if these differences are not considered when calculating energy savings and return of investments. Important bottlenecks in the process were related to the *users*, the *composition of the different options* for renovation, the *calculation of the increase of the rent* related to the home improvements, the tenants' *participation rate*, the application of *different solutions* in one complex, and the *postponed application of renovation measures* after renters refused to participate in the first round (ibid). When considering scenarios based on occupant behaviour after renovation (considering better control and possible rebound effects), the difference between the lowest and the highest heating demand was reduced to 34%. The post-renovation scenarios including behavioural interventions considered that single adults would heat more frequently and to a higher degree to provide a comfortable environment, and that households with seniors and adult couples would have better control of the heating system (e.g. they will use a lower setback temperature).

A similar prebound effect has been highlighted in a study evaluating EE retrofits in Mexico (Davis et al, 2018). In sharp contrast to the engineering predictions, the authors found that the upgrades had no detectable impact on electricity use or thermal comfort. Across specifications there was no evidence of decreased electricity use, either in summer or non-summer months. Moreover, they found no differences in thermal comfort between upgraded and non-upgraded homes, with essentially identical levels of temperature and humidity across all hours of the day. Overall, Davis et al (2018) concluded that the benefits from these investments were less than the costs ($400-$500 USD per home). They highlighted that the lack of evidence of impacts from EE retrofits was not because of a lack of statistical precision, but *ignoring the 'human factor'.* For example, most households did not have air conditioners. Without air conditioning, the upgrades had much less potential to reduce energy use. In addition, they documented that most households had their windows open on hot days, thus largely nullifying the thermal benefits of building insulation and the other EE upgrades.

'Greenwashing' and Green Leases vs Green Leasing

Janda et al (2015) point out that energy management opportunities in leased commercial properties depend on the physical premises, the varying organisational capacities of both landlord and tenant, and the *language of the lease* itself. Most leases do not permit tenants to make alterations to the premises, nor require landlords to share energy data with tenants. 'Green leasing' (see also Janda et al, 2017; and Rotmann & Bulut, 2018) recommends a new form of leasing to enable landlords and tenants to work cooperatively to help meet environmental targets. This is in contrast to a 'Green Lease' (e.g. Williams, 2008), which focuses on the contract itself, rather than the practice of enabling collaboration. Green leases in commercial office buildings in Sweden, where the practice is

widespread, are often regarded as 'greenwash' by the co-signees, and tenants often feel they predominantly benefit landlords (BELOK, 2016, 2018; Janda et al, 2017; Rotmann & Bulut, 2018; but see Feierman, 2015 for U.S. experience). Greener leasing practices usually do more to adjust the incentive structures within leases to facilitate upgrade and retrofit initiatives, promote co-operative dialogue between the landlord and tenant, and incorporate environmentally-sensitive language (Janda et al, 2015).

Market fragmentation (for Behaviour Changers)

A Granade & McKinsey (2009) report pointed to the formidable problem of *market and energy fragmentation* driving high transaction costs: "*Atomised savings are spread across more than 100 million locations and billions of devices used in residential, commercial, and industrial settings ... this dispersion ensures that efficiency is the highest priority of virtually no one*". Indeed, nuances pervade attempts to pursue EE - different building characteristics, heating and lighting systems, fuels, climate zones, appliances, and many other factors related to energy use create a high degree of market segmentation. Property owners include individuals, general or limited partnerships, and corporations, which could include insurance companies, pension funds, and real estate investment trusts - each with different tendencies, resources, and interests concerning ongoing building operations and demands for returns on investments in the asset (Coleman, 2011). The findings by Reina & Kontokosta (2017) on subsidised low-income MFA regulations in the U.S. suggested that, despite the potential for retrofitting multifamily properties, there were often *regulatory factors* that constrained investment and consumption decisions in the case of these properties.

While data on ownership characteristics is incomplete, interviews with individuals experienced with the market indicate that small-scale property owners own a large number of rental properties in the U.S. (Cook, 2013). This makes organising an EE programme difficult, as there is *less opportunity to scale it up* quickly by working with a small number of large-scale property owners. Additionally, many landlords use third-party property management firms to run the day-to-day operations of their properties. This adds an additional layer of complexity, as the primary point of contact for a rental property may not be empowered to authorise large EE improvements. To make things even more complex, many Class A office buildings in major cities in the U.S. are so expensive that tenants are often subleasing their space (Bell et al, 2013). The most commonly-cited barrier to EE in rental housing, the split-incentive problem, is also a form of fragmentation, according to Coleman (2011).

No coordinated private landlord body (for Behaviour Changers)

The difficulties for policy makers in most countries arising from the fragmented nature of the private rented sector are compounded by the *lack of a mandatory governing / associative body* for private landlords (Cook, 2013; Hope & Booth, 2014). This is unlike social housing, which is strongly regulated and perhaps as a result of this, is the best-performing tenure type in terms of energy efficiency. Whilst letting agents[101] can act as a proxy for such a body, in the UK, the *Private Landlord Survey* (Hope & Booth, 2014) indicated that less than half of private landlords use such a facilitator to manage their tenanted homes. Private, subscription based bodies such as the UK *National Landlord Association* and the *Residential Landlords Association* exist, but there is seemingly little incentive for the majority of landlords who only let out one property to become members.

Sweden is one of the few countries that has coordinated national landlords associations and groups. *BEBO*[102], a network of housing owners supported by the *Swedish Energy Agency*, has been an alternative information channel regarding energy-efficient refurbishment. *SABO*[103], the *Swedish*

[101] A letting agent is a facilitator through which an agreement is made between a landlord and tenant for the rental of a residential property.
[102] http://www.BEBO.se
[103] https://www.sabo.se/

Association of Public Housing Companies, is the most important forum to share experience and knowledge (see e.g. Femenias & Lindén, 2010). The data gathered in the Swedish study by Myrhen et al (2018) indicates that the knowledge level about EE work is somewhat higher among large municipal housing owners than in the small private companies: "*In order to spread new scientific information or guidelines, it is, therefore, crucial to inspire representatives from the large housing owners to take part in events where important information is given, and encourage them to take back the message to the regional level. Coordinated meetings were said to be of special importance to the larger companies, which can often afford to participate in these events with their own energy experts.*"

To much focus on large-scale retrofits instead of behaviours (Behaviour Changers)

Most EE programmes in the rental sector (especially residential and MFA) focus on *large-scale retrofits and weatherisation* programmes (e.g. Coleman, 2011; Cook, 2013). Specific behavioural interventions outside of *Home Energy Reports* (HERs) are rare (Kennedy et al, 2014) but need to be considered to ensure successful implementation. For example, evaluation of the Mexican *EcoCasa* retrofit programme showed the need to improve EE simulation models to better consider the behaviour of the inhabitants (Davis et al, 2018). The behavioural factors affected the results both in terms of comfort and energy savings. Also, when the estimated energy savings (23%) of the large-scale MFA retrofit effort of 1537 units in Austin, Texas was compared with the actual savings (5%), the results were rather disappointing (Kennedy et al, 2014).

In addition, one of the biggest interventions in the low income rental market, *Weatherization Assistance Programs* (WAPs), were also found to have significantly lower benefit to cost ratios than expected, by at least one major study (Fowlie et al, 2015): "*While the researchers found that the upgrades did reduce the households' energy consumption by about 10-20% each month, that only translated into $2,400 in savings over the lifetime of the upgrades – half of what was originally spent to make the upgrades, and less-than-half of projected energy savings*."

Even the largest-scale utility-led behavioural programmes, *Home Energy Reports* (HERs), which are sent to about 15 million households in 9 countries, using the 'gold standard' of randomised control trials (RCTs), were shown to be overstating the gains, as traditional evaluation approaches ignore significant costs incurred by such 'nudge' recipients (Allcott & Kessler, 2019). Overall, home energy report welfare gains might be overstated by $620 million, according to this study (ibid). The authors also cautioned against not investigating the individual behaviours that resulted in reported changes from HERs, including their financial and social (non-energy) costs to the households.

Lack of occupant data (for Behaviour Changers)

Guerra-Santin et al (2018) also point out that in practice, there are *limitations* on investigating MFA households based on actual project times (time available to carry out pre-renovation investigations), *resources* to monitor and analyse data collected (time, money and expertise), *accessibility* to the dwellings (not all residents will be willing or able to be monitored), and *scale of the monitoring* (not all dwellings can be monitored, just a sample). Therefore, the use of the data on actual occupancy patterns and actual occupant behaviour will be limited to its availability.

Reina & Kontokosta (2017) found that most studies of the impact of occupants on consumption behaviour were derived from *models, simulations, or surveys* rather than actual energy use data. While these methods are useful for cross-validation and estimating potential impacts, the empirical analysis of actual use data provides an opportunity for new insights into the effects of these factors on building EE (this call is backed up by van den Brom et al, 2018).

Not accounting for multiple benefits (from all perspectives)

Multiple benefits are the impacts of EE improvements beyond energy savings (see IEA, 2014). We include them in barriers here as they are difficult and costly to measure, and are usually ignored by Behaviour Changers designing interventions (often, at their peril). Most evaluations used by regulators do not include the value of benefits beyond the cost or kWh of energy saved, even though the tests are designed to include them (Cluett & Amann, 2015). Such benefits are particularly relevant to multifamily EE programmes where *reduced maintenance costs*, and *improved health and comfort* have been identified as salient results of EE improvements. When applying cost-effectiveness tests to MFA programmes, Cluett & Amann (2015) suggest that programme administrators should consider the fact that MFA property owners have different costs and financial concerns than single-family homeowners. Tenants also experience multiple benefits, and these too affect the building owner's bottom line. Participant non-energy benefits in the multifamily sector include reduced *maintenance costs, improved appliance and equipment performance and lifespans, greater property values, increased building durability,* and *increased tenant comfort, health, and safety* (ibid).

In addition, the utilities can also benefit from such programmes (McKibben et al, 2013): Customers who have *lower, more predictable monthly utility* bills are less likely to get behind on payments (Cluett & Amann, 2015). A single retrofit to an MFA can positively affect many tenants and their accounts, leading to *fewer shutoffs, reconnects, customer calls*, and *debt collection* actions. Some utility benefits, including carrying cost on arrearages and debt collection efforts, may be more prevalent in low-income programmes, so administrators should focus on them during evaluation.

Finally, there are significant *societal benefits* to account for from EE MFA programmes (ibid). For example, *reduced energy costs* for multifamily households can have a positive impact on local economic activity. Money spent on utility bills is more likely to leave the local economy than money spent on local goods and services (Stone, 2011). Research has established that some societal benefits are greater for programmes targeting low-income customers (see also the *Warm Up NZ* evaluation). These include hardship and equity benefits such as *reduced dependence on government aid* resulting from more stable employment and income (NMR Group, 2011).

Other Barriers (from all perspectives)

High transaction costs are a perennial problem with EE implementation and can undermine market uptake as well as policy performance (e.g. Mundaca et al, 2013). Even if the financial issues are resolved, the *difficulty* of finding a good contractor, dealing with the utility company, negotiating with residents, and actually having the work done can be onerous enough to make many landlords give up before they have started. A recent survey of landlords found that many cited the *'hassle factor'* - the expectation of added paperwork and other headaches as an obstacle to improving their properties' EE (Nexus Market Research, 2007). The hassle factor was also shown to be a major source of complaints in an evaluation of the UK's *Warm Front* scheme programme, aimed at energy-poor households: the second-highest complaint (after the heating performance of newly-installed boilers) was contractors 'leaving a mess' or damaging belongings (Hamilton et al, 2016).

Transaction costs are also a serious problem from the perspective of programme implementers. If work is to be done in the rental units themselves, then the programme officers and contractors must deal not only with the landlord, but also with all of the renters in the building, adding greatly to the *complexity* of the operation. This obstacle can discourage contractors from taking on work in the rental sector. However, Kennedy et al (2014) showed in a large-scale MFA retrofit pilot in Austin, that there are a number of benefits to a utility of developing and implementing a comprehensive MFA programme. The greatest may be leveraging economies of scale - a good contractor with two crews may be able to complete ten apartment units in a day, as opposed to two single-family homes (although they do also acknowledge the added complexity of such an undertaking).

Ambrose (2015) also points out that there are *local and regional housing market factors* including 'ceilings' on rent levels and property values in low value areas and associated lack of equity and income to aid investment. In Australia, the usual market failures mentioned above were exacerbated in Victoria by low vacancy rates, short-term rental leases, and a fiscal and regulatory system that favours landlords (Wrigley & Crawford, 2017). In addition, studies in the UK have identified that cold homes and poor energy performance have become regarded as the 'norm' and that *low expectations are entrenched*. There is also evidence of a *sense of impotence*, with landlords doubting the extent to which they could improve energy performance given the inherent weaknesses of ageing housing (ibid). In NZ, references to the existence of a hardship tolerant, ‘masculine pioneer culture’ have similar implications (Ambrose & McCarthy, 2019). Cultural and contextually-specific factors like this may disrupt economic rationality or even counter its existence and that influences concepts of what is regarded as rational, and what is not (ibid). This framework broadens the restricted discourse on actors in the PRS, which is commonly reduced down to 'risky tenants' and 'Ma and Pa landlords', in policy texts (Bierre et al, 2010).

In a study on landlords who volunteered to undertake *Warrant of Fitness* (WoF) certificates for their rentals in Aotearoa, participants were least likely to address identified issues with security stays on windows, and absence of ground vapour barrier (Chisholm et al, 2019). Reasons for not addressing identified issues included *cost*, but also a belief that making the improvement would *not benefit health and safety.* The authors concluded that information about housing defects appeared insufficient to encourage landlords to make improvements to their homes to meet a specified health and safety standard - and that better understanding how particular housing defects pose a risk for health and safety, and provision of funding support in some cases, may encourage people to invest in safer, healthier homes.

Finally, a general *lack of interest in EE* has limited progress for years. *Low energy prices* (in some countries, like the U.S. and Sweden in particular), *lack of understanding of EE* and *basic energy literacy*, the *invisibility* of most measures (e.g. insulation), and *competition* from more exciting topics such as renewable energy technologies have resulted in a subdued response to energy efficiency among both consumers and political figures (Williams, 2008). There is also *little data* on successful EE implementation from low to moderate-income countries (Davis et al, 2018).

Some polls have shown that energy conservation actually elicits *negative reactions* from many consumers because it is associated with *sacrifice, reduced comfort,* and *a lower standard of living*. Attitudes towards EE are more favourable than those related to conservation (e.g. Fermenias & Lindén, 2010), but still some observers have suggested finding a new name or term for EE, one that is more exciting and appealing and moves beyond the association with stale, boring concepts such as saving on utility bills (Egan & Brown, 2001).

Moreover, improving the EE of rental housing involves complex tradeoffs related to *household location decisions* (Joint Center for Housing Studies, 2015). Transportation-related energy use is a major component of a rental unit’s energy footprint, given that location determines tenants’ travel options. Improving the efficiency of the overall rental stock therefore involves not just reducing the energy use of individual units, but also renters’ transportation-related energy use.

Needs

Even though two in-depth reviews of EE programmes by U.S. utilities targeting MFAs showed a significant improvement in the number of programme offerings between 2013 (Johnson & Mackres) and 2017 (Samarripas et al), ACEEE found that total spending on multifamily programmes accounted for no more than 6% of total EE spending in the 51 selected cities. By way of comparison, sales of electricity and natural gas to multifamily properties comprised 11% of all sales in 2009 (Samarripas et

al, 2017). *Low-income renters in MFAs* continue to be among the most underserved audiences, thus there is a clear need to focus more targeted interventions on this HTR group (ibid).

To summarise some of the main needs highlighted in the literature, for renters, landlords and Behaviour Changers targeting these audiences, there is clear need for more:

- *Data*, e.g. on market / audience segmentation (e.g. Cook, 2013; McKibben et al, 2013; van de Grift et al, 2014)
- *Multiple benefits evaluation* (e.g. Elevate Energy, 2014; Cluett & Amann, 2015)
- *Understanding health & safety risks* (e.g. Howden-Chapman et al, 2008; Chisholm et al, 2019)
- *Financial incentives* for landlords and tenants (e.g. Williams, 2008; Johnson, 2013; Ross et al, 2016)
- *Simplified processes*, providing a 'one-stop shop' (e.g. York et al, 2013; McKibben et al, 2013; Samarripas et al, 2017)
- *Clear, trusted sources of information* (e.g. Samarripas et al, 2017)
- *The right delivery mechanism* (timing, medium and messenger) of information to the target audience (e.g. Coleman, 2011; McKibben et al, 2013; Karlin et al, *forthcoming*)
- *A cohesive body* that can engage with implementers on behalf of landlords and tenants (e.g. Williams, 2008; Fermenias & Lindén, 2010)
- *Clear contract guidelines* and processes (e.g. green leases, Williams, 2008; Janda et al, 2017; Rotmann & Bulut, 2018; Drehobl & Tanabe, 2019).

Dimensions
Williams (2008) points out that fragmentation affects many markets for EE, but few to the extent of rental housing. The variability extends across a number of axes:

1) *Landlords* vary in their access to capital, ownership type, investment time horizon, the size of their holdings, whether or not they occupy one of their units, and a number of intangible characteristics such as values, motivations and preferences.
2) *Tenants* also differ greatly in factors such as income, length of tenancy, demographic characteristics, and values and priorities.
3) *Buildings* exhibit diversity in characteristics such as metering type, age, number of units, heating equipment type, age and quality of the building's physical systems, technical complexity, and overall maintenance.
4) *Communities* vary by size, urban versus rural characteristics, demographic and socioeconomic factors, rental market size, vacancy rate, local resources, building type diversity, climate, and utility company type.

Differences across these four rental-specific dimensions mentioned by Williams (2008) can have a significant impact on the effectiveness of policies; that is, some policies work very well for specific types and combinations of landlords, tenants, buildings and communities and less well for others. Due to this complexity (which does not yet refer to commercial rentals!) in the rental market, it is thus rather meaningless to focus on which of the overarching dimensions (economic, technical, psychological, geographic) would be most applicable as wider contexts to focus on in the rental market. In this, more than maybe any other market, the answer is *it depends.*

Estimated size of this HTR audience
We provide estimates on total or proportional audience size, and also, where relevant, estimates of % energy usage by certain audience segments. Sometimes, audience segments can be exceedingly large but have very small energy usage, and thus energy-savings potential (e.g. certain microbusinesses). Targeting such audiences with interventions may be too costly for Behaviour

Changers, whereas other audiences may be exceedingly small (e.g. multinational commercial tenants) in terms of number, but have very high energy-savings potential.

Residential HTR rental market size

Harvard University's *Joint Center for Housing Studies* (JCHS) indicated that 37% of American households were renters in 2015 (Fredman et al, 2018). More than 20 million American households, almost 18% of households nationwide, live in apartments and condominiums in multifamily buildings, commonly defined as buildings containing five or more housing units (Johnson & Mackres, 2013). High-rise multi-unit residential buildings (MURBs) are the most prevalent source of housing in urban regions, and represent almost 12% of all dwellings in Canada, with that number expected to grow significantly over the next 20 years (Stopps & Touchie, 2019). Over half (55%) of the dwellings in the City of Toronto consist of apartment buildings. The majority of all Toronto dwellings (39%) are either mid-rise or high-rise apartment buildings of five or more storeys (Mohazabieh et al, 2016). These MURBs have been shown to be energy-inefficient due to their concrete frames, outdated building structure, and technologies - e.g., heating and cooling equipment and appliances (ibid).

In the UK, In 2017-18, the private-rented sector accounted for 4.5 million or 19% of households (UK Government, 2018). Throughout the 1980s and 1990s, the proportion of private-rented households was steady at around 10%. While the sector has doubled in size since 2002, the rate has hovered around 19-20% since 2013-14. The social-rented sector, at 4.0 million households (17%), remained the smallest tenure, following a long downward trend which has stabilised over the last decade or so. In 2017, 13% of dwellings in the social-rented sector failed to meet the *Decent Homes Standard*. This is lower than the proportion of privately-rented (25%) and owner-occupied (19%) homes. Over the last decade, the proportion of non-decent homes has declined from 35% of the stock in 2007 to 19% in 2017. This decrease was observed across all tenures but has stalled in recent years.

In Aotearoa, the number of people owning homes vs renting has been steadily decreasing. Statistics NZ (2018) estimates there were ~1.8 million NZ households at the end of June, up 1.4%, compared to June the year before. Of those, ~1.1 million, or 62%, owned their own homes, 34% rented their homes (c.f. to 25% in Australia, Wrigley & Crawford, 2017), and 4% lived in free accommodation, such as that provided by a relative. Renters were about twice as likely as homeowners to spend 40% or more of their household income on housing costs (Statistics NZ, 2019). For the June 2019 year, just over 1 in 4 (27.9%) renting households spent 40% or more of their household income on rent and other housing costs. In contrast, about 1 in 8 (12.6%) of people who owned, or partly owned, their own home spent 40% or more of their household income on housing costs. A combination of home audits and analysis of utility company data in Australia indicated that twice as many rental households used electric heating compared to owner occupied, 15–30% of rental properties have poor or no insulation and 52% of rental households report difficulties heating their homes (Wrigley & Crawford, 2017).

In Sweden, there were 4,795,717 dwellings on December 31, 2016 (Statistics Sweden, 2016). These are divided into 43% of one- or two-dwelling buildings, 51% in multi-dwelling buildings, 5% in special housing and 2% in other buildings. In multi-dwelling buildings, rented dwellings are the most common form of tenure, 59% of the total dwelling stock, while 41% consists of tenant-owned dwellings. Among 290 municipalities, rental units dominated in 260 of them. With regard to dwellings in multi-dwelling buildings, about 41% are owned by housing cooperatives, 28% are owned by municipal housing companies and 20% are owned by Swedish joint-stock companies. The remaining 11% are owned by other legal persons and private persons.

The housing sector uses about 40% of the Swedish societal energy, of which a high proportion is heating (Femenias & Lindén, 2010). Sweden has large stocks of technically-deteriorating multi-dwelling housing from the so-called *Million Homes Programme* of 1965 – 1970. Of these, 38%

are public housing, and use district heating. About 300,000 are in need of technical retrofitting - but as major retrofitting projects are scarce and only carried out in 30 to 40 years cycles (see also Samuelson, 2018), it is important that the right decisions are taken. Many of these dwellings are found in areas with social problems and the owners and managers of the stocks work under strained economic conditions (Femenias & Lindén, 2010).

Commercial HTR rental market size

Commercial real estate is property that is used primarily for business purposes (Bell et al, 2013). These buildings include segments such as lodging, retail, restaurants, office buildings, public assemblies, grocery stores, services, multifamily and warehouses (see **Commercial Sector Chapter 6** for more detail). Retail, office, and lodging buildings make up the majority (56%) of energy consumption in the commercial leased market (Rockefeller & Deutsche Bank, 2012). In the U.S., office buildings make up 24% of commercial floor space, and use 24% of commercial building energy (Rockefeller & Deutsche Bank, 2012).

Commercial buildings account for 20% of all U.S. energy use, and 50% of commercial buildings are leased (DOE, 2016). One of the HTR segments that is of most concern to U.S. utilities is renters, which comprise about 40% of the under 500 kW population of small-medium businesses in terms of annual energy consumption. Self-reported participation is 40% below the population average (Quantum Consulting, 2001). Aside from convenience stores and strip malls, renters have the lowest self-reported participation rate among aware customers, due to split incentives.

A 2019 UK survey (BEIS, 2019) identified a total of 1.83 million non-domestic premises identified across England and Wales. The building stock is extremely diverse, in terms of the building type, size of the premise, and the activities being undertaken (Janda et al, 2015).

- Approximately 1.1 million non-domestic buildings, or 60%, are rented, and use approximately 35% of the UK energy consumption (excluding industrial process).
- Though the majority of non-domestic buildings are rented, rented buildings only represent 38% of the total non-domestic floor space.
- The sectors with the highest proportion of rented buildings are retail (68%), storage (66%), industry (65%), hospitality (64%), and offices (63%).
- Across both rented and owner-occupied buildings, the five largest sectors in terms of energy consumption accounted for 70% of total non-domestic energy consumption: these were offices, retail, industrial, health and hospitality.
- In 2015, businesses used 422TWh energy, of which approximately half was used in the day-to-day running of the building stock. BEIS (2019) have identified the potential to deliver up to 40TWh of cost-effective energy savings from the building stock. The future trajectory of the PRS regulations will be key to delivering a large part of that abatement potential.
- For most businesses, 67% of energy consumption was used to provide building services such as heating, ventilation, cooling, hot water and lighting, with only 33% of energy consumption related to sector-specific activity end uses.

Estimated size of split incentives in RES and non-RES market

A report attempted for the first time to quantify the impact of split-incentive problems on residential energy use in the U.S. (Murtishaw & Sathaye 2006). The authors estimated that split incentives affect 30.4 million households in the U.S., and 31% of residential primary energy use for four end uses (refrigerators, water heaters, space heating and lighting) is affected by the problem. This study was part of a larger effort to quantify the worldwide effects of split incentives, in an effort led by the International Energy Agency (2007). The IEA study found that split incentives are responsible for a significant fraction of worldwide energy use, with the total amount varying by the type of application

and national policy context. For example, the impact of split-incentive problems on house heating in the Netherlands was found to be roughly 24.3%. By contrast, the split-incentive impact on energy use in leased office space in Japan was estimated at only 2.3%, probably because Japan has instituted regulations designed to align incentives (Williams, 2008).

Target behaviours

Residential and multi-family housing

Two types of energy end-uses have been defined in the residential sector: *building-related* and *user-related* (Guerra-Santin et al, 2018). Building-related energy consumption is the energy used for services related to the building itself, such as *space heating and cooling, ventilation and lighting*. These energy services can be directly influenced through *design* both in new and renovated buildings, and are mostly dependent on *landlord* decisions and behaviours. These energy requirements can be reduced by delivering a better design (e.g. passive design) that allows the building to retain heat gains in winter, avoid heat gains in summer, and maximise the use of natural light. User-related energy consumption is considered to be mostly influenced by the building's *occupants*. Within user-related consumption, we can find the energy used for *cooking, domestic hot water, and use of electric equipment and appliances*. Although the use of energy-efficient appliances and electric equipment could reduce the energy consumption, the purchase of such products is mostly (but not always, in the case of certain tenants) in the hands of the occupants (ibid).

The appliances and electric equipment were categorised by Guerra-Santin et al's 2018 study of Dutch MFA occupant behaviours, according to their use:

- All day appliances
- Short-use cooking appliances
- Long-use cooking appliances
- Cleaning appliances
- Entertainment equipment
- Office equipment.

Van den Brom et al (2018) discussed that *lowering the set-point temperature by 1°C* can result in a significant reduction in energy use, similar to *roof insulation*. The set-point temperature at night and in the evening has more impact on total energy use than the temperature setting during the day. They also describe Dutch research that showed that more frequent use of electrical appliances over previous years has resulted in an increase of electricity consumption. For example, more frequent *use of dishwashers* caused a decrease of gas consumption for hand washing but increased electricity use (ibid). Energy use for cooking, on the other hand, was shown to have decreased in recent years. People *go out for dinner* more often, and delivery and takeaway meals are more common in Dutch households. Obviously, residential appliance use would have increased quite significantly during COVID-19 lockdown conditions (NEA, 2020).

As McKibben et al (2013) points out, the prevalence of heating, cooling, and hot water use varies by U.S. region (also country, obviously), which will affect what behaviours to target. Depending on the climate, the greatest efficiency opportunities may be in *heating, cooling, or domestic hot water* loads. They may be in electricity, natural gas, or fuel oil. And, they may be in *building shell measures* or in *lighting and appliances*. In addition, pockets of opportunity may exist outside of the most prevalent fuel uses, for example in all-electric multifamily buildings in cold climates, where electric heating drives high wintertime utility bills. In Canadian high-rise multi-unit residential buildings, HVAC typically accounts for approximately 50% of all building energy use, so *reducing HVAC* energy use is key to managing electricity and natural gas consumption (Stopps & Touchie, 2019).

Using data from the 2009 *Residential Energy Consumption Survey*, Melvin (2018) presents empirical evidence that *landlord underinvestment* occurs in multiple categories of residential EE: *space heating*, *water heating, window thickness, insulation,* and *weatherisation*. Because these landlords did not invest at the same rate as homeowners and landlords who pay the energy bill, their tenants' energy bill was higher by nearly 2%. When combined with other researchers' estimations for appliances (Davis, 2010), *insulation,* and *thermostat responsiveness* for tenants (Gillingham et al, 2012), these results imply that renters use approximately 2.7% more energy overall due to the landlord-tenant split incentive issue. Pivo (2014) also showed that MFAs occupied by low-income renters had 4.1 fewer EE features in 2005 and 4.7 fewer in 2009 compared with other households, costing US$200-400 extra per year for most lower-income renters in multifamily buildings. There is thus a significant equity issue in the under-researched low-income MFA sector, with tenant energy use often being dependent on landlord behavioural choices (such as choosing to invest in EE, or not).

Boomsma et al (2019) pointed out that, from the limited literature on the relationship between cold / damp / mould (CDM) problems and energy behaviours, we may expect low-income households who experience CDM problems to engage in other types of ESBs to save money in order to heat their home. Householders who cannot afford to keep their home comfortably warm often live in cold homes, which are associated with condensation, damp and mould issues. The same financial struggles which make it difficult to afford heating bills could also prompt households to *conserve energy*. This was certainly found to be the case in low-income, and particularly elderly households (e.g. Howden-Chapman et al, 1999; Karatasoua et al, 2018; Boomsma et al, 2019). Occupants react to both internal and external stimuli in order to either maintain or improve their thermal comfort. Energy consumption in buildings is also affected by *window opening* behaviour of the building users and their *clothing habits* at home (Esmaeilimoakher et al, 2016; Davis et al, 2018). A study on community housing in Western Australia showed that, during day-time *adjusting clothing level* was the first action taken by more than half of the respondents (53%), followed by *closing the windows* (35%) and *blinds* (11.76%; Esmaeilimoakher et al, 2016). Interestingly, *switching on the heater* was not reported as the first action by any of the respondents on cold winter days (see also Cuppen et al, 2007 for a description of the antipodean cultural trait of "putting on another jumper" in response to thermal discomfort; also described in Australia by Willand et al, 2017). Similar results were found in summer - *window-opening behaviour* and *clothing choices* came before *turning on electric cooling* devices in most households (75% reported opening the windows first; Esmaeilimoakher et al, 2016).

The debate on EE in the housing sector in Sweden still focuses on energy use for *heating*, but discussion also emerged on energy use for *devices and lightning* and the influence of *individual behaviour* (Fermenias & Lindén, 2010). There have been a small number of pilot programmes focused on encouraging behavioural changes in multifamily residents in the U.S. (Kennedy et al, 2014; York, 2015) and Canada (Mohazabie et al, 2016; Stopps & Touchie, 2019). They typically fell into three primary categories (York, 2015), which are more related to the behaviour of Behaviour Changers designing and implementing them, rather than the targeted households:

1. *Direct installation* and related low-cost services to occupants
2. *Rebates* for common measures such as new HVAC systems and building envelope improvements
3. Comprehensive *whole-building retrofits.*

For direct installation, annual participation rates of up to 16% (of MFAs) have been achieved. For leading rebate programmes, annual participation rates reach about 10%. And for comprehensive whole-building retrofits, some programmes are reaching 1–2% of units per year (ibid).

Research has shown that, in the U.S., traditional *programmable thermostats* are only programmed about half of the time (Meier et al, 2011), with 65% of those that are programmed using overnight

set-backs and 56% using daytime set-backs. Occupancy-controlled smart thermostats present an opportunity to reduce HVAC energy use at the suite-level by *reducing terminal unit runtime* when the suite is not occupied, without having to rely on the occupant to properly programme the thermostat. Stopps & Touchie (2019) demonstrated, on average, a 17±7% reduction of HVAC system runtime using an occupancy-based control strategy, with 67% of suites demonstrating an overall decrease in HVAC system runtime.

Myrhen et al (2018) points out that energy occupant behaviour in buildings is a key issue for building design optimisation, energy diagnosis, performance evaluation, and building energy modeling due to its significant impact on real energy use and indoor environmental quality in buildings. *Heating and hot tap water* is responsible for 60% of Swedish residential energy use, lightning and domestic use, e.g. a great number of devices, for the remaining 27% (Femenias & Lindén, 2010). The behaviours mentioned by Myrhen et al (2018) include *adjusting thermostats for comfort, switching lights on/off, opening/closing windows, pulling up/down window blinds, and moving between spaces*. However, they also point out that the influence of occupant behaviour is usually under-recognised or oversimplified in design, construction, operation, and retrofit of buildings, leading to great differences in practical building energy use compared to simulation results.

Commercial energy-saving behaviours

Space conditioning (heating and cooling) and lighting represent over 50% of energy consumption in commercial buildings (Bell et al, 2013; Chester et al, 2020). As a result, most EE programmes focus on these categories. However, as we will point out in the next chapter, the complexities of the commercial (rental) sector are so much greater than the residential one. We will focus on ESBs by commercial sub-sector, building types, and audiences in more detail below.

Conclusions

Rentals make up over 60% of residential (private and public housing), and over 50% of commercial space in our participating countries. The split-incentive issue, which predominantly affects renters, is one of the toughest barriers to overcome (Williams, 2008). Due to COVID-19, additional burdens will be placed upon tenants and landlords, with a frightening rise in numbers of evictions on the horizon (particularly, in the U.S.[104]). This very large audience group (which also includes a majority of SMEs, see **SME Chapter 7** below) is now more vulnerable than ever, and needs urgent attention by Behaviour Changers everywhere.

Fredman et al (2018) also suggest that we need to deepen our discussion on whether new technologies or DSM programmes (as they are currently implemented) actually help or hurt populations that do not own typical single-family owned homes. The clearest response today seems to be, “it depends,” and thus, we need more specific research, particularly on the low-income multi-family and SME renters.

Some highlights to summarise:

- Quite simply: *renters consume energy differently* than homeowners.
- Multifamily buildings are difficult to reach because they *combine the more challenging aspects* of single-family homes and commercial buildings.
- As an aggregation of single-family homes, such buildings are occupied by *multiple decision-makers* who are apt to make diverse choices about how to live in their space, making it difficult to achieve consensus on whether and how to improve the building.

[104] https://www.bbc.com/news/world-us-canada-53088352

- Defining the *actual audience to target* in an MFA can itself be a challenge. In some cases this is the owner of a property, in others it may be a property manager or management company, it may be an individual owner or it could be a corporation or other organisation and it may be individual occupants of units, whether owners or renters.
- This makes organising an EE programme difficult, as there is *less opportunity to scale it up* quickly by e.g. working with a small number of large-scale property owners.
- Traditional utility programmes are designed primarily to overcome *financial barriers* to EE, but the most problematic barriers in the MFA sector are instead *social and structural in nature*.
- Although the *split-incentive* problem has taken most of the blame for the particularly low investment in EE for rental housing, other significant barriers are also fairly unique to this sector-for example, *power imbalances* between renters and landlords.
- Landlords prefer to invest in improvements that are *visible* to renters, such as new windows, and/or equipment required to comply with the law, rather than investing in insulation or other 'invisible' EE measures.
- Multifamily building owners who have made comprehensive EE investments report that one of the biggest project benefits - *reduced tenant turnover rates* - was totally unexpected to them. More effort should thus be placed on exploring co-benefits in rental EE interventions.
- The *time and effort* (and other transaction costs) required to search for information was often enough to discourage individuals and businesses from pursuing EE.
- Transaction costs are also a serious problem from the *perspective of programme implementers*.
- *Transportation costs* are often an additional burden for low-income renters, especially in MFA on the outskirts of large cities.
- This sector is only going to become more urgent and important to identify and engage with, once the *full macro-economic fallout from the COVID-19 pandemic* becomes understood. The potential number of evicted tenants, or small businesses unable to pay their commercial rents, may be staggering and lead to additional public health and other crises.

Chapter 6 - Commercial Sector HTR

Background

While significant gains have been made to affect residential energy-saving behaviours (ESBs), the residential sector only accounts for about 38% of total U.S. electricity use[105], and 18% of total U.S. natural gas use[106]. In the EU, domestic premises were responsible for only 27% of electricity consumption (Murtagh et al, 2014). In Aotearoa, they consume 11% of total energy and 32% of electricity (MBIE, 2019b). The commercial sector accounts for nearly as much energy use as the residential one (globally, around 20%[107]), but the amount of research, governmental initiatives, and advice for targeted behavioural interventions is far more limited. This disparity suggests that significant missed opportunities exist for potential energy savings (Chester et al, 2020).

Commercial HTR audiences can be highly varied and complex, with different barriers, motivations and opportunities to affect ESBs, and these are often not adequately addressed by Behaviour Changers (see **Gap Analysis Chapter 8**, below). Drehoble & Tanabe (2019), for example, when looking at utility-led non-residential energy efficiency (EE) programmes in organisations servicing low-income communities, found that the majority tended to offer only standardised programmes rather than specifically-targeted and designed interventions.

While a general set of EE behaviours can be studied and encouraged for the residential sector across multiple residential building types (see **Landlords & Tenants Chapter 5**, above), the diversity and complexity in the commercial sector means that there is a vast range of ESBs to consider that are specific to a subset of the total commercial sector (see Chester et al, 2020). Some of these audiences and behaviours are most certainly harder-to-reach / change than others. For example, where most commercial behaviour change literature focuses particularly on *offices and lighting* - especially on simple and cheap interventions like stickers on light switches to 'nudge' energy users to turn off lights when leaving rooms - more complex lighting-related interventions, e.g. rezoning or redesigning lighting technology with expert help (which still relies on changing decision-maker behaviours to choose to invest in such expensive measures) are significantly rarer to find in the literature, and more difficult to achieve (ibid).

To complicate matters further, different commercial sub-sectors (e.g. retail vs. healthcare vs. food services) have quite unique energy needs and uses, even if they are sometimes housed in relatively similar building types. For example, a fast food place, a clothing store, a pharmacy, and a cobbler may all be located in the same shopping mall, but they will have their own needs for lighting, hot water use, appliances, or other energy usage despite being located in the exact same building type (Chester et al, 2020). Chester et al (2020) reviewed published commercial ESB literature and identified research on the following commercial sub-sectors:

- Offices
- Retail
- Lodging
- Food service
- Health care
- Warehouse and storage
- Education (mostly schools).

[105] https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_01
[106] https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm
[107] https://www.eia.gov/todayinenergy/detail.php?id=41753

Others, such as religious worship, service (including municipal), and higher education sectors will also be included in this review, where relevant research could be identified. As it is the most-commonly mentioned and largest commercial HTR audience, where businesses can fall into all these other sub-sectors, we will separately describe **Small to Medium Enterprises** (SMEs or SMBs [*Businesses*, in the U.S. and Canada]) in the following chapter.

Definitions

The *California Public Utilities Commission* (CPUC) defined HTR non-residential customers as follows (2001): "*Underserved or hard-to-reach customers should be defined as: 1) small customers that have less than 10 employees; 2) businesses in leased space; 3) rural customers; 4) strip malls; 5) local chain or single-location restaurants; 6) 'mom and pop' restaurants and stores; and 7) convenience stores*." It should be noted here that the CPUC may have run some of the longest (since the early 1990s, see CPUC, 2018) regulatory efforts to define and engage HTR energy users. The fact that they have further broadened how to identify these customer categories in their latest iteration (CPUC, 2019) points to the expansiveness of HTR audiences across the non-residential sector, but also the difficulty programme managers have had to engage them successfully. All commercial sub-sector definitions can be found in **Appendix C.**

Audience characteristics

Types of Audiences

Compared with the residential sector, it is a lot less straightforward to identify which HTR audiences are targeted, and how, in non-residential sector EE studies. There is a lot less research on energy use and occupant behaviour in non-residential buildings and, particularly, on staff energy behaviours in organisations (Morgenstern, 2016; Steddon et al, 2016). The lack of segmentation and targeted audience characterisation by most studies basically makes the majority of this sector HTR (you cannot reach who you haven't clearly identified, or whose barriers and needs you don't understand). One UK government smart meter study (BEIS, 2017a) at least attempted to use cluster analysis to segment different commercial sub-sectors into clusters (see Figure 11 below).

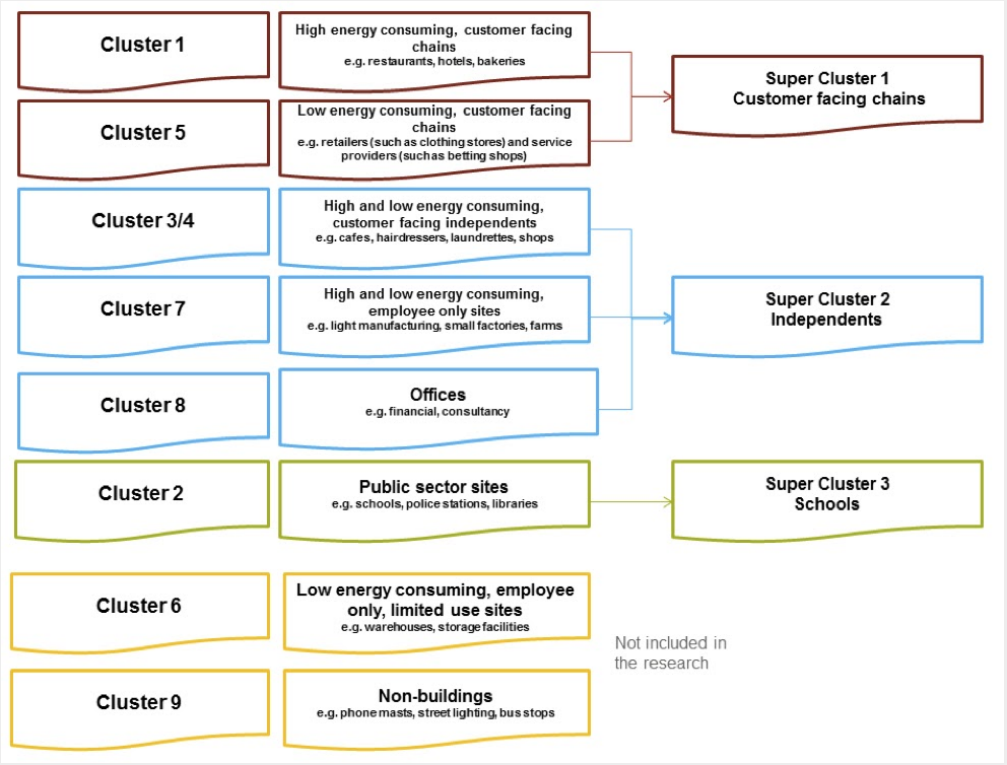


Figure 11: Cluster analysis of different commercial sub-sectors in the UK (Source: BEIS, 2017a).

Steddon et al (2016) point out that a similar variety of factors that are important in understanding residential energy-use behaviours (including contextual, socio-demographic and psychological factors) are also significant in non-residential settings. However, we cannot provide individual non-residential audience characteristics based on demographics or psychographics, as we did in the residential sector, because the audiences are so complex and heterogeneous. One study focusing on low-income non-residential EE interventions (Drehobl & Tanabe, 2019), for example, showed that programme implementers used numerous definitions to identify target communities, employing factors such as *household income, housing costs*, and the *number of individuals receiving help* from social support programmes. About a third of the EE programmes specifically targeted *buildings under a certain size* or those that use *less than a certain amount of energy*, which helps identify smaller businesses and buildings that are generally overlooked by traditional EE programmes - but again, not at a sub-sectoral or business-type level.

When looking at *equity* as a main motivation to create EE programmes for the commercial and industrial sector, VEIC (2019) also highlight a lack of metrics from these sectors. The most sophisticated metrics they found include (but are not limited to) *racial and ethnic* diversity, contracts with *women-owned businesses,* and *relationships with community organisations in underserved* areas. In another example, *job creation* was used as a key metric.

Locus of Decision-making

An important distinction that needs to be made is who is in charge of making energy-saving decisions (the so-called 'Behaviour Changers', see Rotmann, 2016) and who is targeted with EE or behavioural interventions (so-called 'Audiences', see Karlin et al, *forthcoming;* or 'Energy Users', see Rotmann, 2016). In the commercial sector **Gap Analysis Chapter 8** (below), we differentiate between: *External Behaviour Changers* (boards, policy makers, regulators etc.), including building owners and property managers; and *Internal Behaviour Changers* such as senior management, building operators and facility managers, sustainability or green teams, and custodial and cleaning staff (although they are often externally contracted). *Energy users* are all employees, and often also (external) visiting customers / contractors / clients. Each of these audiences have different mandates, knowledge, opportunities and impact on energy use in various commercial facilities, and unless the different roles are clearly identified and the locus of decision-making is outlined in a study, it becomes hard to untangle which audience has been targeted and why, and also, how hard-to-reach they actually are (see also CSE & ECI, 2012; Janda, 2014; Wolfe et al, 2014; Goulden & Spence, 2015). Andrews & Johnson (2016) also categorised articles on business energy behaviour as: *individuals* within organisations, *organisations*, and *institutional forces* influencing organisations' behaviour.

Parag & Janda (2014) highlight an important group of (external or internal) Behaviour Changers, so-called '*Middle Actors*'. Their function, - as opposed to 'intermediaries' who function solely as go-betweens - is to act with their own *agency* (the ability and willingness to make free choices) and *capacity* (the ability to enact those choices) to influence organisational decisions from the 'middle-out'. Yet, Parag & Janda (2014) also point out that middle actors are usually overlooked because policy makers tend to concentrate either on the big actors ('top') such as energy utilities, which have the capacity to make or influence many changes but often lack agency, or the millions of small energy consumers ('bottom'), which have the agency to decide on many changes but often lack the capacity to exercise them. In addition, these middle actors are often in better moral, financial, technical or social positions to enable and facilitate the action of other actors, with qualities that 'top actors' (are perceived to) lack, and' bottom actors' appreciate, such as *trustworthiness, legitimacy,* and *ability to shape social norms* and practices, as well as *providing relevant resources* (ibid). Similar roles from the behavioural socio-ecosystem are outlined by Rotmann (2017a).

It should be noted here that just because certain positions allow for the possibility of being Behaviour Changers who can influence energy users' behaviour, does not mean that they regard themselves as such, or have the mandate or opportunity to do so (Rotmann, 2016). Often, individuals holding significant influence in their organisations, including responsibility for energy management, are chosen for more in-depth study (Hampton, 2019). However, dealing primarily with one individual can be a limitation when wishing to bring about wider organisational change (ibid). In addition, it needs to be noted that employees and other energy users can also be Behaviour Changers (e.g. *Energy Champions*) and that all employees, including senior management, sustainability and facilities staff are obviously also Energy Users in any given business.

CSE & ECI (2012) used the following decision-making framework in their rapid evidence assessment of the non-residential sector in the UK:

a) *Individual* - the small dots within the various organisational subcultures
b) *Subcultural* – the groups within the organisations often organised by job role
c) *Organisational level*
d) *Socio-technical external context*, imagined as a landscape constituted by the interaction of
e) Various kinds of factor in *four domains*, characterised as:
    1) Material domain
    2) Market domain
    3) Social and cultural domain
    4) Regulatory and policy domain.

Their framework suggests that an organisation's energy behaviour is shaped by five levels of activity :

1) The *decision-making* and activity of individuals
2) The *interactions* between the various subcultures within an organisation
3) The *independent 'life'* of the organisation inscribed in its procedures, history and ethos
4) The *relationships* that the organisation maintains with other organisations in its supply chain
5) The *socio-technical context* constructed by the interaction of various types of factors.

Important considerations regarding internal and external audiences in different sectors

Offices

Steddon et al (2016) note the importance of engaging *internal energy-using* employees through all stages of an energy-saving programme, including through participatory interventions which facilitate continual employee involvement. The role of office management and organisational decision-making, and the attitudes such decision-makers personally hold are also important in creating energy-saving opportunities. Opportunities also exist for human resource management to support the idea that managers are the gatekeepers to environmental performance in office environments (ibid).

Lodging

One challenging aspect specific to the *lodging* sub-sector (other than, say, the health sector, which also 'accommodates' patients and has 24/7 operations) is how much of the footprint of energy use is really under the domain of the customer, an *external energy user,* not the business (Dong et al, 2016; Chester et al, 2020). Dong et al (2016) refer to the "unpredictable behaviour of customers" as a main influence over the difficulty of quantifying energy usage in hotels and that occupancy rates are the most important variable to predict energy usage. They also modelled up to 25% energy savings from hotel customer behaviour change. Although tourists are more and more interested in so-called ecotourism offers, perceiving a moral obligation to visit green hotels (Chen & Tung, 2014), many hotel guests still engage in energy-wasteful behaviours, such as leaving lights and air conditioning on when

leaving their rooms (sometimes combated by hotels by automating this behaviour, e.g. by having to remove the room key which switches off the electricity to the room). This is why a lot of effort has gone into creating energy-saving campaigns using social norms and nudges for hotel guests[108] (Goldstein et al, 2008; Bohner & Schlüter, 2014; Reese et al, 2014; Chang et al, 2016; Nisa et al, 2017).

Less effort has been placed on changing behaviour of *internal energy users*, such as those involved in managing turnover, housekeeping, and lobby / reception / common areas[109] (but see Dong et al, 2016). However, one study (Cingoski & Petrevska, 2016) found that hotel managers have very positive perceptions on sustainability and pose high awareness of the benefits, even though they may still lack adequate knowledge to perform EE behaviours, and another study (Said et al, 2017) promotes focusing on housekeepers for behaviour change interventions.

Restaurants

Restaurants, on the other hand, see most of their energy use coming from employees (*internal energy users)* in the form of cooking and food preparation (Miller & Othmar, 1994; Chester et al, 2020). These employees are often actors with a great amount of agency over energy use but little incentive to reduce it, especially as some behaviours (e.g. *turning down burners when not in use*) may be perceived by them to be inconvenient. A real challenge comes from having those in the restaurant with the stakes (the business owners and/or managers) being able to convey and enforce these behaviours over those audiences who have the most impact (but least motivation), their staff.

In addition to staff, there are other *external Behaviour Changers* with a lot of influence over EE decision-making: dealers and suppliers of kitchen equipment; distributors; manufacturers and reps; and design consultants[41]. One study at least pointed out the importance of customers' perception of green practices of the restaurant and customers' behavioral intentions to the restaurant, including their own green practices (Jeong & Jang, 2010). Improving the green, corporate image of a restaurant is also thought to improve customer loyalty (ibid).

Healthcare

Healthcare is an area where saving energy is just not a top concern, as the main motivation is (rightfully) the health, comfort, and wellbeing of patients (Cowen et al, 2017; 2018). While nurses and doctors can be great agents for behavioural change (e.g. to ensure speedy recovery or prevent relapse), if they feel they have to sacrifice any (time for) patient care to enforce energy efficiency, then those behaviours will be ignored. Even those tasked with energy management in a hospital (e.g. building operators; ibid, and Morgenstern, 2016) see patient care as their number one mandate: Their priority is to ensure constant access to energy services, with EE improvements often being an afterthought (see Cowen et al, 2017; 2018). Another challenge comes from the fact that hospitals never close, making them different to many other commercial operations, including other areas in health care such as doctors' offices (EPTA, 2007; Chester et al, 2020). Finally, even though it would seem that the significant monetary savings from EE programmes (up to US$4m per year in the case of the *Atrium Health* case study) would offer a great incentive to focus on reducing more energy waste, for CFOs and other decision-makers it is multiple steps removed in cause and effect, and the impact is perceived to be (or actually just is) rather small in the end. Thus, this consideration often holds very little weight with health care decision-makers.

Morgenstern (2016) points out that socio-technical constraints on departmental workings should take account of the shared use of spaces between teams, the available local knowledge on the control of building services and equipment, the morale within the organisation, as well as the suitability of the

[108] https://www.psychologicalscience.org/observer/dont-throw-in-the-towel-use-social-influence-research
[109]https://www.facilitiesnet.com/green/article/Hospitality-Employees-Play-Big-Role-In-Sustainability-Efforts-Facilities-Management-Green-Feature--13929

proposed interventions. She promotes collaborative efforts between energy managers and interested clinicians as well as health administrators and equipment technicians, something Cowen et al (2017; 2018) successfully brought to practice in their *Energy Connect*[110] behaviour change pilot.

Education

Education is the second-largest consumer of energy in the service sector (Gormally et al, 2019). In this sub-sector, we have to differentiate between *schools* and *universities* although both have important potential Behaviour Changers in their students and teachers. However, most of the behavioural interventions taking place in universities, usually describe them as 'office buildings' (e.g. Scherbaum et al, 2008; Miller, 2013; Murtagh et al, 2013; Dixon et al, 2015; Cobben, 2017), with the exception of Gormally et al (2019) who focus on 'research labs'. The majority of these trials focused on employees, particularly of the tech departments, and/or students - especially when it came to shutting down ICT equipment when not in use (e.g. Miller, 2013; Murtagh et al, 2013; Cobben, 2017). However, Cobben (2017), in a comparative analysis of three different universities' ESB trials, points to the importance of involving other *internal Behaviour Changers*, especially from leadership as well as the student body, in the roll-out of such interventions.

The UK government (BEIS, 2017b) found that day-to-day energy management decisions which did not involve large sums of money were typically the responsibility of the business manager and, where they existed, the energy manager. The head and the board of governors would be involved in decisions involving larger sums. The Senior Leadership Team was important in securing the commitment of the school to EE and making any changes in culture that would support energy management. Site managers, teaching staff, students and caretakers who tended to have a greater knowledge of, and responsibility for the plant, such as the boilers and heating systems, also played an important role in the implementation of energy management decisions. External actors that were reported as playing some role in energy management included local authorities and energy brokers and their energy suppliers. Although most of the schools had been approached by energy consultants, there was little take up of the services on offer.

Energy costs loom large in school district budgets, comprising the second-biggest operational expense after personnel, and energy is a vital input in managing school buildings and optimising the learning environment for students (Crosby & Baldwin Metzger, 2013). The U.S. *Department of Energy* (DOE)[111] has found that at least 25% of energy consumed in schools is wasted - and that between 5-15% of that wasted energy could be saved with no-cost behaviour change measures (EPA, 2011). Co-benefits highlighted from improving EE in K-12 schools, aside from reduced energy costs, are: increased economic benefits; demonstrating leadership; improved student performance; improved indoor air quality leading to less absenteeism; improved security and safety and better teacher retention, reduction in insurance costs and legal liability, and, not to ignore its potential for impacting long-term societal change, the positive educational influences on young children (EPA, 2011).

The U.S. *Environmental Protection Agency* (EPA) points out that a key element is effective education that engages and trains *students* who have a huge potential impact over energy use - both, by being enthusiastic champions and due to misinformed ideas around keeping schools 'warm and friendly', thus often leading to inefficient energy behaviours. Another issue is that most adults within a school rarely know how much the school is spending on utilities, and this knowledge gap keeps faculty and staff from being proactive (EPA, 2011). Raising awareness among all building occupants is just as important as working with custodial and facilities staff to ensure EE maintenance and operations (Crosby & Baldwin Metzger, 2013). However, like in the residential sector, staff operating in service

[110] https://www.toolsofchange.com/en/case-studies/detail/718/
[111] https://www.seenmagazine.us/Articles/Article-Detail/articleid/4371/including-students-in-your-school-8217-s-energy-program

sectors such as schools also suffer from competing priorities and mandates, where there is simply little time for energy-saving activities (unless specifically mandated by e.g. school board or curriculum).

Rural schools represent about one-third (32,000) of the public schools in the United States (DOE, 2019). Despite, or maybe because of the remote locations and under-resourced facilities, rural schools are characteristically known to be collaborative and intentional problem solvers. However, they also face some unique challenges, due to their smaller populations; by falling into a 'service black hole', with large equipment where specialised systems maintenance personnel is located far away in urban centers; but also because many state-level and utility financial incentives are not developed with the rural school or facility manager in mind (ibid).

Retail

Grocery store facilities are among the top three facility types for energy use intensity and number one for electrical use intensity in the U.S. (EIA, 2013). However, with low profit margins it can be difficult for grocers to make large investments that result in significant energy savings to benefit their overall bottom-line (Geers et al, 2014). Christina et al (2015) and Janda et al (2015) point out how little research has been done into behaviour change and workplace practices in the retail sector. Janda et al (2015), with their *WICKED* research project on EU retailers, included energy suppliers, retail property owners, landlords and tenants, business support groups, and energy advice companies as project partners (most are *external Behaviour Changers*). Christina et al (2015), on the other hand, describe an *internal energy users* Energy Champion system in a major UK retailer. This was a network of volunteer staff nominated to undertake additional training in EE to influence their store peers. As part of their intervention, they redesigned jobs previously managed through the *Energy Champion* network to incorporate existing energy tasks into appropriate departmental management roles. Their findings demonstrated divergent perceptions of energy management in the organisation and highlighted misconceptions around energy strategies, building management and goals.

Christina et al's (2015) systems research has also highlighted the perceived problem of multiple goal conflict in reconciling internal energy management and customer goals: Building EE strategy is generally concerned with adherence to set lighting times and heating / cooling set-points, and ensuring that staff take responsibility for energy-savings actions. However, in retail organisations these priorities have the potential to overlap with concerns over customer comfort in shops and staff availability to serve their customers (see also Chester et al, 2020 for examples). Janda et al (2015) point out that behavioural classification is one of the possible analyses that can be performed with the presence of big electricity meter data sets. Detecting groups of customers with similar patterns of energy consumption can be helpful for e.g. detecting failures and discovering fraudulent usage or applying focused marketing (ibid). It could, of course, also be used to help identify customer segments for targeted EE messaging.

Warehousing

When looking at the *warehouse* sub-sector of commercial operations, these businesses have the unique characteristic that their operations don't have any *external energy users* (e.g. customers / patients / guests). With that in mind, the opportunity to enhance EE behaviours should be more straightforward as all relevant actors can be more easily compelled and motivated, but to do so, highest-impact behaviours must first be identified (Al-Shaebia et al, 2017; Chester et al, 2020).

Industrial and manufacturing

In the *industrial and manufacturing sector*, Mahapatra et al (2018) assert that very little research has been done to understand the barriers and opportunities to influence behaviour of production workers and the corresponding energy-saving potentials. They provide an example of a Swedish *Volvo* manufacturing plant where worker behaviour change caused a 10% reduction in plant energy use.

This was managed by engaging the different Behaviour Changers within the company, like the Environmental Manager, Operational Leader, Production Leaders and Group Leaders. Each had different responsibilities to achieve changes in production practices and worker habits. Fawcett (2010), in his survey on the 'unconstrained'[112] commercial sector in the UK found that manufacturing sites were those least-likely to state that everything possible was being done in terms of EE.

Local government / municipalities

One study which focused on municipal behaviour change interventions (Ambrose et al, 2014) found that a centralised *Sustainability Office* was the most useful Behaviour Changer to drive different interventions across different organisations and locations. However, this top-down approach was complemented by bottom-up internal *Energy Champion*s. Additional research on state- and federal government EE and behaviour change initiatives is usually found buried in office-based campaigns.

Barriers - General

As Schleich & Gruber (2008) so rightly point out, multiple types of barriers can be found in the commercial sector, but they vary considerably across sub-sectors. The generic barriers for the commercial (and services) sector, as summarised by Schleich & Gruber (2008) fall into the following groupings: *information and other transaction costs; bounded rationality; capital constraints; uncertainty and risk; investor / user dilemma (split incentives)*. They also mentioned *bias towards projects with short payback periods*; *lack of departmental accountability of energy costs*; and *separate budgets for capital and operating costs* without full transferability of funds between budgets. BEIS (2017b) also includes *(lack of) staff compliance; building condition; perceived lack of control over energy use,* and *the ability to demonstrate impact* as general barriers in the non-domestic clusters they studied. CSE & ECI (2012) add *the way that EE savings are framed as a 'gain' compared with the theoretical counterfactual case (of not investing in EE)*; *not including non-energy benefits of EE which are critical to raising the strategic value of EE,* and they even question the wider validity of the concept of barriers in this sector (ibid):

"*The language of barriers and their removal in order to close the 'efficiency gap' assumes that organisations will behave rationally and in accordance with the classical economic model if individual barriers are removed. Instead, the conceptual framework and the evidence reviewed here suggest that behaviour is the outcome of 'socio-technical' processes which have little resemblance to market actors attempting to maximise utility in a context of limited information and market imperfections. The socio-technical view forces a more nuanced understanding of technological change which highlights, for example, that 'barrier' removal will have multiple, perhaps unanticipated, effects because a complex system has been perturbed and that efforts to remove barriers should appreciate they are often sustained by a mix of technical, market-based, cultural and social forces. Equally, it becomes clearer to see how barrier removal may be insufficient to catalyse the desired activity.*"

Despite this critique, they have continued to use barriers as a convenient, easy-to-understand concept. We will outline some other general barriers in more detail first, and then dip into specific sub-sector literature on barriers, below.

Different reporting practices

Steddon et al (2016), in their review of workplace energy-saving behaviours, point out that numerous issues stem from very different reporting practices in workplace case studies. For example, energy savings reviewed differed according to:

- Form of energy used (e.g. gas vs. electricity)

[112] The "unconstrained" sector includes both private (usually SME) and small public sector organisations falling outside of existing UK policy tools.

- Source of energy use (e.g. computer screens, work stations, lights, whole office, whole building)
- Length of time of intervention and over which the savings were sustained
- Sample size
- Experimental design (e.g. use of control or not)
- Building type (e.g. individual offices, open-plan floors, universities, schools).

As we have highlighted from the beginning in this chapter, the complexity of the non-residential sector demands more in-depth analysis and segmentation of the different sub-sectors, building types, Behaviour Changers, audiences, target behaviours and, finally, which engagement strategies and evaluation metrics and strategies are most useful when designing interventions.

Lack of access to important Behaviour Changers

Goulden & Spence (2015) rightly point out that one of the greatest challenges when designing or researching behaviour change interventions in the commercial sector is simply gaining access to participants, all of whom have jobs to do, and few have EE as their main mandate, despite their potentially large impact over energy consumption. Cowen et al (2017, 2018) highlight these issues from the healthcare sector. Nurses often have disproportionate impact over ensuring patient (thermal) comfort, which can lead to highly-inefficient energy practices. However, nursing staff are extremely difficult to engage (including by the internal Behaviour Changers tasked with energy [efficient] management, such as building operators, facilities managers and the sustainability office) for anything outside of their primary and hugely time- and energy-consuming mandate, which is patient care.

EE improvement in existing vs new commercial buildings

Even though more and more governments regulate EE or passive design principles for commercial buildings, these savings are predominantly technical interventions targeted at new buildings. Due to the legacy of existing stock, the impact of EE measures in new commercial buildings on overall energy consumption will take considerable time to realise (Mulville et al, 2017). Moreover, 80% of a commercial building's energy over its lifespan is consumed during the operation phase (Azar & Menassa, 2014), and occupants play a major role in how energy is used during this phase (Miller, 2013). However, although research has examined how cognitive biases can influence building occupants' and building operators' energy decision making, Klotz (2011) points out that these occupants and operators control only a portion of a building's energy use. Much of a building's energy performance is also related to decisions made by stakeholders (e.g. architects, engineers, contractors) during planning, design, and construction, yet the influence of cognitive biases on these pre-occupancy decisions is underexplored.

Next 10 (2009) released a study into the untapped energy-savings potential of Californian existing and new commercial buildings. In it, they separate out different barriers for existing vs. new commercial builds (see Table on page 10 for details) as follows:

Existing commercial building barriers to EE

- Agency issues - the problem with the split incentive (see discussion in **Chapter 5**, above)
- Elevated hurdle rate[113]
- Upfront capital constraints
- Information gap.

New commercial building barriers to EE

[113] A hurdle rate is the minimum rate of return on a project or investment required by a manager or investor.

- Lack of developer incentives
- Ineffective installation and inspection.

The tragedy of the commons

Several authors (Murtagh et al, 2013; Lokhorst et al, 2015; Steddon et al, 2016; Murville et al, 2017) point out some obvious differences in barriers between residential and non-residential energy behaviours: The cost of energy use in the workplace is of little relevance to most employees, whilst the sharing of facilities and appliances may create barriers to behaviour change - the so-called 'tragedy of the commons', whereby management of a shared resource is delegated to a figure with only limited means of exercising control. Masoso & Grobler (2010), in a rather shocking study of commercial buildings in Botswana and South Africa, found that more energy was used during non-working hours than working hours (56% vs 44%) - mainly because occupants left lights and equipment on at the end of the day. Janda (2014) points out that different organisations, whether tenants, landlords, or owner-occupiers, will place different emphasis on the importance of environmental performance, as will different subgroups within them. Steddon et al's (2016) review of workplace behaviours also highlights that the interaction between individual (e.g. job satisfaction; see Murville et al, 2017) and organisational factors (such as culture, organisational focus and structure; ibid) is poorly understood. Finally, since an organisation's employees are usually more numerous than household members, incentives to energy saving in the office are not so readily apparent and are thus less efficacious (Lokhorst et al, 2015).

Human behaviours vs technology solutions

Recent studies (reviewed by e.g. Azar & Menassa, 2014) show that human actions (both by occupants and facility managers) are major determinants of energy use and could hinder, and even defeat the purpose of technological investments. They argue that the lack of understanding and account of human actions has significantly contributed to the observed differences between desired and actual energy levels, even when significant 'technological' strategies are implemented in the building (ibid). As a result, designers, facility managers, researchers, and policy makers are becoming increasingly aware of the need to improve commercial building operations through energy conservation, and integrate the corresponding operation-focused solutions in energy policy frameworks (e.g. Rotmann & Karlin, 2020*)*. These solutions can include (1) *energy management strategies* by facility managers and engineers to optimise the performance of the different building systems (e.g., regular maintenance, energy audits, and energy monitoring), and/or (2) *occupancy interventions* that encourage occupants to adopt energy conservation practices (e.g., energy education and training, feedback techniques, and incentives).

Azar & Menassa (2014) describe several (human) barriers that explain slow policy adoption:

1. Building energy modeling tools adopt a systems-focused approach to energy use analysis in buildings, typically overlooking the important role that *human actions* can have in determining building energy performance.
2. Studies that considered human drivers to energy conservation are mostly qualitative, and do *not integrate a quantitative energy calculation aspect* that generates measurable results for energy policy purposes. Many studies do not translate the findings into quantitative energy savings values.
3. Research on quantifying energy savings potential in commercial buildings is *limited to few observational case studies* with results that are hard to generalise due to the small sample sizes used.

Information Asymmetry

In larger organisations, it is assumed that middle management is closer to operations and thus better informed than upper management (Cooremans, 2012). Yet, according to Cooremans (2012), middle management decisions are "*biased by bounded rationality and opportunism. This situation is known as moral hazard, a form of information asymmetry theorised by agency theory. To reduce the potentially negative consequences of such a situation for their organisation, upper management fixes a priori rules, or routines, which frame and control decision-making*." The author goes on to describe how these information asymmetries regularly lead to suboptimal investment decisions, especially around payback for EE (see also CSE & ECI, 2012; Goulden & Spence, 2015).

Goulden & Spence (2015) highlight three contrasting, and at times conflicting, rationales which shape the actions of facilities managers, important middle actors in a given organisation:

1. *Energy as a cost*, likely to be expressed in financial terms, but can alternatively be reputational or environmental.
2. *Energy as a utility*, conceiving energy as a background service, necessary for the organisation to carry out its functions.
3. *Energy as an implicit right*, where energy goes unacknowledged, but the demands made by this rationale have direct consequences on energy consumption.

These rationales are applied differently by the various tiers and specialisms of the organisation, causing further information asymmetry.

Lack of dedicated energy management / managers

Janda (2014) describes an energy manager as one "*who sees, monitors and manages energy use but, depending on the size, composition, and interests of the organisation, this management function may be served by no one, one person, an entire team, or even moved offsite*". Janda et al (2015) point to the presence or absence of an energy manager as one important indicator of organisational capacity to manage energy; an energy-reduction plan being another (also mentioned by Rohden & Thollander, 2006). A UK survey of major energy users found that 75% of respondents had at least one staff member responsible for energy management, and 62% had a clearly defined energy reduction strategy for their business (ibid).

Gormally et al (2019) also discuss how energy conservation dialogues in higher education happen across different managerial and disciplinary perspectives, thus diluting the efforts and focusing on individual behaviour change rather than exploring more systemic, contextual factors. Goulden & Spence (2015) point to both the huge importance (interfacing between senior management, an organisation's energy strategy and huge control over the building's equipment and infrastructure), and significant barriers facilities managers face. These include demands to meet workforce expectations of comfort, and a lack of support from senior management leading to marginalisation and a shortage of resources. They argue that despite, or perhaps because of, this central position, the *Facilities Manager* should not be assumed to be the energy manager – that is, an individual whose job is to optimise energy use. Instead, they describe them as "*facing a set of often-contradictory demands in their daily activities and reconciling these demands can result in energy management that, to the outsider, may appear highly irrational*". Curtis et al (2017), despite promoting targeting facilities managers to encourage EE retrofit uptake, found that *complex building ownership arrangements, poor communication skills, isolation from key decision making processes, a lack of credible business cases and information, split incentives*, and the prospect of *business disruptions* can all impact on Facility Managers' ability to drive organisational change.

Importance and 'impotence' of commercial building operators

Aside from Energy Managers, Aune et al (2008), Wolfe et al (2014), Goulden & Spence (2015), Morgenstern (2016), and Cowen et al (2017, 2018) all point out how important *Building Operators* are in energy management of commercial buildings. As opposed to energy or facilities managers, building operators are trained professionals in *Building Automation Systems* (BAS), responsible for 'operating' and 'maintaining' building systems. However, in some, especially smaller organisations the three functions can overlap (Goulden & Spence, 2015). Despite their enormous impact on the safe and efficient operation of a commercial building, they are also vastly outnumbered by building users, including the core staff of the organisations inhabiting a building and building visitors. In hospitals, for example, building users will include at least *clinical staff* (doctors, nurses, scientists in laboratories), *administrative staff* (health records staff, clerks, receptionists), *non-clinical support staff* (including cleaners, porters, security staff), as well as *patients* and their *visitors*, and contractors and vendors.

Cowen et al (2017) point out that building operators often feel overwhelmed "*juggling hand grenades and putting out fires*" with e.g. patient complaints overriding any other maintenance or repair jobs and leading to conflicting demands, with energy waste not seen as important; a lack of training in energy literacy; and highly reactive, risk-averse culture by senior management. Another issue they pointed out was that third-party vendors were often responsible for installing and implementing highly-complicated building automation systems and they rarely trained the facilities and building operations staff in how to use them to maintain optimum efficiencies. Morgenstern (2016) also highlighted the difficulty of obtaining information from clinical staff or equipment manufacturers as to whether the equipment or parts of it can be switched off, whether recalibration is necessary after switch-on, and how long it takes or whether the equipment is affected by frequent switching.

Administrative barriers (for Behaviour Changers)

Geers et al (2014) describe in some detail the difficulties utility programme administrators face, in particular with *on-bill financing programmes* for grocers. Seeing a utility is not usually accustomed to being a lender, the many different parties and complex administrative challenges pose significant barriers for roll-out (ibid).

Issues with evaluation, especially of co-benefits and energy savings potentials

There has been a continued call for better evaluation of behavioural interventions in the commercial sector from both academia and practitioners (e.g. Banks et al, 2012; Morgenstern, 2016). Importantly - and in contrast to technical measures where energy and cost savings are the main focus - behavioural EE interventions can co-generate a number of non-energy or multiple benefits (IEA, 2014); in particular, regarding *patient experience* (Gray, 2011), *employee satisfaction and morale* (Knight & Haslam, 2010), as well as *organisational image* (Pellegrini-Masini & Leishman, 2011). It is important to take into account both the 'knock-on' benefits and costs to allow for comprehensive cost-benefit analyses of behavioural interventions (Morgenstern, 2016). Energy managers often need justification as to why their organisations should invest in EE, making savings potentials and benchmarking helpful - although both methodology and terminology to determine such energy-savings potentials, especially in the more complex commercial sector, are yet to be standardised (ibid).

Moezzi & Janda (2014) point to three kinds of (relative) potentials which could be tapped to reduce building energy use: a *technical potential* (best-case efficiency scenario based on engineering and economic calculations), a *behavioural potential* (savings from simple energy behavioural changes), and a *social* potential (where social organisation is optimised for energy performance). The authors also point out, however, how far we still are from including calculations beyond the technical potential. Morgenstein (2016) and Karlin et al (*forthcoming*) recommend combining quantitative measures such as comparing utility bills with qualitative measures such as monitoring behaviours or interviewing staff.

'Invisible' energy policies

Gormally et al (2019) describe interesting ways in which energy systems can be affected by a range of non-energy policies, or what are sometimes described as 'invisible energy policies' (see also Fawcett & Killip, 2017). They define them as "*those policies that are not purposely designed to intervene in the energy system but do so as a result of the indirect implication of their design*." Their research, the first qualitative investigation into the impact of invisible energy policies on higher education (HE), reveal points of tension in relation to sustainability (including energy), and most notably relating to the neoliberalised agenda of the HE sector, and how this tension impacts on efforts to reduce energy consumption, specifically.

Campus sustainability efforts generally focus on the *physical* (buildings), *educational* (teaching, curricula, research), and *institutional* dimensions (see also Cobben, 2017) - however, embedding themes of sustainability in this way has been criticised for greenwashing due to being driven by market imperatives and economic benefits. Some of the examples Gormally et al (2019) provide how the 'neoliberalisation' of the HE sector (which led to reduced government funding, thus needing to increase student numbers to fill funding gaps) negatively impacts on energy demand, as universities are investing in more facilities, 'luxury' accommodation and 24-hour library provision, and more high-tech equipment for labs. They also point to the tension of competing demands where university researchers are attempting to 'do good science', be a 'good employee' and also a good environmental citizen, yet the universities do not recognise the limits to workplace reconfiguration available to individual researchers.

Individual behaviours or social practices?

Finally, Morgenstern (2016) points to important learnings from social practice theory (SPT). Important barriers pointed out by research on energy practices are:

- *Temporal organisation of daily life* appreciating expectations of 'convenience' and 'speed' associated with routines as well as when may be a reasonable moment to instigate change - so-called 'Moments of Change' (Darnton et al, 2011).
- *Complementing material changes with knowledge and engagement* - while technological rearrangements may seem like a straightforward and hence potentially attractive route to foster change, their role should not be overestimated (see also Stephenson et al, 2010).
- *Post-rationalisation of habits* is a good explanation for the so-called 'attitude-behaviour' or 'value-action gap' (e.g. Brown & Sovacool, 2017).

Barriers - Specific Sectors

Barriers in office buildings

Miller (2013) highlights several high-level barriers why there are few ESB interventions in the office sector: Organisations often choose to make investments in *more 'visible'* cost reduction efforts than energy; they may hesitate to invest in new technologies due to the *physical disruption, hassle and other inconveniences*; *time* is an important but often minimal resource that needs to be available in order for employees to take action; and *multiple tenants* in one office building may make certain interventions too complex. Ornaghi et al (2018) also point out that "*people favour office spaces where they can interact with the façade to regulate their indoor environment*". However, this *ability to individually change* the internal environmental conditions based on personal comfort can also lead to compromising the energy performance of an office building. Marquez et al (2012), in their review on barriers in commercial (office) buildings, outline the following principal barriers preventing adoption of EE measures: *Capital constraints and investment priorities; High implementation and transaction costs; Market structure and supply constraints; Regulatory barriers and inaccurate price signals; Information gaps; Workforce and skill barriers; Non-economic factors.*

Murtagh et al (2013), in their field trial on feedback interventions on university office workers described the following barriers to energy-saving behaviours (with the majority labelled under "*reasons not to switch things off*"):

- Don't care enough about use
- Lack of control (over heating/cooling and lighting)
- Issues of shared space
- Inconvenience / speed it takes to restart
- Technical reasons
- It's not worth it - saving is too small
- Lack of incentives
- Electricity is a commodity
- Political reasons
- Forgetfulness
- Lack of habit
- Tried, but failed.

Barriers in healthcare

Cowen (2016) and Cowen et al (2017, 2018) describe several barriers to promoting ESBs in the healthcare sector. They can be summarised as follows:

- *Extreme operational demands* (24/7 running time and year-round massive base load)
- *Decision-making and financial silos* (OPEX and CAPEX budgets usually controlled by different entities; often replacing equipment only when it is broken and usually 'like-for-like'.
- *Standards are not consistent or not consistently implemented* (vague building codes; different space types and requirements; regular changes in form and function of spaces).
- *Risk aversion* (over-engineering and slow uptake of new technology).
- *Frontline staff not engaged in energy actions or decision-making* (lack of energy training and common energy language and literacy).
- *Getting the right information to the right people at the right time* (standard metrics are lacking, communicating system requirements to external consultants is difficult).
- *Documenting information* (poor documentation of information and systems).

Barriers in the food service industry

Nonaka et al (2015) describe several barriers specific to the food service industry, particularly around the difficulty of measuring energy consumption:

- *Intangibility*: In the food service industry, dishes and related services are provided, and the dishes can be regarded as tangible goods. The service production systems, however, are intangible.
- *Heterogeneity*: In a kitchen in a restaurant, service operations still have many hand-made processes that create value. Generally, an index of EE is evaluated by measuring the amount of energy consumption and its produced value. The heterogeneity of service may lead to difficulty in defining its produced value because of unstandardised functional units.
- *Perishability*: The storage time of food is very short, and food deteriorates rapidly in a large proportion of cases in the food industry, yet it is required to provide fresh cuisine. Further, difficulties in storing pre-made food inventories lead to the implementation of the build-to-order manufacturing system. In addition, the need for refrigeration drives the highest energy consumption in this sector.

- *Simultaneity*: A degree of simultaneity in the food services industry is defined according to the location of consumption, both spatially and temporally. High demand in a short period may also make energy demand management hard.

In addition, Livchak (2017) points to the *high-stress environment where speed of service* is key; *low wages for equipment operators with no incentive for energy savings; some inefficient equipment being easier to operate than EE equipment; and EE equipment being more expensive and requiring more maintenance.* Another issue he describes is that restaurant designers have the biggest influence over the restaurant's future energy consumption, and they use foodservice consultants to specify appliances. Foodservice consultants are sometimes loyal to a certain appliance brand and may *specify inefficient appliances*.

The U.S. DOE also highlights several barriers specific to commercial kitchens:

- They regard the entire *Commercial Food Service* (CFS) sector as HTR - due to its *fragmented nature, diverse equipment supply channels* and *end use sectors*.
- In addition, CFS equipment suppliers usually stock only a limited number of EE equipment and customers usually *make replacement decisions under urgency* once equipment has failed.
- ENERGY STAR-certified equipment is also *more expensive* than standard gear.
- Both equipment suppliers and end users do *not have adequate knowledge* on the availability of EE kitchen equipment.

Barriers in the lodging sector

It is difficult to generalise and identify specific barriers in the lodging sector as the energy consumption per night spent in a hotel changes a lot (Said et al, 2017), depending on various factors such as the:

- Facilities provided
- Category of hotel
- Occupancy rate
- Geographical situation
- Weather conditions
- Nationality of clients
- Design and control of the installations.

Barriers in the retail sector

Christina et al (2015) undertook a case study with a large UK retailer. They describe various barriers pertaining to the following themes (see Table 3, p.4):

- Organisational culture
- Limited pro-environmental concern
- Lack of energy goals
- 'Energy Champion' job design misalignment
- Shop building issues
- Perception of delayed response on maintenance problems
- Need for a better support / response system for reporting faults
- Energy strategy has too much emphasis on technology-led solutions
- Potential for lack of trust between stores
- Limited consultation with staff over 'silent' interventions
- Processes / procedures misaligned
- Store staff are not engaged.

In addition, Geers et al (2014) point out that grocers are usually restricted by the availability of capital to invest in large-scale EE projects. They might only have enough funds available to complete only one to two EE measures per project, and only once savings from initial projects are realised, can the customer invest those savings into more complex projects - a process that can take up to several years (ibid).

Barriers in manufacturing industries

Rohdin & Thollander (2006) wrote a paper on identifying barriers and drivers for EE in the (Swedish) manufacturing industries. They summarise them (see Table 2, p.1838) as follows:

- *Economic non-market failure* (heterogeneity; hidden costs; access to capital; risk aversion)
- *Economic market failure* (imperfect information; split incentives; adverse selection; principal-agent relationships)
- *Behavioural* (bounded rationality; form of information; credibility and trust; inertia; values)
- *Organisational* (power and culture).

The major barriers to EE found in this specific study were: *cost / risk of production disruption / hassle / inconvenience; lack of time or other priorities; cost of obtaining information on the energy consumption of purchased equipment; other priorities for capital investments; lack of sub-metering;* and *split incentives with ESCOs*.

Barriers for low-income community-serving institutions

Audience barriers in institutions serving low-income communities may include (see Drehoble & Tanabe, 2019 for descriptions):

- *Competing priorities*
- Lack of up-front *capital and financing options*
- *Limited* energy efficiency *expertise*
- The need for enhanced *incentives and support*
- *Split incentives* with building owners
- *Mistrust and uncertainty* about programme benefits.

This is due in part to historical policies of economic and social exclusion that have left community-serving institutions in LMI communities and communities of colour with fewer resources and greater barriers to accessing affordable EE investments. Low-medium income and economically-disadvantaged communities often have similar characteristics, such as *racial segregation, high unemployment, high poverty rates, poor housing conditions,* and *lower educational opportunity*, due in part to systemic policies leading to historical economic and social exclusion (Rothstein, 2017). Policies that have acted as forms of economic and social exclusion in communities of colour in the U.S. include neighbourhood *segregation and redlining, lack of access to mortgages and other loans, mass incarceration, employment discrimination*, and the *legacy of segregated and underfunded schools*. Policies of *prohibitive lending* and *underinvestment* in marginalised communities that limited wealth accumulation for past generations continue to affect these communities today (Drehobl & Tanabe, 2019). Barriers to Behaviour Changers serving these communities and community-serving institutions are often related to the *cost to reach* them, which is higher than the cost to reach general commercial and industrial customers, due in part to the *lower savings* achieved from smaller buildings (similar to the **SME** sector, see **Chapter 7** below). Programme *cost-effectiveness tests* and requirements may disincentivise programme implementers from targeting and reaching these underserved organisations (Drehobl & Tanabe, 2019).

Needs / (co)benefits

As we have seen with other audiences described in this literature review, the literature identifying specific *audience needs* is exceedingly rare. There is (some) research into *key motivations* and *drivers* for EE and behavioural interventions in the non-residential sector (e.g. Rohdin & Thollander, 2008; Fawcett, 2010; BEIS, 2017a), and a few publications highlight non-energy co-benefits which could fulfil audience needs unrelated to energy use. The main drivers and motivations given in the literature are *reducing energy costs; being (seen as) a responsible or sustainable organisation; increases in utility prices; equipment needing refurbishment / replacement; refurbishing or moving into new buildings; improving staff comfort* (Fawcett, 2010; BEIS, 2017a).

In the U.S. K-12 school environment, several drivers of success are mentioned by Crosby & Baldwin Metzger (2013):

- *School dynamics and leadership* (faculty and staff leadership; principal support; student engagement and including custodial staff)
- *District-level support* (including data and feedback; programme assistance and providing additional partners)
- *Programme momentum* (including progress reports; clear communication and awards and honours).

Anderson et al (2013) give similar examples from a successful healthcare behavioural pilot:

- *Senior-level support*
- *An internal coordinator*
- *Measurement to prove it worked.*

Miller (2013) points out several *research needs* to improve research into ESB of commercial sector organisations, particularly around integrating individual and organisational variables into the analysis, using more than one organisation as sample sizes. Understanding of the demographics and psychographics of internal energy users (and also the Behaviour Changers designing behaviour change interventions for them) may be useful, but can be costly and difficult to achieve. Other issues, such as how long / when building occupants are using the building, firmographics and if other organisations are occupying the same building, may be more relevant. In addition, knowledge on staff comfort and perceptions around (turning off) technology is important to overcome barriers before designing interventions, and there are many co-benefits in commercial settings that can drive ESBs (e.g. increased productivity, staff retention, improved comfort, fewer sick days, loyalty and corporate pride; IEA, 2011; EEA, 2013; IEA, 2014; Miller, 2013).

Many non-residential programmes targeting low-income community organisations have a goal to serve historically underserved markets with energy-efficiency offerings, with sub-goals and co-benefits such as (see Drehobl & Tanabe, 2019 for descriptions):

- Reducing capital and maintenance costs, time spent on upkeep, and monthly utility costs
- Increasing available capital
- Improving indoor air quality, health, and indoor comfort
- Opportunity to scale up programmes
- Greenhouse gas reduction and positive environmental justice impacts
- Improving community economic stability.

Behaviour Changers targeting these communities and community-serving institutions can also benefit in multiple ways, such as (Drehoble & Tanabe, 2019 has details):

- Improving relationships between implementers and community members and between implementers and community-serving institutions
- Better outreach, partnerships, engagement, and participation in other residential or commercial programmes
- Meeting regulatory requirements (if any are in place)
- Expanding their reach and the number of customers they serve
- Reducing the risk of unpaid bills, and
- Lessen overall demand and the need for new power generation.

Dimensions

Janda (2014) points out that "*research worldwide has often followed a* physical, technical*, and* economic *approach to increasing the level of energy performance in the building sector.* Social and institutional *factors have been understudied relative to technologies, yet they hold the key to significant market transformation in practice*". From the literature reviewed here, and especially the barriers that were outlined above, it becomes clear that the social and institutional factors, in addition to *individual perceptions* around e.g. thermal comfort (which can be based on demographic factors, such as women feeling the cold more easily) and wanting a sense of control over workplace temperature (psychographic factor) are hugely important drivers for energy consumption in the commercial sector (see Goulden & Spence, 2015). That said, Janda (2014) points to the widely-recognised fact that organisations, firms, and social groups do not behave like individuals.

Approximate size of commercial HTR audiences

From a 2001 study into Californian non-residential utility customers of the under 500kW population (i.e. small-medium businesses in their definition, see Quantum Consulting, 2001), it was found that:

- *Renters* comprised 40%
- *Small businesses* were 38% (with 10 or less employees)
- *Local chain or single-location restaurants* comprised 7% (these are restaurants that have either 1 location, or have less than 5 locations that are concentrated in one part of California)
- *Strip malls* made up 10%
- *Convenience stores* were only 1%
- *Rural customers* made up 22%
- *'Mom and Pop' restaurants/groceries* comprised 5% of single-location restaurants or groceries with 10 or less employees.

Office sector

The office buildings sector "*is the largest in the commercial sector in floor space and energy use in most countries*", according to Miller, 2013. However, U.S. office buildings only make up about 18% of total commercial buildings (as well as total commercial floorspace and commercial building energy use), according to the EIA[114]. In fact, EIA (2012) found that *office buildings* were on the lower end of commercial buildings energy-use intensity at an average of 77.8 Btu/square foot compared with *food service* at 282.7 Btu/square foot, *healthcare* at 172.7 Btu/square foot, *lodging* at 96.9 Btu/square foot, and others. Despite office buildings representing a minority of the commercial sector, and being on average less energy-intensive than the rest of the sector, they are the most commonly-mentioned (Marquez et al, 2012; Paone & Bacher, 2018; Chester et al, 2020).

Retail

EIA (2012) categorises mercantile buildings in the U.S. as representing 11% of all commercial buildings, 13% of all commercial floorspace, and 14% of all commercial sector electricity consumption.

[114] https://www.eia.gov/consumption/commercial/data/2012/#b22-b33

Where food services are first in energy consumption in the U.S., food sales (grocery stores and supermarkets) are third (Billhymer, 2016). In the UK, the retail sector is the largest commercial property sector, accounting for 1 in 12 companies and employing 1 in 9 people (Janda et al, 2015).

Lodging

Hotels are one of the most energy-intensive facilities in the U.S., with correspondingly high energy costs. They are ranked among the top five in terms of energy consumption in the commercial sector and are thought to have at least 20% of energy-saving potential (Cingoski & Petrevska, 2016). Similar to the retail sub-sector, the category of lodging comprises a wide variety of enterprises that share an end goal (providing lodging) but have very different strategies and implementations, from a small bed and breakfast to a five-star resort to a college dormitory (Chester et al, 2020).

Educational facilities

Educational facilities in the U.S., according to EIA (2012), represent 14% of commercial buildings, 8% of commercial floorspace, 7% of commercial electricity consumption, and 8% of commercial natural gas consumption.

Renters and small businesses

Small businesses (under 20 kW businesses according to the Quantum Consulting (2001) definition) that were studied in the U.S. were the 23% of businesses with peak demand less than 20 kW and 3% which were restaurants and groceries. Although the under 20 kW group of customers (small businesses) comprise over 80% of the number of customers in the under 500 kW population, they only consume about one quarter of the total energy in the population.

Strip malls and convenience stores (which comprise about 15% of the SME population in California) were found to be the most underserved, i.e. those with the lowest participation rates in energy efficiency programmes. Renters and small businesses (with less than 10 employees) were found to be the two segments where the greatest emphasis should lie, as renters comprise about 40% of the under 500 kW population in terms of annual energy consumption, and small customers comprise 38% (note that 41 percent of renters are also small, see Quantum Consulting, 2001). These two segments were also found to overlap significantly with strip malls, convenience stores and local chain / single-location restaurants. Combined, renters and small customers comprised over 60% of the under 500 kW population, in terms of annual energy consumption.

Restaurants and food services

U.S. restaurants use an average of 590,000 Btu per square foot annually, twice as much per square foot as the next largest commercial user (Miller & Othmar, 1994). In fact, they use 5-7 times more energy per square foot than commercial offices (EIA, 2012). By identifying all potential efficiency behaviours and training employees on using them from the beginning, significant behavioural opportunity exists in this sector. One study (Mudie et al, 2016) identified behavioural factors and poor maintenance as major contributors to excessive electricity usage with potential savings of 70% and 45%, respectively. Efforts such as proper maintenance and no cost or low cost implementations were estimated to realise energy savings up to 20%, with retrofits, employee training, and serious energy management, up to 40% savings in some of the restaurants audited by Miller & Othmer (1994) could be realised.

Target behaviours

Commercial ESBs are highly-diverse but also patterned and linked in systematic ways to the size of an organisation, its sector, sub-sector and local and national context (CSE & ECI, 2012). CSE & ECI (2012) highlight *investment strategy* as the most highly represented behaviour type, concentrated in the industrial and cross-sector categories; *implementation of energy management systems* was the

next most represented behaviour type, concentrated in the same categories; *occupant behaviour* was most highly represented in cross-sector and higher education buildings and *innovation* was the least-researched category, again split between the industrial and cross-sector categories. They describe occupant behaviour as "*influenced by a mix of habits, conscious and unconscious drivers such as perceived norms and comfort seeking. The contexts of occupant behaviours are particularly linked to the material structure of the building and its controls, formal and informal organisational procedures and the norms operating in an organisation*." It is thus not so simple to extract specific commercial ESBs from their wider socio-technical context. We have highlighted (using *italics*) target behaviours that were mentioned in the literature, below.

The behaviour-related potential energy savings in commercial buildings was found to be in a range of 5–30% (Ahl et al, 2019). Morgenstern (2016), in her review of the commercial literature reports around 20%. Ahl et al (2019) note that ESB varies in a number of ways between commercial and residential buildings. The key differences they describe include the lack of monetary incentives for energy use reduction for workplace occupants, and the incorporation of managerial system control, group norms, role models, and work-related activities in commercial buildings. Morgenstern (2016, Table 2.3) provides an overview of behavioural studies in the commercial sector, with most research focusing on electricity only (n = 8), some on heating and electricity (n = 3), and only one focusing on heating only. Almost all of this research took place in university or office settings.

Where greenhouse gas emissions from residential buildings have gradually decreased over the last decade in the UK, emissions from non-domestic buildings have increased by 6% in the period 2007–2015 (Committee on Climate Change, 2016) - a trend which could be reversed if occupants were *using building systems and controls* more effectively (Ornaghi et al, 2018). Energy-related commercial building occupant behaviour, in its simplest form according to Hong et al (2016), includes *adjusting thermostat settings, opening / closing windows, dimming / switching lights, pulling up / down blinds, turning on / off HVAC systems, and movement between spaces*. In addition, the authors also suggest that behavioural adaptations (e.g. *clothing adjustments, the consumption of drinks and changes in the human metabolic rate*) all directly affect individual comfort which in turn influences building energy consumption.

Various direct and indirect drivers, at the individual, local, whole-space or zonal level each impact the building energy consumption differently, as does *utilisation of technologies* and *designs* that strengthen the correlation between occupants' perceived control of building systems and thermal comfort (ibid). This helps occupants to exhibit ESB without perceived loss of comfort, according to Hong et al (2016). Hong & Lin (2013) compared work styles in a single-story office building, finding that an energy-saving work style consumed up to 50% less energy, whereas an energy-wasteful work style consumed up to 90% more energy (compared with a control).

Erhardt-Martinez (2016) describes ten specific end uses in commercial sector building energy consumption, for which she describes 91 specific ESBs. She does, however, admit that this list, although differentiating between different sub-sectors and business uses, is not comprehensive (cf. with Chester et al's 2020 list of almost 600 commercial ESBs, which they also claim not to be comprehensive). One of the big issues with identifying target behaviours is that different Behaviour Changers can have very different expectations of what constitutes 'energy behaviour' and 'behaviour change' (refer to our **Glossary of Terms, Chapter 2** for the broad definition used by this Task; Lopes et al, 2012; Rotmann & Mourik, 2013; and Rotmann & Ashby, 2019). This is even more so in the non-residential sector, where complex technologies and building (automation) systems interact with various Behaviour Changers and energy users in ways that go way beyond obvious behavioural measures such as putting stickers on light switches (see Rotmann & Karlin, 2020). Thus, decision-making takes place in a context of social, technical and cultural interrelationships, a so-called

'socio-technical' landscape (CSE & ECI, 2012). We will provide some more detail on target *behaviours* (highlighted in italics) from certain sectors in some of this socio-technical context (where literature could be found), below.

Offices

Miller (2013) provides a review of ESB interventions in office settings, finding that "*the influence of building occupants was highly significant, especially where indoor and outdoor temperatures are similar*." He also found that most behavioural interventions in office environments are low / no cost and achievable with already-available technologies. However, he also notes that ESB opportunities depend on the climate and building size and that "*implementing a more moderate level of change may lead to a larger impact on energy use in the long-term than more dramatic changes*." This was particularly related to occupants' perceptions around indoor comfort and control of *heating / cooling thermostat settings* and Miller noted that physical comfort needed to be kept in mind when designing behavioural interventions - in fact, it could be used to drive energy savings. In addition, as Masoso & Grobler's (2010) study showed, a lot of potential for energy savings actually takes place during night-time, weekends and holidays. *Shutting down equipment and lighting* before leaving the office and *automating temperature controls* during those times, can thus potentially achieve greater energy consumption reductions.

Restaurants and food preparation

ENERGY STAR provides brochures for small restaurants[115] and big commercial kitchen[116] owners. They focus on refrigeration, lighting, heating and cooling and, of course, *buying ENERGY STAR-certified appliances*. Miller & Othmer (1994), in their audits of 46 restaurants in Florida found that guest comfort factors had an impact on restaurant energy consumption - particularly humidity, lighting and air conditioning. However, these authors also argued that *strict maintenance protocols* and *more appropriate sizing of refrigeration* would be of greatest benefit to energy reduction in commercial kitchens. The *layouts of the kitchens* Mudie et al (2016) studied in the UK, however, did not lend themselves to energy conservation regarding refrigeration. *Refrigerating appliances in close proximity to a heat source* (grill, etc.) were noted to have raised consumption by ~30% in some instances. The reduction of energy use from *food preparation and cooking* is seen as the largest challenge for catering establishments (Miller & Othmer, 1994; Mudie et al, 2016). Grills, for example, were found to contribute a relatively constant load to the kitchens' electricity use (12%). The grill and gas cookers are both significantly influenced by operator behaviour (ibid). Kitchen staff *not placing lids on pots and pans, leaving hot water taps running, leaving doors propped doors open* during deliveries and sometimes all day whilst air conditioning was running, and *using walk-in refrigerators to cool off* were other behaviours found to have a significant impact on energy waste (Miller & Othmer, 1994).

Healthcare

Morgenstern (2016) provides an overview of the very sparse literature focusing on energy behaviours in healthcare. EPTA (2007) point to up to 50% reduction in energy consumption from improved lighting systems, and 15% reduction in improved heating systems in healthcare. They provide a list of examples of simple and low-cost behaviours that require no capital investment, such as *control of the use of the openings (windows and doors) between spaces in different thermic conditions; periodic maintenance of the boiler; control and maintenance of the devices of defrosting and of the expansion valve of heat pumps; closure of diaphragms (dampers)* etc. Jensen & Petersen (2011), when looking at reducing stand-by energy use of medical as well as laboratory equipment found that, for some departments, stand-by electricity consumption from non-transportable equipment can account for more than 50% of annual power consumption, so there may be fewer behavioural opportunities here outside broader *energy management efforts*. The influence of clinical staff on hospital electricity use

[115] https://www.energystar.gov/buildings/facility-owners-and-managers/small-biz/restaurants
[116] https://www.energystar.gov/ia/partners/univ/download/CFS_Program_Administrator_Guide_for_Utilities.pdf

was found to vary between departments, and hospital-specific energy behaviours were limited to operating rooms as specialist areas where *manual switch-off of specialist ventilation systems and anaesthetic gas scavenging pumps* might be required (Morgenstern, 2016). In other department types, clinical staff mainly impacted on departmental electricity use through *reducing the after-hour use of lighting, equipment and space conditioning systems*, similar to actions which have been described for other building types (ibid).

Atrium Health's *Energy Connect pilot* specifically focused on building operator behavioural changes around *documenting overrides of the building automation system* (BAS); *avoiding simultaneous heating and cooling; solving comfort complaints for root causes; scheduling heating and cooling system set-backs during unoccupied times on evenings and weekends; advising vendors of control equipment of Atrium's energy expectations and then addressing any deviations during service calls* and *using the ENERGY STAR 75 design guideline* for new construction projects (Cowen et al, 2017, 2018).

Education

Most of the energy used in schools comes from HVAC and lighting (DOE, 2019), and there are some behavioural myths, particularly around lighting that can lead to inefficient behaviours (e.g. *that turning lights off and on again* costs more energy or that school children work better under artificial lights, or that *leaving lights on at night* improves security)[36]. In addition, plug and process loads account for 10% of energy usage in educational buildings. Behavioural programmes working with students and teachers have found to be highly effective[117], yet they are often not recognised by U.S. *Investor Owned Utilities* (IOUs) as *Demand-Side Management* (DSM) resource projects, decreasing the amount of funding available for these programmes[118].

Lodging

The unique aspects and offerings of the different businesses in the lodging sub-sector will offer their own opportunities for efficiency behaviours that may not be universal to other businesses within the sub-sector (Chester et al, 2020). Said et al (2017) break down energy use in hotels as follows: *heating rooms; cooling rooms; lighting; hot water use and other energy-consuming activities by guests; preparing meals; swimming pools*; and others. In a typical hotel, lighting, air conditioning and water heating represent up to 70% of total energy consumption (ibid). A lot of energy savings could be implemented via *automating controls*. Laundry is considered one of the largest consumption segments of electrical power in hotels. This explains why the main focus of research on behavioural interventions in hotels has been on *towel use for hotel guests* (e.g. Goldstein et al, 2008; Bohner & Schlüter, 2014).

Cingoski & Petrevska (2016) and Said et al (2017) also outline the following short- and long-term behaviours:

- Quick low-cost or no-cost solutions, like a *dimming system*; *changing HVAC settings in lobbies, offices and peripheral rooms; covering the pools and hot tubs to diminish heat loss; setting housekeeping procedures to motivate the staff; training the registration staff to book rooms in clusters; operating washing machines with full loads in off-peak hours; reducing laundry water temperature; regular cleaning and maintenance* etc.
- Longer-term solutions, like *recommissioning; an upgrade to more-efficient lighting (compact fluorescent lamps, light-emitting diode bulbs, 'group relamping' etc.); an installment of*

[117] https://www.pge.com/en_US/small-medium-business/business-resource-center/energy-management-articles/energy-management-articles/past-articles/lighting-the-way-for-energy-efficiency-in-schools.page
[118] https://www.ase.org/blog/funding-efficiency-programs-schools-behavior-counts

occupancy sensors; an upgrade of the chiller; the use of smart vent hoods in the kitchen; the use of efficient water heating systems; ozone and tunnel washers; heat-recovery systems; heat pumps in swimming pools; adjusting the building management system; control vending machines, etc.

Retail sector

There are countless sizes and building types of retail operations, from kiosks or boutique shops all the way up to big box shopping centres and warehouse retail outlets. Even the products being sold can influence the type of EE behavioural advice to offer, as certain aspects may be flexible for some retailers but not others (e.g., clothing shops desire a very specific and mandatory level of lighting so their clothing looks good and, even more importantly, makes customers trying it on feel good; Chester et al, 2020). That means that e.g. advice on *dimming lighting or turning lights off at night* may not be appropriate for certain mercantile sectors who display their wares in shop windows at all hours.

Warehouses

The two biggest energy consumers in warehouses (~76% of energy use) are lighting and temperature control (heating, cooling and refrigeration)[119]. Many solutions are technical and automated, though closing warehouse doors is a major behavioural intervention that can help reduce energy use[120]. One study also measured the impact of *forklift driver behaviour* on energy efficiency and found large discrepancies between different drivers and driving styles (Al-Shaebia et al, 2017). For example, t*ravelling and lifting at the same time* increased the EE by 12% when compared to the behaviour of lifting and maintaining the truck stationary. This also led to up to 9% improvement in productivity. The driver who was the most energy-efficient, was also the fastest and safest (ibid).

Industry and manufacturing

Backlund et al (2012) have introduced the “extended energy efficiency gap” concept. It illustrates that industrial EE could be better achieved by *incorporating energy management* of the innovative technologies rather than by concentrating only on the barriers to technological investment - as has been the case with the traditional “energy efficiency gap” discourse. Low-cost measures such as *staff training* and day-to-day change in energy-using practices such as *reducing idle electricity use* were shown to create significant, 10% energy reductions in a Swedish Volvo plant (Mahapatra et al, 2018).

Low-income communities-serving institutions

In a review of low-income community EE programmes, it was found that changes to *lighting / lighting use* was the most common measure, followed by *heating and cooling upgrades* and *education* and *programme support* (Drehobl & Tanabe, 2019).

Conclusions

We hope to have highlighted here the many difficulties when addressing HTR audiences and behaviours in the non-residential sector: how they differ between the many commercial sub-sectors; how many different loci for decision-making and users who are influencing energy use there are within organisations and sub-sectors; how different building and ownership types will affect energy use and associated behaviours; and how little relevant research there is in this sector that teases out those complexities, and provides detailed data and insights into audience and behaviour characteristics. Behaviour change interventions are ultimately more likely to be successful if they are compatible with the work-related interests, rules and procedures and the corporate culture of an organisation (Miller, 2013; Wolfe et al, 2014) - but in order to understand the wider socio-ecological contexts and practices, more research and data collection is essential.

[119] https://www.facilitiesnet.com/energyefficiency/article/Stock-Up-on-Energy-Savings--5388
[120] https://www.remaxdoors.com/warehouse-management-blog/4-top-tips-for-reducing-warehouse-energy-costs-and-carbon-footprint

It seems too easy to regard the entire commercial sector (minus offices, maybe) as HTR, but from the perspective of Behaviour Changers, any interventions or engagement strategies aimed at the wider commercial (sub)sectors, or even individual businesses or buildings, will suffer from very high initial costs on collecting relevant, targeted data (both quantitative and qualitative), not to mention evaluating actual (co)benefits as important drivers and motivators, and their persistence. We can only suggest using a well-defined research process, such as the one used in this *Users TCP HTR Task* (Rotmann, *forthcoming;* Karlin et al, *forthcoming*), to ensure all relevant data can be collected and used to inform the most cost-effective, and impactful interventions in this highly heterogeneous sector.

In summary:

- The commercial sector is not homogenous.
- There is a vast range of energy-saving behaviours to consider that are highly specific to subsets of the total commercial sector. The most extensive list to date, of almost 600 of them (Chester et al, 2020), is still only a subset.
- Different commercial sub-sectors have quite unique energy needs and uses, even if they are sometimes housed in relatively similar building types.
- Generalised ESB advice can thus backfire and lead to mistrust in ‘experts’. Defining target behaviours, in their wider socio-technical context, is hugely important.
- Locus of decision-making is also a very important factor in this sector that needs to be carefully assessed and understood for specific businesses and interventions.
- Heterogeneity of audiences and behaviours needs to be highlighted and teased out for specific sub-sectors and business (and sometimes, building) types.
- Audience needs are rarely assessed, and barriers are not necessarily factors.
- The socio-technical and socio-ecological landscape and context need to be assessed more carefully in commercial sector behaviour change interventions.
- Co-benefits are huge potential drivers for EE and behaviour change, yet they are rarely measured and communicated in the commercial sector.
- Equity considerations are even more underexplored in this sector than the residential one.

Chapter 7 - Small to Medium Enterprises (SMEs)

Background

The underserved non-residential small business HTR markets are important for many reasons. Most obviously, they represent around 17% of U.S. national electric usage (Meyers & Guthrie, 2006), or an estimated 13% of global energy use (Hampton & Fawcett, 2017). Collectively, SMEs, due to their large number, consume about 2.5 times the amount of energy in total as compared to large enterprises (IFC, 2012). The potential savings from energy efficiency (EE) and behavioural measures are estimated to be as high as 30% (IEA, 2015). It is very difficult to find clear delineations of energy use that can be attributed to SMEs (partly because a large percentage operate out of residences, see below) but it needs to be recognised up front that transport also represents a major source of energy consumption by SMEs (Hampton & Fawcett, 2017). It has even been suggested that travel demand management may represent the largest opportunity for energy savings in this sector, but as DECC (2016) pointed out, identifying SME travel behaviours (both, commuting and transporting goods and services) is a hugely complex and error-prone task.

SMEs are often a large active population within the local community, sometimes even recognised as “the soul of the community” (Meyers & Guthrie, 2006). They also promote innovation, put business ideas into practice, foster regional economic integration, inject economic variety, generate competition and maintain social stability (Franco & Haase, 2010). Much of the low-hanging fruit in this untapped market has not yet been picked and efficient processes with low transaction costs can reach many SMEs very quickly. Once reached, they can act quickly due to being less-encumbered by layers of corporate management and budgeting processes. Many community-based organisations (CBOs) and chambers of commerce have programmes cultivating economic development among their local businesses (Meyers & Guthrie, 2006). Helping them reduce their bills not only supports a sustainable energy policy, but supports economically-sustainable communities. A recent survey of small U.S. businesses during the COVID-19 pandemic (Bartik et al, 2020) showed how massive the scale of job dislocation in this commercial segment was, and how much worse it would be if the crisis lasted for 6 months (35.1 million projected job losses!) - a deadline that is rapidly arriving. As the market segment that is arguably hit the hardest by COVID-19 (e.g. in the U.S., over 30 million jobs in small businesses are under severe threat[121]; see also Bartik et al, 2020), SMEs need more help than ever to support their important functions in the community and recovery efforts by reducing their utility bills.

However, there are also a lot of issues with identifying and engaging SMEs for energy savings programmes - which is why the entire sector is often regarded as HTR (e.g. CPUC, 2001; van de Grift et al, 2014; York et al, 2015). This is in part due to their diversity - SMEs operate in every sector, in all property types, and vary from one-person operations with no business premises, to manufacturers with up to 250-1000 employees (in some countries). Their energy use - where, how, by whom or what, and how much - is also poorly understood (Hampton & Fawcett, 2017).

Almost half of UK SMEs are located in residential settings (Fawcett, 2010), and 25% of UK employees work from home (Hampton & Fawcett, 2017), a number that is now significantly higher, thanks to COVID-19 pandemic ‘lockdowns’[122]. We could not find similar numbers for the U.S., NZ and Sweden but seeing that, e.g. 70% of all small businesses in Aotearoa (which make up 97% of businesses overall) have zero employees (so-called ‘sole traders’), it is highly likely that a majority of them operate at least partly (i.e. when they are not out and about providing services to customers) out of their own homes. We will concentrate on small businesses with commercial premises, in this section.

[121] https://www.mckinsey.com/industries/social-sector/our-insights/covid-19s-effect-on-jobs-at-small-businesses-in-the-united-states
[122] https://www.weforum.org/agenda/2020/03/working-from-home-coronavirus-workers-future-of-work/

Definitions

All sub-sector and audience definitions can be found in **Appendix C.**

Audience characteristics

Types of Audiences

The small business market is a diverse one, spanning firms as different as hair salons, convenience stores or dentists' offices (York et al, 2015). Although houses come in all sizes, shapes, and insulation levels, on the most basic level, most have a refrigerator and a stove / oven, and other appliances common across most homes. However, with small businesses there is much greater diversity - a small restaurant will be full of kitchen equipment, whereas a nail or hair salon will depend entirely on other appliances. A small bed and breakfast may look much like a home in terms of equipment and usage (ibid). That they're often not even using energy in remotely similar ways is an ongoing challenge to better engaging the diversity of SMEs. There are also, however, common characteristics within the small commercial sector, such as their low energy use due to their small size and the constraints of limited time and money. Meyers and Guthrie (2006) state that the HTR classification can be sub-segmented into 'very-hard-to-reach' markets such as strip-malls, renters, and facilities with <10 employees (typically <20kW) with specific needs. Strip-mall businesses were only one-ninth as likely to have participated in EE programmes as the overall HTR market (Quantum, 2001).

BEIS (2017a, see Figure 11 in the **Commercial Sector Chapter 6** above) also clustered several non-residential sub-sectors. For example, the smallest of the *customer-facing chains* cluster had more in common with the *small, customer-facing independents* and the smaller *employee-only* sites and organisations occupying offices than they did with the larger chains. They lacked any form of head office or a regional structure and the decision-makers were either the owners or senior managers who might spend only a small percentage of their time on energy-related issues. One thing these clusters had in common in terms of their (lack of) approach to energy management, with a few exceptions, was consisting of small and microbusinesses where the owners were responsible for all aspects of running the business, meaning they had little time to devote to, or interest in, energy management. In addition, this lack of in-house expertise, coupled with a reluctance to engage with external experts, meant that especially the small, customer-facing organisations were often reliant on the advice of family, friends, and local tradespeople. BEIS (2017a) outlines different factors and barriers in the different clusters but provides limited information on audience characteristics. We will highlight the small number of studies that did look more in-depth into specific SME sub-sector audiences, below.

Small grocery (retail) stores

Billhymer (2016) published one of the rare studies that identified a specific sub-segment of SMEs in the U.S.: *grocery stores* that both occupy small buildings and are small businesses, where the owner is often busy keeping the store open and running basic operations. These stores include grocers, meat markets, bakeries, and convenience stores. Their electricity cost is three to four times the money spent on average for electricity by commercial office space (ibid). Over 50% of their energy use goes to refrigeration. There is a relatively low cost to establish or buy a business in this category, so there are low barriers to enter the industry, and this makes it attractive for first time business owners - including (new) immigrants.

Kenington et al (2020) describe case studies of three different small retail stores on the same street in London - a butcher, a fishmonger and a cycle shop. For all of them, retaining and attracting new local customers "coming in off the street" was seen as the main business opportunity across all three - this had implications for EE, as the premises had to be made attractive and welcoming to customers, first

and foremost. Widespread and strict COVID-19 lockdowns obviously also impacted this business model, with many businesses struggling to pay rents and utility bills for empty stores[123].

Manufacturing industry

Trianni & Cagno (2012) claim that >99% of the industrial sector in Italy is composed of SMEs. Their study into 128 Italian manufacturing SMEs showed that 70% of the sample belonged to four important manufacturing sectors, i.e. textiles, plastics, basic and primary metals, and that 85% of them had fewer than 100 employees. In the U.S., small-medium manufacturers (SMM) make up about 90% of manufacturing establishments and use about 50% of the energy consumed by industry (Trombley, 2014). Micro and small enterprises (MSEs) such as *grain millers* or *metal fabricators* in the manufacturing sector use vast amounts of energy in the production process, making them ideal candidates for EE interventions (Never, 2016).

When she studied such MSEs in Uganda, Never (2016) found that entrepreneurs' *education and training levels, gender, risk-taking ability, insufficient technological capacities to upgrade,* as well as *general business skills and managerial competence* were all relevant for MSE performance. In addition, she speculated about the condition of poverty leading to *risk aversion,* and noted that having to manage a limited budget can reduce people's ability to ignore distractions. Most entrepreneurs in this study did not keep complete books or conflated their business and family budgets. There were also clear *energy literacy* challenges and misconceptions about the meaning of EE (it was often equated with larger machines or more horsepower). The *immediacy effect* (the preference for smaller rewards in the near future instead of larger rewards at a later point in time), was also more strongly pronounced among the poor in that one study (ibid). Studies on different psychological profiles between entrepreneurs in developed vs developing countries, like this one, are exceedingly rare, and yet they may be able to provide insight into more of the world's HTR audiences.

Rural small businesses

Carter et al (2019) describe a U.S. programme promoting uptake for implementing renewable and EE projects in small, rural businesses in Kansas. An eligible business must meet several criteria including being a for-profit business, being a 'small' business as defined by the *Small Business Administration* for its particular *North American Industry Classification System* code, and being in a 'rural' area, defined as a population of <50,000 people (even so, 83% of the communities in their study came from a population of <10,000 inhabitants, and 69% have a population of less <5,000 inhabitants). *Grocery stores* accounted for the majority of facilities, followed by *food processors, lodging facilities, agricultural producers,* and *retail* (see Fig. 1 in Carter et al, 2019). Local grocery stores provide healthy foods to local communities, in addition to contributing economic benefits: "*More than 30 percent of Kansas counties are classified as food deserts – which the USDA describes as not living within a mile of a grocery store in urban areas or within 10 miles of a grocery store in rural areas*" (ibid).

Aramyan et al (2007), when studying Dutch horticultural firms, found that the adoption of EE measures increased with *farm size, family size, solvency, modernity of machinery,* and if the *farm owner has a successor*. Diederen et al (2003), in a study with a similar demographic, also found that *uncertainty about future energy prices* increased the hurdle rates and lowered the adoption rate of EE measures with Dutch farmers.

Restaurants and construction

Revell & Blackburn (2007) surveyed small firms in the UK restaurant and construction sector and found that there was very little engagement for environmental sustainability. Builders in particular highlighted the issue of sustainability being of *low interest to their clients and to architects* (this may

[123] https://www.nytimes.com/2020/09/17/business/small-business-rent-landlord.html?referringSource=articleShare

have changed somewhat since 2007). Most restaurateurs who were surveyed saw *their environmental impact as negligible* and that *other priorities* overtook the need to save resources.

Tourism and hospitality

Coles et al (2016) outline several factors that are driving energy-saving and behavioural interventions in the SME tourism sector: Rate of uptake depends on such issues as *perceived business benefits, payback periods;* the *capacity for innovation*; the *nature of the buildings and premises*; *governance structures and regulatory regimes*; and the *value sets* of entrepreneurs, including their *personal valorisation of climate change*.

Other SMEs

Janda et al (2014) discuss the difficulty of defining 'other' organisations, such as *non-profits* (which can be very large, e.g. universities). Seeing their core business purpose is not to make money but to provide some other kind of societal service (e.g. a healthier community, better education, reduced environmental impact), they are quite interesting from an energy point of view, including introducing non-economic motivations (ibid). Janda et al (2014) describe, in some detail, the understudied categories of *arts venues* (especially theatres) and *churches*. Churches in particular are interesting as they have very few 'employees', but a large volunteer force. For example, *The Church of England* has only about 100 employees, yet covers about 16,000 buildings, from cathedrals to schools to churches and vicarages (ibid). This portfolio of buildings is huge, diverse and ancient (and thus heritage listed) - and each parish is individually responsible for energy bills, maintenance and upgrades. One of the important issues this research highlighted is that survey respondents often think of 'buildings', rather than their wider organisation. It is therefore important that future research efforts take account of the connections between buildings and organisations - and their workforce (volunteer or paid), which may be invisible to a strictly 'energy and buildings' lens (Janda et al, 2014).

Demographics, psychographics and firmographics

Hampton & Fawcett (2017: Table 2) provide some characteristics to use in segmenting small businesses:

- Size of organisation
- Sector
- Location
- Business strategy
- Building type
- Technology
- Data availability
- Legal infrastructure
- Typical working practice
- Behavioural determinants.

Hampton (2019) also adds *building occupancy* (owner or tenant); *energy supply; primary energy services; business networks;* and *self-reported awareness* to this list. The IEA (2015) says that, at a minimum, *company size, ownership structure, industry sector, energy intensity, energy supply issues,* and *geographic location* need to be taken into account when designing EE interventions for SMEs.

Van de Grift et al (2014) differentiate between *vertical segmentation* (via business type which can be geo-coded), *custom segmentation* (an analysis approach that allows the user to understand how specific entities in their general market might react to a specific product or service, often based on demographic data), and *micro-targeting or propensity scoring* (which combines primary [e.g., past

participation data, billing data] and secondary data [like the vertical segmentation data] in order to predict customers' likelihood of taking specific action).

When Barton (2015) segmented SMEs in Aotearoa according to their EE potential, she identified four main perspectives:

1. *Frugal*: Those SMEs not interested in energy but who don't overuse; they switch off to save costs; and don't see a relationship between energy and core business.
2. *Do more with less:* Those SMEs not interested in energy but who don't overuse; they develop ways to use energy more productively; and don't see a relationship between energy and core business.
3. *Integrate:* Those SMEs interested in energy consumption; they develop and invest in ways to use energy more productively; and do see a relationship between energy and core business.
4. *Market it:* Those SMEs whose business is built on being energy efficient; they invest in ways to use energy more productively; and they actively build a relationship between energy efficiency and core business.

Van de Grift et al (2014) point out that "*small businesses and their decision-making process are much more akin to those of residential customers than they are to commercial or industrial customers*". Small business owners manage very constrained budgets and are driven primarily by the threat of higher electricity bills - yet they still hesitate to spend money today on future uncertain savings (Meyers & Guthrie, 2006). A Quantum/Xenergy (2001) study showed that approximately 84% of HTR customers will take no-cost actions to reduce their bill (more important than consumption), but participation drops to about 50% on measures with a 1-year payback. Understanding who makes the buying decisions in a small business is key, according to van de Grift et al (2014): "*The main questions we need to be able to answer is who the decision-makers are, what decisions they influence and how, and what evaluation criteria they use for decision-making*" (ibid). Research by the UK government (DECC, 2014) also indicates a tendency for SMEs to seek shorter leases to maximise flexibility and to be less likely to measure and keep performance records, compared with larger businesses.

Revell & Blackburn (2007) point to an interesting oxymoron in the UK small business owners they studied: despite often shunning regulatory compliance with environmental legislation, surveyed owner-managers typically felt that it was "*up to the government to take the lead on environmental issues by creating a 'level playing field' via regulation*". The authors thought that this perception of parity helps business owners to feel they are safeguarded against 'free riders', who might avoid costly environmental measures and thus gain competitive advantage, and that only regulation would provide a clear signal of what their environmental responsibilities were.

Kenington et al (2020) point to another interesting psychological factor influencing investment into EE: *where at the career cycle a small business owner stood*. Mid-career business owners with long-term plans were obviously more likely to make strategic investments than the business owner shortly before retirement who was planning to sell his shop soon. That was despite the fact that any operational cost savings would have been very beneficial given narrow profit margins. Several potential '*moments of change*' were linked to energy management, such as shop fitouts[124], energy billing and contracting and equipment replacement / maintenance (ibid). However, some trigger points were more influential than others and other variables, such as having to interact with a mistrusted actor (energy utility) for changing billing or utility contracts reduced the potential for change. Shop fit-outs, which occur very infrequently, also had the highest potential for impact to change. This paper also highlighted the

[124] Shop fitting (leading to a shop fit-out) is the trade of fitting out retail and service shops and stores with equipment, fixtures and fittings.

importance of *trust*, for example in 'independent' middle actors such as electricians who undertook general wiring and basic equipment servicing including portable appliance testing.

Finally, Hampton (2018) points to the wide variety of values which underpin SME approaches to the environment: "*These include* power values*, where motivations include wealth and efficiency, to* achievement value*s, where managers strive for positive, visible outcomes, and* universalism*, where concern for social justice or environmental issues actively motivate individuals*." He also discusses moving away from the conventional framing of SMEs as an "*amorphous population of hard-to-reach, inflexible consumers. Rather, an attention to [business] practices can help to identify opportunities for their active involvement in the energy system*."

Barriers

Small buildings and buildings with low energy use or demand are often overlooked by utility-led EE programmes, as they first have to pass cost-effectiveness tests (Meyers & Guthrie, 2006). Single-site, single-facility enterprises are among the least cost-effective for Behaviour Changers to work with, as the administrative and marketing costs per unit of energy saved are higher (York et al, 2015). Utility-led EE programmes thus usually target high energy users and larger buildings with greater energy-savings potentials. Smaller buildings have *less potential*, and their owners or tenants may also have *fewer financial resources and time to invest* in energy efficiency upgrades (Meyers & Guthrie, 2006; Drehobl & Tanabe, 2019). Small business tenants also often don't have leases that best protect their commercial interests (see **Renters and Landlords Chapter 5,** above; and Janda et al, 2014).

SMEs are also considered to have *limited capacity for economies of scale*, to suffer from *lack of information, time or expertise* to deal with regulations or administrative rules, and to find it more difficult or expensive to *access capital* than larger organisations (Fleiter et al, 2012; Nyman, 2016; Hampton & Fawcett, 2017; BEIS, 2019). *Low awareness of the overall environmental impact* of small firms (largely based on their own self-perception), and *lack of customer and supply chain pressure* has also been a major hindrance to change (Revell & Blackburn, 2007; Barton, 2015). Revell & Blackburn (2007) also describe the perception of a '*burden of environmentalism*' for small UK restaurant owners. In addition, the perception of high cost for, and lack of enforcement of compliance led to '*vulnerable compliance*' in the majority of UK SMEs. These authors also showed that barriers vary across sectors and geographies, and observed uptake is low, even for very cost-effective measures.

Dong & Huo (2017) summarise the barriers to EE containing many aspects such as *institutional construction*; *policies and regulations; technical updates;* and *market mechanisms*. In order to develop the most-effective policies for energy-efficient projects for SMEs, they argue that it is very important to fully understand and handle the massive difficulties existing in the financing processes. These difficulties include the multiple perspectives of policies, economic markets, financial institutions, behaviour and economic non-market. External factors include *market, governmental policy, technology, finance, design* and *manufacture elements*. The internal factors include the aspects of *economy, behaviour* and *organisation* related to enterprises (Sorrell et al, 2000; Cagno, et al, 2013). Dong & Huo (2017, Tables 1&4) provide a long list of barriers just related to financing EE projects in the SME market. Franco & Haase (2010) also discuss the difference of external and internal barriers, highlighting that internal factors are imminent and not satisfactorily recognised: "*Even though some owner–managers showed a certain awareness regarding their internal weaknesses, many problems such as* lacking strategy and vision, low educational levels, and inadequate social capital *are not sufficiently recognise*d."

Having *dedicated staff for energy management* and *energy reduction plans* (see **Commercial Sector Chapter 6**, above) is common in larger commercial buildings and of utmost importance to achieve targeted energy savings (Janda et al, 2014; 2015; Hampton, 2019). Either of these two dedicated

resources are sorely lacking in smaller businesses (Janda et al, 2014; York et al, 2015). In addition, one study (Carbon Trust, 2007) found that many SMEs do *no energy monitoring* at all, paying bills being their only exposure to energy use and cost - with many still having 'legacy meters', which means billing is only quarterly or annually (Janda et al, 2014). Even where smart meters are rolled out, they often *benefit the utility more* than the (small) business (Janda et al, 2015), seeing the utility derives highly-valuable customer data and most customers never even know there was a different metering system installed.

Many of the barriers faced by community-serving organisations in LMI communities (see **Commercial Sector Chapter 6***,* above) are similar to those faced by small-business owners, though some barriers are compounded by limited resources (Nowak, 2016). A 2001 Quantum-Xenergy survey of Californian small business owners showed that 49% of customers were concerned that their *actual savings will be less than the estimated savings*. Most small businesses also do not have expert energy staff making these decisions, and they are therefore at a disadvantage for *evaluating EE opportunities*. 48% of customers were uncertain about the *reliability of information* provided by non-utility firms - illustrating *mistrust* in consultants and energy auditors. 38% of small business customers said that selecting a contractor to perform the work in small facilities is *too time consuming* and *too much of a hassle* given other business priorities. 35% of customers *lacked information* about what EE technology would benefit them most and how those measures would be installed. Finally, only 33% of customers identified *lack of financing* as a barrier (cf. Fleiter et al, 2012 who found this to be the main barrier).

CSE & ECI (2012), in their rapid evidence assessment for the UK government, outlined the following differences between large and smaller organisations in the non-residential sector (though see Fleiter et al's (2012) multivariate analysis showing that company size did not affect the uptake of EE measures):

- Larger organisations are more bureaucratic and hierarchical which can lead to *principal agent problems* as facilities' staff tend to be some distance in the hierarchy from the senior managers who are setting the strategic direction of the organisation.
- However, larger organisations also tend to have *more strategy, more time and capacity to act* on energy issues and are more responsive to issues affecting their public image – including their performance on energy and environmental issues.
- Larger organisations are more inclined to develop *energy efficiency strategies and adopt certificated management systems*.
- Larger organisations are better able to *bear the costs* of participation in Voluntary Environmental Programmes and will have better *access to capital* to allow borrowing for energy-efficient investment, and will accept longer payback periods.
- *Lack of internal skills* to interpret technical information and the time and capacity to plan energy management is a major barrier for smaller SMEs.
- SMEs are also found to perceive a *'cultural' barrier* to participation in the EE and carbon mitigation agendas because they feel that their contribution is insignificant (see also Hampton, 2018), and the energy-saving agenda is more appropriately pursued by institutions and larger companies.
- The more *energy intensive* the sector is the more EE opportunities are noticed and acted upon.
- Energy consumption is also more salient in sectors which *trade directly with the public* such as retailers. This is driven by the need to maintain brand and reputation.
- *Sector* also affects energy salience in indirect ways. For example, sectors that have a major investment in the productivity of their staff, such as banking and finance, tend to lease EE office spaces as these are considered more comfortable and beneficial to staff morale and consequently these greener offices help to maintain staff productivity.

Hampton (2018) also highlights that "*external business advisors are used by over 90% of businesses in the UK - the majority of advice (75%) is provided by private sector sources, with accountants, customers, business friends and consultants each more likely to be called upon than government agents. However, most SMEs do not actively seek advice relating to their environmental performance*." Even worse, Hampton (2019) found that "*over the course of the relationships developed with SMEs, that the ways they responded to external advice were unpredictable, unexpected and often resulted in little or no reduction in environmental impact*." Coles et al (2016) also found that *energy and environmental literacy* is low amongst SMEs. This again highlights the importance of collaborating with trained, *trusted* middle actors with relevant soft skills to engage these audiences (Mourik & Rotmann, 2013; Parag & Janda, 2014; Hampton, 2018 and 2019).

York et al (2015) pointed out that barriers also tend to reinforce each other and summarised specific issues with the small business sector as follows:

- *Size*: Efforts that only result in small energy savings per location increase the administrative cost per unit of energy saved, which is compounded by the 'siloed nature of DSM'.
- *Time and money constraints*: Businesses require short payback times achieved with minimal time commitment from the business owners.
- *Diversity*: Industry subsectors and types of businesses vary in energy uses, savings opportunities, financial needs, languages spoken, and culture.
- *Lack of awareness / Mistrust*: The diversity of the sector makes it difficult for utility customers to develop familiarity with the programmes on offer, what the benefits may be, and how they work. Consequently, trust in the utility-sector programmes is low.
- *Remote decision makers*: Many small businesses are owned and operated by large franchises or chain stores where the corporate offices may be responsible for buildings and operations decisions, not the local managers.

The issues with barrier analysis in the SME market

Finally, Fleiter et al (2012) and Hampton & Fawcett (2017) point to the many inherent problems with *barrier analysis* in SMEs: it is usually based on an economically-rational model of decision-making and typically uses (self-reported) interview and survey data from small business owners and managers. These data collection methods are unlikely to capture *barriers of management support* for EE measures, something regularly mentioned in larger organisations (Hampton & Fawcett, 2017). Fleiter et al (2012) criticise survey-based analyses for typically relying on a rather *general description* of EE measures which may not always be technically feasible for a particular company. Barrier variables in surveys are often taken from *subjective judgments* by the respondents, leading to biased responses, and it is challenging to find *adequate proxies* for barriers such as bounded rationality (ibid). Plus, Sorrell et al (2004) note that the barriers SMEs face may *overlap, co-exist and interact*, and a phenomenon may fall under more than one barrier category.

Hampton & Fawcett (2017) also point out that *non-economic factors*, such as environmental values and the attitudes of individuals can be more important in SME decisions on energy than for larger organisations. The assumptions that SMEs will act economically-rationally (a long-debunked notion in other sectors, e.g. Mourik & Rotmann, 2013) have also been contested by empirical research produced for a UK government report (DECC, 2014), which found that up to 37% of EE measures required no capital investment, and yet take-up remained low. Similarly, Hampton (2019) found several reasons given why the energy management practices they knew and endorsed weren't enacted: e.g. they weren't "*the organisation's core activities of servicing clients and winning new business*" or that "*paying our staff is our number one priority*" or that "*competing priorities during the Christmas rush meant we forgot*".

In addition, what is true for one SME sector in one country may not hold for another. Trianni & Cagno (2012), in their study on barriers for EE in Italian SMEs, highlighted the need to *avoid bundling together* SMEs of different sizes and sectors, as they observed different behaviours with respect to the perception of the barriers. Van de Grift et al (2014) also highlight the need for much more *sophisticated market segmentation,* and Hampton (2018; 2019) advocates for using '*softer skills*' when engaging small business owners, with a focus on discussing values instead of simply offering technological solutions for cost savings. We will note barriers for specific sub-sectors in the SME market, where literature is available, below.

Barriers in the small retail sector

Komor & Katzeff (1988) describe *lack of feedback* on energy consumption, *separation of managers from costs, low energy costs* relative to gross sales, and other factors that distinguish this sector from the residential sector. Kenington et al (2020) also add *competition from bigger retailers* and *logistical issues* such as parking. *Energy bills* were particularly high for the food grocers, with over 80% of energy consumption from refrigeration (ibid).

Billhymer (2016), focusing on small grocers, outlined these main barriers:

- These businesses are *very time-poor*, and do not have the *human resources* to devote to considering EE. Store owners are usually doing many different jobs such as managing the cash register, accepting shipments and stocking shelves, or cooking behind the deli counter.
- Many utility contractors do not often have a *specific mandate* to reach low-profile small businesses.
- Small businesses often develop a *distrust* of a large market of enterprises that sell various services, not all of them legitimate (especially in deregulated energy markets).
- The transactional *complexity of an energy retrofit*, at both the 'sell' and 'follow-through' phases, is often daunting to a small business owner.
- A lack of *available capital* for EE investment in severely capital-constrained organisations makes even small projects off-limits.
- Store owners are often *renters* of a building or part of a building and have limited control of the HVAC systems.
- Their HVAC and refrigeration equipment is often *poor-performing, second-hand, very old, and at or beyond end-of-life.*
- Building electrical wiring is *old, overloaded with equipment, and not up-to-code*.
- The building envelope is in *poor condition*, which, depending on the season, can stress building HVAC and refrigeration equipment.

Barriers in the manufacturing sector

Trombley (2014) points out that, compared with institutional and large commercial settings where the vast majority of energy is used on lighting and space conditioning, these end uses only account for around 15% of energy use in the small and medium-sized manufacturers (SMM). The rest of the energy is consumed by the manufacturing process, the specifics of which vary greatly across subsectors (and even from plant to plant within a subsector) - needing specific technical expertise to deliver EE. On top of that, Trombley (2014) found that manufacturers were wary of changing their process lines for purposes of energy savings. Safety, production throughput, and product quality were seen as paramount; anything that might interfere with those was viewed with suspicion. All of this leads to greater transaction costs in smaller manufacturing businesses.

Trianni and Cagno (2012) point out that the greater the size of a business, and the more structured the firm's organisation is, the lower is the perception of barriers to EE. On the other hand, they also found that, in smaller businesses, the person in charge of energy issues (usually the entrepreneur / CEO),

has the opportunity of better controlling the EE behaviour of the personnel during the plant's operations. The textiles sector, under grave threat from competition in Italy, was the one most open to EE interventions. Previous adoptions of energy-efficient practices also lowered the perception of barriers. Overall, Trianni & Cagno (2012) pointed to *lack of capital* as the main barrier.

Fleiter et al (2012: see Table 1, p.867 for full barrier analysis) provided an overview of the literature examining industrial and manufacturing SMEs:

- UK breweries ranked *technology inappropriate at this site* as the most important barrier, followed by *other priorities for capital investment* and *lack of time.*
- The Swedish pulp and paper industry and foundry industry ranked *technical risk of production disruption* first.
- *Lack of capital* was perceived as more important in the foundry than in the pulp and paper industry.
- For less energy-intensive SMEs in the Swedish manufacturing sector *lack of time* and *low priority for energy efficiency* were the main barriers.
- In German SMEs, *information* on available EE measures and support programmes was positively correlated with company size. Also, energy audits conducted by engineers tended to be more effective than audits conducted by utilities or industry sector organisations, indicating that the *quality of the audit* also affects barriers.

Never (2016), in her study on manufacturing MSEs in Uganda, also pointed to several behavioural and cognitive biases as barriers to EE: The *endowment effect* describes the situation when an individual keeps an inefficient device, even though it is costly, simply because he/she already owns it. The cognitive difficulty to forego short-term temptations and instead invest in long-term benefits is due to the human tendency to *discount the future.* She also found that *poor electricity infrastructure* reduced productivity and investment in firms and that *investment costs* were the key barrier to EE technology uptake, overriding *access to information, taste preferences* and *women's roles*. She sums her research into MSE barriers to EE up as follows: "*The key barriers were short-term thinking, self-control problems [in psychology self control is about denying distractions and sticking to a plan], and giving in to temptation, habits, a bias for the status quo, and mis/trust. These barriers are often reinforced by a lack of business skills such as bookkeeping, a lack of knowledge and technical skills, a general lack of capital and difficulties in market access*."

In China, more than 40% of SMEs interviewed by Kostka et al (2013) declared themselves *unaware of energy-saving equipment or practices* in their respective business area, indicating that there are *high transaction costs* for SMEs to gather, assess, and apply relevant information. In addition, the *role of family ownership structures, lax enforcement* of government regulations and the *absence of government support* as well as a *lack of skilled labour* were also barriers with specific cultural contexts (ibid). Finally, SMEs in China have *limited access to credit*, especially since the banking sector in China remains dominated by four large state-owned banks that devote less than 10% of loans to SMEs (ibid). These kinds of cultural context factors need to be researched as part of any good 'audience definition phase' (see Rotmann, 2019; Karlin et al, *forthcoming*).

Barriers in the rural small business sector

Carter et al (2019) mainly allude to a specific barrier that was "*caused by changes in* regulations *which removed the energy assessment as an eligible cost, requiring rural small businesses to pay for the assessment without any guarantee the application would be approved. Few small businesses were willing to accept this risk; consequently, small businesses stopped applying for the grant and the USDA Rural Development office was forced to return unallocated state funding to the national level*."

Barriers in restaurant and construction sector

Revell & Blackburn (2007) showed that *initial, short-term capital costs of energy efficiency, lack of eco-literacy* (in both clients and middle actors such as architects and especially builders), *and other priorities* were the main barriers in the construction sector. In restaurants, in addition to other priorities, many energy-using appliances such as ovens, stoves, refrigerators were seen as *essential to leave running*, and intensive lighting and heating / cooling requirements were seen as *essential to customer comfort*. It was also seen that there was already so much *health and safety regulation* on these sectors, that additional environmental regulation would be too onerous.

Barriers in the tourism and hospitality sector

Coles et al (2016) highlight some interesting barriers in the literature when it comes to promoting clean energy efforts in the tourism industry: "*Rarely is there discussion about whether it would be either strategically desirable and/or feasible for tourism businesses to engineer emissions reductions by targeting particular* (fossil) fuel types *and/or to target* cleaner generation *techniques. Moreover, markets in many economies allow customers to* select suppliers and tariffs *based on their environmental credentials, not just price. Hence, it is not only reduced demand from a business, but also its sourcing practices that have the potential to result in emissions reductions.*" They also criticised that energy has been regarded too much from a *downstream perspective* (i.e. after it has entered a property), and that *aggregation* into broad energy services has obscured disparities in demand. *Micro-geographical variations* (not just country contexts) in consumption practices can also be an issue when overlooked (ibid). Like Hampton & Fawcett (2017), they warn of the entire approach being based on *wrong rational economic* ideas how to manage decision-making in this sector (e.g. that businesses habitually monitor energy use, and that they have the necessary time and competence to calculate, interpret and respond to the data). *Time stressors, competing priorities and energy illiteracy* were also issues for a sector where none of the businesses studied by Coles et al (2016) said they had *dedicated energy management*.

Barriers in the construction sector

Pardalis et al (2019) discuss the micro *construction* SMEs (MSEs) tasked with one-stop-shop (OSS) renovation services for detached houses, which account for more than 50% of the building stock in Sweden. These MSEs, however, are currently "*not prepared to take the coordinator's role in such a concept mainly due to the* perceived business risks*, the* lack of flexibility *to organisational restructuring, and* lack of resources *and management* competency *to coordinate multiple tasks and actors. Those organisations lacked* awareness *of existing policy support and* access to funding *mechanisms to try new business models*."

Needs

As we have found with other audience groups, the literature analysing specific needs is very sparse. Energy-efficiency programmes that target small businesses and other small non-residential customers often face challenges due to the small size of these customers, and the diversity of their energy needs (Drehobl & Tanabe, 2019). Successful EE programmes often tailor each programme element to the specific needs of the target market. Some programme elements are common to nearly all interventions and include *marketing, identifying energy-conservation-measures (ECMs), quantifying costs and benefits, communicating results, installing measures,* and *assuring proper payments* (Meyers & Guthrie, 2006).

A study of U.S. non-residential small business customers (Quantum Consulting, 2001) showed an overarching information need: "*SMEs want more reliable sources of information, coming from a source they find credible. They emphasised a need for customised information – in particular, they want information that will provide them with accurate estimates of energy savings*." Hampton (2018) also

underscores the need for qualified middle actors and business advisors who possess the soft skills needed to engage with SMEs around values and practices, not just cost savings and technologies.

Hampton (2019) delves into the importance of *sensemaking* in organisational theory: "*Weik's (1995) model conceives of organisations as the outcome of organising processes, as they respond to, and make sense of, collective experiences. Sensemaking research attends to how meanings, identities and knowledge are constructed through processes such as retrospection, performative enactments or the telling of stories*." This is why some empirical studies of organisations have used ethnographic methods and narrative accounts (e.g. Franco & Haase, 2010; Hampton, 2019; see also Moezzi et al, 2017) - especially in the healthcare sector (Georg & Fussel, 2000; Currie & Brown, 2003; Cowen et al, 2017, 2018). Hampton (2019) also points out that "*energy management is woven into the culture and practices of small organisations, and is influenced by the ongoing sensemaking processes which give organisations their character. Energy underpins the doings and sayings of all organisations, and although each SME in this study described its management as a peripheral and non-strategic activity, it becomes clear when seen through a practice lens that it can incorporate meanings, materials and competences which relate to an organisation's core identity*."

A common theme that emerged in the research on MSEs in Uganda was the relevance of direct, first-hand experience with EE technology for the understanding and acceptance of energy management. This leads to a decrease in uncertainty and increase in trust through direct experiences when learning switches from passive to active learning (Never, 2016). Peer learning by visiting similar businesses was also found to be particularly effective - in a training context - although the willingness to share information may be lower for competitiveness reasons outside of a training setting. It is even more important in non-English speaking countries to ensure that existing misconceptions of what energy saving and energy efficiency means are countered by direct, hands-on experience. For example, many Ugandan languages do not have a literal translation for the term 'efficiency', leading to misconceptions that e.g. it means an increase in horsepower (ibid). Seeing that many efficiency and behavioural interventions are imported into developing countries by consultants or researchers from developed nations, such cultural contexts need to be established first.

One main *driver* for EE in SMEs was found to be the prospect of *competitive advantage* (Andrews & Johnson, 2016). DECC (2014) have, in addition, found two main drivers for EE in SMEs in the UK: quite a few businesses they interviewed reported that they looked to *what others were doing on EE* to drive their own actions; and the *internal business culture regarding EE* was also reported to be an influencing factor on its uptake. Franco & Haase (2010) point to features such as "*flexibility, innovativeness, and problem-solving orientation being considered as key factors for SME success*". Other co-benefits SMEs can expect from energy-saving activities include improved competitiveness, product quality, materials efficiency, and staff commitment as well as positive relations with the wider community, lower insurance premiums, lower finance rates and improved public profile (DECC, 2014; IEA, 2015).

Estimated size of these audiences

Globally, around 99% of all businesses fall into the SME category (IEA, 2015). In the U.S., small businesses spend >$60b per year on energy costs (van de Grift et al, 2014), and use about half of total industrial energy demand (IEA, 2015). In Aotearoa, 68% of all SMEs do not have any employees (other than the business owner), and smaller businesses survive for shorter periods than do larger ones (Barton, 2015; see also discussion on developing countries below). SMEs in the UK and China are responsible for as much as 60% of industry's carbon emissions (Revell & Blackburn, 2007; Kostka et al, 2013). Industrial SMEs in China account for 41% of the total energy consumption, followed by non-industrial enterprises (29%), and they are known to be generally much less energy-efficient than

larger businesses (Kostka et al, 2013). This makes SMEs prime target markets for behavioural and efficiency interventions.

For comparison, in the majority of Sub-Saharan Africa, MSEs (a *microbusiness* in Uganda has 0-4 employees; a *small* business has 5-49 employees) represent between 70 and 90% of all enterprises; many of them are informal (i.e. not legal entities). The informal sector in Sub-Saharan Africa represents between 40 and 60% of GDP, consisting of small merchandise traders, selling and producing services, simple manufactured goods and processed food and beverages (Never, 2016). However, the majority of them fail, with 90% not existing after one year. This is partly because smaller businesses pay more for electricity and have less reliable energy access than larger firms - for example, for micro grain milling businesses, electricity costs take up 25-75% of their monthly turnover (ibid). The average life expectancy of an SME in China is also only 3.7 years, compared with the average lifespan of an SME in the US (8.2 years) and Europe (12.5 years), respectively (Kostka et al, 2013). These millions (2.4m in China alone) of small businesses in developing countries (which often create the goods and services used by developing countries) are thus clearly great target audiences for EE and behavioural interventions. Yet their small size, often rural locale, informal structure and the fact that they rarely survive long enough, make them possibly the world's hardest-to-reach markets.

Some more detailed size estimates from specific SMEs in participating countries

There is little data on SME sub-segments to support estimates for audience sizes and their energy contribution. We have outlined a few examples from the literature below.

U.S. commercial buildings that are less than 10,000 ft^2 in size account for 73% of all buildings (EIA, 2012). *Small grocery stores* (<10,000 ft^2) are both highly consumptive, and are members of the smallest and most populous size class of buildings - there are almost 154,000 such stores in the U.S. (Billhymer, 2016).

In the UK, *retail* energy use comprises 17% of the non-domestic sector, of which small shops (the majority of which are independent retailers) comprise the largest sub-sector (42% of total) - the retail sector also has a large energy-abatement potential of 34% (Kenington et al, 2020).

In 2013, there were 169,000 SMEs involved in *accommodation* and *food service* (the standard government categorisation) in the UK, and the SME *tourism* sector is estimated to account for 5% of global greenhouse gas emissions, to a large part from energy usage (Coles et al, 2016).

In Sweden, SMEs account for 30% of total *industrial* energy use. Both the relative EE potential and the cost-effectiveness for implementing EE improvement measures in industrial SMEs is higher, compared with large and energy-intensive companies (Paramonova et al, 2014). 99% and 92% of the Swedish *construction* companies are micro and small enterprises, respectively (Pardalis et al, 2019).

The impact of COVID-19 on different SME segments

Bartik et al (2020) undertook a survey with almost 6000 small business owners during the onset of COVID-19 lockdown in the U.S. It became clear that COVID-19 disruptions did not affect all businesses equally - some were deemed essential and remained open, while others were required to close. Some businesses could shift workers to telework, while others found this transition impossible (ibid). The *restaurant industry* was particularly vulnerable to a long health crisis, as we are still witnessing. Restaurateurs believed that they had a 74% chance of survival if the crisis lasted 1 month, but only a 29% survival chance if the crisis lasted 4 months, and only 19% thought they could survive the crisis lasting for 6 months (which it clearly will). In addition, climate-fighting moves such as

France banning outdoor heating on restaurant patios, have taken a step back due to the pandemic and need for social distancing[125].

Similar to restaurants, the chance of survival for firms in *tourism and lodging* dropped to 25% by the 6-month mark in Bartik et al's (2020) study. On the other hand, *banking and finance*, *real estate*, and *professional services* reported much more optimistic outcomes. These massive and never-before-seen changes to large and specific segments of the economy will obviously have an impact on HTR audience sizes and their ultimate make-up. Depending on how many millions of small businesses will not survive the extended pandemic lockdowns (this is obviously most pronounced in the U.S. and much less so less so in NZ, which first managed to eliminate community transmission of the virus by early June 2020, and swiftly managed a second outbreak in Auckland in August, allowing the economy to retain a greater level of freedom than that seen in many other countries), their owners and employees may shift from being HTR SMEs to being HTR vulnerable households.

Target behaviours

Utilities often use direct-install programmes for the HTR small business sector (York et al, 2015). Qualified contractors selected by the programme administrators do the energy audit and equipment installation, while the customers simply have to enroll in the programme and approve specific measures. This makes participation simple and easy for the small business owner (a 'one-stop-shop' approach is best according to York et al, 2015). Typical measures installed in SME programmes include *high-efficiency linear fluorescents, screw-in LED lamps and ballasts, LED display case lighting and open/closed signs, window film, occupancy sensors, and vending misers* (ibid).

Billhymer (2016) classifies ESBs related to **small grocers** into categories of *lighting, refrigeration, HVAC, envelope* and *plug load*. The most common measures offered by SME programmes in a study on non-residential low income-serving community organisations (Drehobl & Tanabe, 2019) were *LED lighting* and *heating and cooling repairs and replacements*. Some programmes also included *initial energy audits,* and *energy education* components targeting *behaviour change*, as well as measures for *kitchen equipment* (e.g., for schools and businesses), and *network/building controls* for more efficient building operations. A few programmes included additional weatherisation measures, such as *insulation and air sealing*, though this was less common.

While many programmes have historically focused on *lighting* measures (e.g. York et al, 2015; Drehobl & Tanabe, 2019), **community-based organisations** have a variety of other energy end uses beyond lighting that can achieve substantial savings, e.g. *refrigeration*, which uses high amounts of energy in restaurants, grocery stores, convenience stores, warehouses, schools, and food banks. Programmes can also explore different combinations of low-cost and high-cost measures. Measures that address *heating and cooling* end uses tend to achieve high energy savings and provide benefits (including thermal comfort improvements) to the majority of participants. Programmes that also incorporate *energy efficiency education* and other specific *behaviour change interventions* can often achieve additional and longer-lasting savings (Drehobl & Tanabe, 2019).

Two studies in the **tourism** sector have focused on specific behaviours (Coles et al, 2016): Chan et al (2008) investigated *solar control window film* as an energy saving device in hotels in Southern China, while Bode et al (2003) demonstrated the potential for vacation facilities to "be supplied CO_2-emission free with the commodities [of] *electricity, water, heat, cold (air)* and *mobility*". As discussed in the **Commercial Sector Chapter 6** on the hospitality industry above, guests also had a disproportionate influence over energy waste, e.g. *leaving towel warmers on* or *turning the thermostat up* (Coles et al,

[125] https://www.nytimes.com/2020/07/28/world/europe/france-heated-terraces-coronavirus.html

2016). Tourism businesses also had to absorb the cost of *charging personal devices* such as laptops, cameras, phones etc., removing the incentive to get guests to conserve energy.

Never (2016) in her unique study on EE measures in **manufacturing** MSEs in Uganda, shows that there is no direct payoff for no-cost options such as *switching off machines when not in use, shifting production to off-peak times* when the electricity tariff is lower or *producing in bulk* instead of restarting machinery for every new customer. Low-cost options such as *installing a Compact Fluorescent Light bulb (CFL)* have a short amortisation period of two to three months and can save approximately 2% of the electricity costs of the average MSE in her sample. *Not rewinding motors more than twice*, *using the full number of belts and pulleys* on a machine and *simple maintenance* of machinery increases energy efficiency by approximately 10%. Investments with higher initial costs and longer amortisation periods such as purchasing a more efficient machine or motor offer the highest electricity cost savings (~15–30%, depending on the type of technology, ibid).

Most SME programmes we found here focus on technologies, rather than the specific behavioural changes associated with installing, operating, maintaining and repairing those technologies (see also Hampton, 2018; 2019). Sam Hampton (2019), narrating his case studies of three types of SMEs (an owner-occupied accounting firm, a charity in part-owned, part-rented premises, and a manufacturer-retailer who rented) provides detailed interventions for changing energy behaviours such as *re-setting the master timer on the thermostat correctly to benefit from the differential tariff; home working policies to reduce commuting;* and *investing in a better heating system*. He then helped the business owners, by explaining the three-element model of practice theory (Shove et al, 2012) to better understand their energy management practices by looking at the *material* elements (e.g. of their ageing heating system), how their collective *skill sets* were underdeveloped, and that a set of negative *meanings* for their staff had thus developed. The UK government (DECC, 2014) estimated that 37% of energy-saving interventions were zero cost (see also IEA, 2015).

In their *SME Guide to Energy Efficiency*, the UK government (DECC, 2015) provides several examples of low- and no-cost energy efficiency behaviours, for example:

- *Heating / cooling*: e.g. set thermostat timers to right time & date and change over with daylight savings; set heating at recommended 19°C and cooling at 24°C; either open windows or use A/C, never both; make sure staff desks are in the right distance from radiators; regularly check and maintain any air conditioning units and ensure air filters are free from dust.
- *Lighting:* e.g. turn off lights in unoccupied areas including cupboards; create reminders and promotional materials to encourage staff to turn lights off; relocate any objects that block windows; open window blinds during daylight hours; regularly clean your light fittings.
- *Office equipment*: e.g. turn computers off after 10 mins not in use; reduce brightness on monitors; switch electrical kitchen equipment off at the plug at the end of the day; repair damaged door seals on freezers and refrigerators.
- *Production equipment*: e.g. switch motors off when not in use; label switches and train staff in correct operating procedures; establish optimum fan speeds; keep motors clean.
- *Refrigeration*: e.g. fridges & vending machines containing non-perishable items are switched off when they are not in use; doors kept closed to keep warm air out of cool rooms; refrigeration units aren't overfilled so cold air can circulate; condensers are regularly cleaned.

Conclusions

One quote from an SME owner interviewed by Hampton (2018) stood out: "*SMEs are not a sector*." The incredible diversity and complexity of this audience, which also amounts to 99% of all businesses and 13% of global energy consumption, explains why SMEs are routinely regarded as HTR. It does not, however, explain why there are so few studies that identify specific SME sub-sectors and

audiences, still lumping most of them into an amorphous bucket with similar barriers. In addition, the social aspects and how they tie in with EE technology adoption in SMEs have been massively understudied (Kenington et al, 2020).

According to Hampton (2019), "*more important than the content of information, advice or reports provided by external advisors, are the processes by which such resources are absorbed and made sense of by organisations. These processes are unique to each organisation, bound up in its traditions, cultures and established practices. Whilst this finding might be unsurprising to many social scientists, as an action researcher and business advisor, it is also frustrating. If each organisation manages energy in unique ways, and absorbs advice unpredictably, does this mean that there can be no scalable solutions to accelerate the energy transition amongst the 5.7 million SMEs in the UK*?" This is an important question to be asked when designing and implementing behavioural interventions in this market - simply providing expert energy advice, a preferred SME policy solution by IEA (2015), may not be enough. The problem may sit with the dominant framing of organisational energy management being largely a technical activity which needs outside expert advice. This ignores and downplays the important role of low-tech solutions and tacit knowledge (Lutzenhiser, 2014).

In summary:

- The SME market may just be the *most hard-to-reach sector* of all audience groups, especially in the developing world.
- Much more research is needed into *different SME sub-segments*, both within and between cultural contexts.
- There is more 'individuality' and more *overlap with the residential sector*, in many ways, especially once we take into account that a large number of small businesses are run out of residential properties.
- Small businesses and their decision-making process are much more akin to those of *residential customers* than they are to commercial or industrial customers.
- There are some overlapping, clear *barriers* standing out in this audience group: *lack of internal expertise* (e.g. energy manager or energy reduction plans); *mistrust in external consultants*; *competing priorities* (although energy costs can make up a large part of business overheads they are often hidden); *split incentives* (especially in rented premises), and *discounting the future*, especially in developing countries.
- There are likely to be a lot of *no- or low-cost behavioural solutions* in this audience segment but they are highly heterogeneous (similar organisations can use very different amounts of energy, whereas seemingly different organisations can appear to have similarities), and would need to be identified and targeted for individual businesses and business types.
- The estimated *size and impact of this audience* on energy use and communities is vast and they are some of the hardest-hit following the COVID-19 pandemic. Focusing on supporting small business recovery, including solutions on how to save on utility bills, should be a key driver for most countries.

Chapter 8. Gap analysis

This extremely comprehensive literature review has delved, in detail, into various HTR definitions in the (energy and non-energy) literature; HTR audience characteristics based on demographics and psychographics, barriers, needs and dimensions; estimated audience sizes; and target energy-saving behaviours (ESBs). However, despite the over 870 scientific and technical publications that we have parsed on this important subject, there are some obvious gaps in the literature that potentially stop Behaviour Changers from identifying and engaging various HTR audiences.

VEIC (2019) recommends that additional *demographic* information for residential and multifamily populations should be used to inform analyses focused on determining disparity of programme impacts. Similarly, *firmographic* data should be used when conducting these analyses for eligible programme businesses. Energy efficiency (EE) programmes rarely collect demographic or firmographic information for their participants, outside of income qualification for low-income targeted programmes (ibid). The VEIC (2019) review of current programme efforts to assess equity and participation in clean energy found that these data were sourced either from publicly-available resources, such as the U.S. Census Bureau's *American Community Survey*, or in the case of firmographic data, from commercially available third-party data sources. Examples of demographic and firmographic data VEIC (2019; see also Table 2) recommended to collect include: *Demographics* (household size; income; race and ethnicity; age; education level; rural vs. urban location; energy expenditures – self reported), and *Firmographics* (industry type; property characteristics; business size; business sales).

Table 2: HTR audience characteristics of interest.

	Demographics	Firmographics
Highest Priority	Income Own vs rent Home type Urban vs rural	Business type Urban vs rural Own vs rent
Other characteristics of interest	Race / ethnicity Primary language Household age # of residents in household Highest level of education Years lived in home Remodeled in last 5 years # of children under 18 years Past programme participation	NAICS (or other) business code Race / ethnicity of owner/s Highest level of education Owner born overseas Gender of owner Age of owner Veteran status Disabled status Primary language of owner Lease type (if rent) # of employees Year business was established Languages used in transaction Gross revenues Type of business Past programme participation

Source: Adapted from NPCC (2018)

Residential sector

We found almost three times more literature on HTR energy users in the residential (**Chapters 3** [*n = 270*]**, 4** [*n = 143*] and **5** [*n = 120*]) than non-residential (**Chapters 6** [*n = 93*] and **7** [*n = 45*]) sector. Vulnerable, and especially, low-income households are still most likely equated with the HTR energy

literature. That said, we found significant gaps in the literature with regards to specific audience and behaviour definitions and characteristics.

Demographics

A vast bulk of the HTR residential literature analysed here covered *low-income* and otherwise vulnerable (e.g. *fuel poor, and, to a much lesser extent also mentally or physically disabled, minorities, rural, indigenous, refugees and immigrants, very young or elderly*) households. However, most of the previous studies have ignored spatial heterogeneity of the determinants of energy poverty - Mashhoodi et al (2019) claim that the best way to understand a phenomena is achieved only when spatial heterogeneity of the effects is taken into consideration. Although Sweden does have vulnerable households, the country's hardest-to-reach energy users may actually be in the most wealthy household category. That is why we focused a whole chapter on **High Income Households** in this review. There was significantly less literature, which was also less directed at changing ESBs in these audiences (as well as medium-income households), compared with low-income households.

References to *geography*, specifically rural versus urban customers, were infrequently found in EE programmes (Frank & Nowak, 2016), with some notable exceptions (e.g. *Energy Trust of Oregon*; and the *Focus on Energy* statewide EE programme in Wisconsin [Focus on Energy, 2019]). Of the other demographic variables, targeting programmes based on *dwelling type* (e.g., multifamily housing, MFH) is relatively common in the clean energy industry (e.g. Ross et al, 2016; although note the dearth of low-income MFH programmes, see Reina & Kontokosta, 2017), and there are efforts in some U.S. states (e.g., California, Massachusetts, Vermont) to target programme education and marketing to *non-English language* speakers. VEIC (2019) did not find U.S. clean energy industry examples targeting groups based on *education level, resident age, race, or ethnicity*.

We focus on highlighting the (gaps in) literature around three specific demographic indicators (*gender, age and race*) which are largely ignored in the EE and HTR literature (see e.g. Petrova & Simcock, 2019) in **Appendix D**. Fell et al (2020) support the need for more focus on these demographics as the COVID-19 pandemic is reconfiguring them "*in rapid and unforeseen ways, with advanced morbidity and mortality and differentiated effects across age, gender*[126]*, or ethnicity*."

Psychographics

Psychographic analysis uses the attitudes and lifestyles of audience members to develop target groups (Freimuth & Mettger, 1990). Psychographics may offer a way to focus on differences rather than deficits of audiences that have been labelled 'hard-to-reach' (ibid). They provide a more detailed and richer portrait of a group, and yield many implications for message development and delivery (e.g. Boomsma et al, 2019). Psychographic segmentation also reveals differences in audiences that demographic segmentation might overlook - and yet, they are much less-commonly characterised in the literature than demographics. We tried to provide insights into any psychographic analysis in each chapter, on audience characteristics, where we could find such research - but it was unfortunately sparse, with the most work found in the **Vulnerable Households Chapter 3**.

Target energy-saving behaviours

As important as clearly defined audience characteristics are, as important is it to clearly identify what ESBs to target in these audiences (Karlin et al, *forthcoming;* Rotmann & Weber, *forthcoming*). However, there is a distinct lack of clearly-outlining specific target behaviours in most research on HTR audiences. Instead, the focus is usually on energy (saving) technologies and/or energy services. This gap is particularly prominent in terms of *mobility and transport behaviours*, which are often seen as sitting outside the residential energy-saving literature, and for which rather limited evidence-based research has been undertaken (e.g. Ogilvie et al, 2004; Mourik & Rotmann, 2013; Arnott et al, 2014;

[126] https://www.nytimes.com/2020/09/26/world/covid-women-childcare-equality

Titheridge et al, 2014; Robinson & Mattioli, 2020). Seeing that changes to transport and mobility behaviours are particularly prominent during COVID-19 responses (IEA, 2020; Abu-Rayash & Dincer, 2020; Kanda & Kivimaa, 2020), and that embedding some of these behaviours long-term could lead to significant public health and environmental benefits (e.g. Ogilvie et al, 2004), this research gap should be acknowledged.

Multiple, or Non-Energy Benefits (NEBs)
Finally, multiple, or non-energy benefits (or impacts, to include costs) of EE are regarded as hugely important drivers for energy efficiency and conservation interventions (IEA, 2011 and 2014; UNECE, 2015; Ürge-Vorsatz et al, 2016). We have captured them, where available, in the audience needs assessments in the audience **Chapters 3-7**, above. Despite their known usefulness, they are usually excluded from most EE programme's cost-effectiveness tests for two reasons (Cluett & Amann, 2015):

1. Lack of data on their value
2. Lack of consensus on methodologies for establishing values and incorporating them into cost-effectiveness tests.

In short, many co-benefits and -costs are harder to quantify than project energy savings and project costs. There is still a major methodological gap in the literature, especially in the residential rental literature, on assessing and including multiple benefits in EE programmes (Ürge-Vorsatz et al, 2016). What is even less-commonly considered or studied are non-energy costs arising from behavioural interventions (Ürge-Vorsatz et al, 2016; Allcott & Kessler, 2019).

The potential co-benefits of EE interventions in vulnerable households could lead to reduction of unwanted mobility, promotion of local employment, improvement of community appearance, and reduction of local spending and energy infrastructure costs (Gillard et al, 2017). Ürge-Vorsatz et al (2016) summarise additional significant impacts as:

- *Improved human well-being* (increased disposable income resulting from decreased energy expenditure; employment impacts; increased air quality and thermal and visual comfort of workers; improved health and well-being, including reduction of respiratory and pulmonary disease, lower winter excess mortality and morbidity, increased thermal comfort, improved mental health due to reduced stress associated with bill payments and, improved nutrition; increased energy security at national level in particular, increased sovereignty and resilience)
- *Improved social equity* (positive public budget impacts from energy cost savings; reduced need for energy subsidies and unemployment and social welfare related subsidies; reduced health care costs due to reduced exposure to air pollution; improved housing quality, and increased general physical activity; poverty alleviation through reduced energy bills; increased disposable income and increased employment; reduced energy prices due to reduced energy demand; as well as reduced cost of energy services resulting in increased welfare and decreased energy poverty).

Non-residential sector

As highlighted in the **Methodology Chapter 2,** we found less than half the literature focusing on the **Commercial (Chapter 6)** and **SME (Chapter 7)** market combined, compared with literature focusing on **Vulnerable Households** in **Chapter 3**. Similarly, very few papers in the **Renters and Landlords Chapter 5** focused specifically on the non-residential sector.

While the commercial sector accounts for only marginally-less energy use, the amount of thorough and actionable academic study, governmental initiatives, and overall advice recommendations for commercial sector efficiency behaviours is dwarfed by the research focus on the residential sector

(Chester et al, 2020). One could even argue (ibid) that the entire commercial sector (with the possible exception of office buildings) can be regarded as HTR from a non-residential Behaviour Changer perspective.

CSE & ECI (2012) list the research gaps in the non-residential sector as follows:

- There is a *mismatch* between the distribution of high-quality research and the distribution of carbon emissions across non-residential sectors. *Retail* and *hospitality* sectors are particularly overlooked given their significant carbon emissions.
- *Decision-making in SMEs* is also overlooked and the SME classification itself needs to be broken down. Their evidence base has found quite different behaviour in small, medium and large SMEs, for example. *Small and micro SMEs* are particularly under-researched.
- Research into establishing an *energy-based segmentation* of the market is needed - principally by *size, sector and the interaction* between the two. To fill the gaps, research into energy-saving behaviours across a broad range of sectors and size categories is needed.
- The evidence or impactful ESBs were concentrated in studies of *offices,* and there were very few studies of the wider (UK) context.
- There were also very few robust *policy evaluations*. This is due, in part, to a lack of a robust, transferable and straightforward methodology or set of *methodologies for evaluation* of government energy policy.

We have focused on specific audience characteristics in sub-segments of the commercial (building) sector in the **Commercial Sector Chapter 6**, above. Here, we summarise some general gaps in the non-residential research literature.

Commercial Building Types

In the commercial sector, similar to the UK's focus on 'hard-to-treat' homes (BRE, 2008; Center for Sustainable Energy, 2012), the focus of programmes and policies is often on the physical properties of building. *Building type* often, but not always, indicates the type(s) of businesses operating in them, which influences the energy-using behaviours that a business might be willing to take (Chester et al, 2020). The CBECS (EIA, 2012) definitions (see **Appendix C**) of different building types in the commercial sector show the extreme diversity and complexity of business and building types. Most commercial sector literature does not push the narrative further to fill in the gaps by segmenting the commercial building sector more appropriately into its many sub-sectors and building use types (e.g. Azar & Menassa, 2014; Paone & Bacher, 2018). A lot of analyses apply to building characteristics that include *size, age, and location* rather than focusing on the commercial sub-sectors or business uses these buildings are used for (see Chester et al, 2020). Many authors simply mean 'office buildings' when they talk about 'commercial buildings' (e.g. Wolfe et al, 2014; Ahl et al, 2019; Tam et al, 2018).

Energy / business usage and its impact on ESBs

Wolfe et al (2014) rightly argue that energy behaviours relevant to buildings occur at many levels, from individual to institutional. Inside a building there are open and enclosed spaces with many different uses (e.g. work processes, product development, meetings, social gatherings, and housing energy / water / mechanical systems). In Chester et al's (2020) review of commonly-available literature, energy and business usage was another level of detail that was only marginally better described than different subsectors and building types. The authors argue that "*acknowledging the presence of multiple sub-sectors does little good if those sub-sectors are still given the same broad and minimal behavioural tips*". For example, a technical analysis of potential energy savings that is broken out by building types and sub-sectors, still only quantifies energy savings by end use technology (e.g. HVAC, hot water, lighting etc.) without providing insights on how each of these technologies should be optimised, based on specific building and energy usage needs (Navigant Consulting, 2016).

Another in-depth study by Illume Advising (2017) segments the Minnesota commercial sector into different sub-sectors and building types, even providing bill savings by segment and energy conservation measure. They highlight that *food service, grocery,* and *retail* share many characteristics such as occupying free-standing buildings, paying their own utility bills, having fewer than 50 employees, being more likely to be franchises than other segments, having high staff turnover with many non-staff occupants in the business throughout the day, and being good candidates for programmes incorporating prompts or competitions. They also highlight that e.g. retail and food service have higher rates of leasing than grocery stores and are more likely than grocery stores to be in a multi-tenant building or mall. Similarly, unlike retail, grocery and food service both have opportunities to save energy through refrigeration and kitchen exhaust measures. However, despite these insightful comments, the study still fails to target the ESBs to each of these segments and their appropriate audiences and Behaviour Changers, as needed.

Most commercial sector ESB initiatives focus on the three main energy technologies previously mentioned (lighting, HVAC, and plug load). They also assume that people already know what ESBs they need to change, treating the effort to make those simplistic behaviours happen as the main area worth studying (Chester et al, 2020). However, the primary challenge (both in terms of the more difficult area to tackle and the problem that has to come first, chronologically) is identifying, researching and disseminating what those target ESBs are for each aspect of the commercial sector, sub-sectors, building types, and business use types. In addition, different people have different levels of knowledge, motivation, and impact on energy use in different commercial sub-sectors, and they need to be identified and engaged in ways that are relevant to them.

Locus of decision-making, agency vs capacity

There is a serious disconnect between agency and capacity in the commercial sector (Parag & Janda, 2014). A major issue sits with the locus of decision-making, where top-down actors (e.g. CEOs or CFOs) may have capacity to create change, yet lack agency or motivation. For example, Edison Energy (2016) found that 45% of the companies surveyed cited a *lack of executive interest* or understanding as a major barrier to energy-related action, only 6% of companies believed they had already exhausted all opportunities for energy savings, and 24% of companies didn't even have an accurate sense of their energy usage.

Rotmann (2016) identified different Behaviour Changers, both internal and external to an organisation. Each one of these actors has a crucial, yet differing impact on energy savings in a given business. Some, such as external *regulators* setting targets, can have very high energy literacy and impact on a business' motivation to change, even though they have low understanding and impact on a business' actual energy use. Some, such as *building operators* or *employees* using the building during operating hours, have very high impact on actual energy use (e.g. Cowen et al, 2017), but may have lower motivation to change, or insufficient energy knowledge. *Customers or clients* often have very low impact on actual energy usage (though not always, e.g. *patients* in a hospital, see Cowen et al, 2018), but potentially very high impact on motivating leadership to change by voting with their wallets (e.g. by insisting on certain sustainability credentials or low-energy products and services).

We identified specific examples around locus of decision-making in the audience characteristics section in the **Commercial Sector Chapter 6**, above. However, it is clear from the few examples given for specific commercial sub-sectors that there is a definite gap in the research identifying different external and internal actors who need to be engaged in ESBs.

Commercial ESBs

Having a detailed understanding of occupant behaviour and being able to quantify its impact on the use of building technologies and energy performance of buildings is crucial to their EE improvement,

however, specific behaviours are rarely identified and targeted in interventions (Myrhen et al, 2018). In addition, targeted ESBs must differ based on the audience for which they are intended - though the existing literature largely does not include such nuance (Chester et al, 2020). For example, behavioural advice needs to be different when it is given to the *building owner* compared with the *management* of the company who is paying the utility bill, as well as *employees* vs. *business customers*. Each of these different potential actors and audiences has a unique agency over energy use, their own motivations (or lack thereof) to embrace EE, and a different level of potential impact on energy use. However, the existing pool of ESB literature rarely addresses these facts.

An analysis of the commonly-available resources for identifying ESB tips found that the challenges stretched across work done in the academic field, in government sources, in industry trade materials, and elsewhere (Chester et al, 2020). Rather than providing useful instructions and resources where actors in the commercial sector can identify behaviours that are relevant to their situation (based on sub-sector, size of the business, and relevant actors that can influence or levers available to pull), these commonly-available resources provide commercial sector tips that are superficial in nature and unspecific in delivery. Further, many of the implied 'commercial sector' tips really just refer to office setting ESBs (which represent only 18% of commercial sector energy use), without calling them such. Even when Behaviour Changers search for specific building- or business-type advice, such as "retail clothes shop energy saving tips" or "hotel energy saving tips", the EE advice given is rather generic and doesn't delve into specific audience characteristics, barriers and needs or the exact target behaviours, and how they could be specifically addressed via tailored (behavioural) interventions.

A risk when addressing commercial sector ESBs is the instinct to overgeneralise and assume what the main EE behaviours and strategies should be without undertaking specific audience research, first (Chester et al, 2020). The amount of focus on resources dedicated to reminding, motivating and prompting commercial behaviours should be treated as the secondary aspect of effective behaviour change interventions, while the study of what the necessary target audiences and their most relevant ESBs actually are must come first (both chronologically and in emphasis; Karlin et al, *forthcoming*).

Andrews & Johnson (2016), in their extensive review of literature on business energy behaviours, identified the following research gaps:

- *Factors influencing businesses' adoption* of clean energy
- *Sector-specific studies on barriers* to energy innovation
- Integrated studies of influences on businesses' energy behaviour at the *individual, organisational and institutional levels*
- *Cross-cultural comparisons*.

We hope that this research Task will at least help plug some of these gaps - especially around sector-specific barrier analysis, influences on behaviour on several organisational levels, and cross-country comparisons.

Other non-residential sectors
The majority of non-residential ESB literature focuses on the commercial (office) sector (Balaras et al, 2017), with much less targeted research in the *industry and manufacturing, construction, mining* and *agricultural* sectors - despite their significant EE potential (e.g. Brown & Elliott, 2005; Berardi, 2012; Cagno et al, 2013).

In conclusion
In a review of the available published literature specific to the commercial sector, we discovered two main types of literature:

1. Much of the available resources for the sector treat commercial buildings as a homogenous entity, failing to capture the potential opportunities in most sub-sectors of the commercial sector. This outcome is accomplished either via:
    - Treating the whole commercial sector the same without acknowledging the existence of sub-sectors, or
    - Acknowledging a separation into sub-sectors but not highlighting the unique energy-saving behaviours or the particular actors in play within those sub-sectors.
2. For literature that does recognise that commercial buildings are a complex subset of the existing building stock, they tend to be resources that only present information on a single sub-sector, focusing mostly on engagement strategies rather than how to target relevant audiences and behaviours.

Neither of these two approaches are perfect. The commercial sector has too much diversity to treat all commercial buildings the same when it comes to ESBs, and there are not enough authoritative resources that slice the commercial sector down and present uniform and comprehensive opportunities for commercial energy behaviour changes.

Chapter 9 - Concluding thoughts

Households are seen as one of the most promising domains for reducing emissions (Carrico et al, 2011; Murtagh et al, 2014), with an expectation that changing energy-using behaviour in the home will be relatively easy to accomplish (Dietz et al, 2009). However, even in Sweden, a leader in both sustainable energy[127] and energy poverty reduction (EEPI, 2019), the energy consumption of the entire residential sector (~40%) could be halved if EE interventions such as improved insulation and updated heating systems were actually implemented (Samuelson, 2018). Even in the highly-researched residential sector, some authors still estimate >50% of energy users to fall into one or more of the HTR audience categories outlined above (Ramsay & Pett, 2003; Meyers & Guthrie, 2006). This estimate is likely correct, especially following the COVID-19 pandemic and its devastating impact on (already or newly) vulnerable households and businesses, particularly renters (Kneebone & Murray, 2020), who already make up >60% of energy users globally. Furthermore, especially small businesses, which constitute over 95% of all businesses in the world, are dramatically under-researched, with a majority of the non-residential sector thus also falling under HTR (or rather, 'hardly-tried-to-reach') categories (Chester et al, 2020). We clearly need to do more, and better, to embed long-term sustainable energy habits and energy efficiency (EE) into our households and businesses in order to foster a just sustainable energy transition.

The COVID-19 pandemic, as dreadful as its impact is on the world economy and on individual lives, has also given us an opportunity to reflect on what hasn't worked in the past, and how important individual behaviour change can be to support (global) systemic government response, recover, and resilience efforts (e.g. Betsch, 2020). Individual behaviour change, however, also clearly isn't enough in and of itself, as reduction in this year's carbon emissions remain below the minimum annual targets of what is necessary to achieve the 2015 *Paris Agreement* (le Quéré et al, 2020). Many of the behaviours we have changed so drastically are energy-using behaviours (IEA, 2020): we almost completely reduced *non-essential (air) travel* and *commuting* (Abu-Rayash & Dincer, 2020); *teleworking* increased from <10% to 42% in the U.S. alone, with 80% of teleworkers now saying they would like to continue working from home post-pandemic[128]; *online social networking, gaming* and *streaming services* became an important lifeline for billions of isolated people in lockdown; and *non-essential business activities* have been curtailed to a very large extent in most countries etc.

Countries in full lockdown had an average decrease in energy demand of 25% (ibid) and this has led to some positive co-benefits like decreased air pollution (Bauwens et al, 2020), further benefiting public health and the environment. On the flip side, us being locked down in our homes and working from home (if we were lucky enough to be able to - there remains stark inequality in who could do so[129]) also meant increasing energy-using appliances and services, using more hot water and heating, and suffering from cold and damp housing stock, in those countries where EE improvements have still not reached far enough (like Aotearoa, see Johnson et al, 2018). In addition to increased residential energy use, we are also looking at global unemployment rising to almost 21%, with job losses concentrated in already vulnerable lower-income segments (IEA, 2020). The UN has called for social inclusion for everyone[130]: "*We must come to the aid of the ultra-vulnerable – millions upon millions of people who are least able to protect themselves. This is a matter of basic human solidarity. It is also crucial for combating the virus. This is the moment to step up for the vulnerable*."

This review shows that those audiences most-commonly identified as HTR by Behaviour Changers (e.g. *vulnerable, low and high income households, renters and landlords, SMEs*) already made up a

[127] https://trilemma.worldenergy.org/
[128] https://www.ibm.com/thought-leadership/institute-business-value/report/covid-19-trilemma#
[129] https://theconversation.com/remote-work-worsens-inequality-by-mostly-helping-high-income-earners-136160
[130] https://www.un.org/development/desa/dspd/everyone-included-covid-19.html

majority of energy users, pre-pandemic. Post-pandemic, their numbers will have risen significantly, and those households and businesses who have become newly vulnerable will struggle identifying as such and finding support in an increasingly compromised, and polarised world. Embedding long-term individual behaviour changes and creating systemic change with considerations around equity, welfare and social inclusion, will create multiple benefits, socially, environmentally, and economically, for all global citizens. Years 2 & 3 of our research will focus on what such efforts could look like in practice.

Summary conclusions:

- The *terminology around hard-to-reach energy users* is complex and has been rightly critiqued for seemingly putting the onus on energy users, instead of the Behaviour Changers trying to reach them. We have developed a definition for this HTR Task that is broad enough to encompass most HTR groups, and remove the perceived value judgement.
- This *literature review is likely one of the most extensive and comprehensive* attempts to characterise HTR audiences by their demographics, psychographics, barriers, needs and dimensions; establish some target energy-saving behaviours (ESBs); and estimate audience sizes.
- Although existing literature provides *some estimates of the size* of some of these groups, it's often unclear what proportion of total energy users in a region or country are accounted for by these various audiences - or how much they have changed post-COVID-19.
- There are *many definitions and methods of measuring* energy / fuel poverty or energy hardship / burden / insecurity, and they often vary with geography and research discipline. Energy poverty and vulnerability, while related, are two distinct issues which are context-dependent.
- We have identified *vulnerable households* based on (low) *income*, *minority* (race / ethnicity, disability, gender), *geographic isolation, age* (elderly and young, including single parents or pregnant mothers), as well as *socially-stigmatised and -criminalised* groups.
- The *intersectionality* of vulnerabilities cause additional complexities, which have been underexplored in the literature to date.
- As we found with all literature outlining *audience characteristics* (see **Chapters 3-7**), there is a lot more emphasis on the *barriers* they face, rather than in-depth *needs-based audience analysis*.
- Only a few specific *target energy-saving behaviours* are outlined in the literature, most studies focus on energy-efficient technologies or services.
- Even though the main dimension affecting low-income and energy-poor households is *economic*, there are many others (e.g. *geographic* for rural [especially Indigenous]; *psychological* for disabled or stigmatised people; *technological* for the elderly) that play important roles. Dimensions are often dependent on further audience segmentation.
- *Income, and related affluence*, *lifestyles* and *consumption patterns* play a critical role in large energy use disparities. Income-driven energy use inequalities were identified across and within countries. Depending on the metrics, the potential size of this high-income audience can be substantial, yet they are very under-researched.
- Multifamily buildings are difficult to reach and they often *combine the more challenging aspects* of single-family homes and commercial buildings.
- As an aggregation of single-family homes, such buildings are occupied by *multiple decision-makers* who are apt to make diverse choices about how to live in their space, making it difficult to achieve consensus on whether and how to improve the building. Defining the *actual audience to target* in an MFA can itself be a challenge.
- Although the *split-incentive* issue has taken most of the blame for the particularly low investment in EE for rental housing, other significant barriers are also fairly unique to this sector-for example, *power imbalances* between renters and landlords.

- *Transportation costs* are often an additional burden for low-income renters, especially in multi-family apartments on the outskirts of large cities.
- *Renters* (both residential and commercial) make up the majority of building energy users on the planet. They are also under-researched, especially in the commercial and SME sectors.
- There is a vast range of *energy-saving behaviours* to consider that are highly specific to subsets of the total commercial sector. The most extensive list to date, of almost 600 of them (Chester et al, 2020), is still only a subset.
- Different *commercial sub-sectors* have quite unique energy needs and uses, even if they are sometimes housed in relatively similar building types.
- *Locus of decision-making* is also a very important factor in this sector that needs to be carefully assessed and understood for specific businesses and interventions.
- *Heterogeneity of audiences and behaviours* needs to be highlighted and teased out for specific sub-sectors and business (and sometimes, building) types.
- *Co-benefits* are huge potential drivers for EE and behaviour change, yet they are rarely measured and communicated in the commercial sector.
- *Equity considerations* are even more underexplored in the commercial sector than the residential one.
- The *SME market* may just be the most hard-to-reach sector of all audience groups, especially in the developing world.
- Much more research is needed into *different SME sub-segments*, both within and between cultural contexts.
- There is more ‘individuality’ and more *overlap with the residential sector*, in many ways, especially once we take into account that a large number of small businesses are run out of residential properties.
- The *estimated size and impact* of this SME audience on energy use and communities is vast and they are some of the hardest-hit following the COVID-19 pandemic. Focusing on supporting small business recovery, including solutions on how to save on utility bills, should be a key driver for most countries.

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Appendix A - Non-energy HTR literature

Table 3: HTR audiences mentioned in the non-energy research literature.

HTR audience	Sector / Theme	Country	Citation
Low income, minorities, literacy	Health	US	Freimuth & Mettger, 1990
Populations with HIV	Health	Review	Del Rio, 2016
Socio-economically disadvantaged	Health	Review	Bonevski et al, 2014
Young unemployed	Health	UK	Nelson & Taberrer, 2017
School-aged children	Health	Finland	Sormunen & Mittienen, 2017
Deprived immigrants	Health	Kenya, UK	Ndomoto et al, 2017
Homeless, youth	Health	US	Tyler & Olson, 2018
Pastoral communities	Health	Tanzania	Caudell et al, 2019
Parents	Health	US	Wozney et al, 2019
Military	Mental health	US	Hourani et al, 2017
Men, sports clubs	Mental health	UK	Lewis et al, 2017
Underage sex workers	Mental health	NZ	Thorburn & deHaan, 2017
Families, socially excluded	Therapy	US	Aggett et al, 2015
Families	Therapy	US	Lord, 2015
Families	Therapy	UK	Singh, 2015
Women and babies	Smoking cessation	UK	Morgan et al (2016)
Urban poor, ethnic minorities, rural children	Biomedical research	Southeast Asia	Ngyen Than et al (2019)
Drug users	Social Science (SS)	US	Heckathorn (2002)
African-Americans, rural, young	SS	US	Kogan et al, 2011
Drug users	SS	Australia	Barrat et al, 2015
Immigrants	SS	US, Mexico	Núñez-Mchiri, 2009
Young adolescents	SS	Review	Taylor et al, 2015
Marginalised	SS	Review	Bhopal & Deuchar, 2015
Sex workers, homeless, drug users	SS	US	Crawford, 2016

HTR Communities, sex workers	SS	Sweden/review	Kock, 2016
Working class	SS	UK	Walkerdine, 2016
Smartphone users	SS	UK	Firchow & McGinty, 2017
HTR populations	SS	US	TenHouten, 2017
Transport users	SS	NL	Zijlstra et al, 2017
Muslim women	SS	US	Mehrsa et al, 2018
Male ex-prisoners	SS	US	Sugie, 2018
Communities, newcomers	SS	Canada	Goopy & Kassan, 2019
Refugees	SS	Germany	Keusch et al, 2019
Homeless, mental health	SS	US	Stanhope, 2012
Homeless	Social services	US	Coryn et al (2007)
Disabled, carers, elders	Social services	UK	Leece & Leece (2011)
Homeless, young marginalised, drug use	Social services	Australia	Bryant (2014)
Young fathers	Social services	UK	Osborne, 2015
Young male offenders	Social services	Scotland	Nugent, 2015
Young fathers	Social services	UK	Davies, 2016
Young, homeless	Social services	UK	Gombert et al, 2016
Rural communities	Social services	Scotland	Steiner, 2016
Parents, child welfare	Social services	US	Mirick, 2016
Immigrants, students	Social services	Review	Kirwan, 2017
Homeless, ex-prisoners	Social services	US	Umamaheswar, 2018
Gangs	Social services	US	Cheng, 2018
Immigrants, limited English	Social services	US	Sha et al, 2018
Gypsy & Roma, Travellers	Social services	UK	Condon et al, 2019
Homeless	Social services	Czechia	Dankova et al, 2019
Women	SS	Bangladesh	McNicol, 2019
Gypsy & Roma	Social justice	UK, NL	Townsend et al, 2018
Families, LI	Crime-related	Review	Doherty et al, 1999

Illicit drug use	Crime-related	Australia	Hughes & Moxham-Hall, 2017
Ghanain immigrants	Justice	US	Pryce, 2018
Gangs, gender	Health & Safety, Crime	Trinidad & Tobago	Pawelz, 2018
Elderly, disabled, immigrants, low income	Health / Nutrition	US	Gorman et al, 2013
Elderly, obesity	Health & Exercise	US	Maher et al, 2018
Men	Sports and Health	UK	Hulton et al, 2016
Vulnerable communities	Sports	Wales	Bolton et al, 2018
White working class, LI	Cultural activities	North England	Symons, 2018
Marginalised students	Education	England & Wales	Brooks-Wilson & Snell, 2012
Children	Education	UK	Putwain et al, 2016
Families, low income	Education	UK	Watt, 2016
Immigrant parents	Education	Spain	Paniagua, 2018
Parents, immigrants	Education	US and Spain	Garcia-Carmona et al, 2019
Parents	Education	UK	Wilson, 2019
HTR communities	Public policy	Australia, NZ	Blomkamp, 2018
Political elites	Political science	BE, CA, Israel	Walgrave & Joly, 2018
Women	Business	EU	Humbert & Roomy, 2018
Middle managers	Business	Iran	Ershadi et al, 2019
Formerly incarcerated	Employment	US	Ogbonnaya-Ogburu et al, 2019
Disabled, migrants, refugees, LGBT, elderly people, homeless, 'hidden population'	Libraries	Turkey	Taskin et al, 2014
Isolated, disabled, elderly	IT access	US and UK	Boeltzig & Pilling, 2007
Smartphone users	Privacy	Germany	Kreuter et al, 2018
HTR population	Social Media	Russia	Dusek et al, 2015
Men	Gaming	Austria, NL	Gugerell et al, 2018
LGBT, elderly, NGOs	Marketing	US	Precourt (2016)
Rural, multi-family	Housing mobility	Russia	Polukhina, 2017

Female labour migrants	Demographics	Russia	Agadjanian & Zotova, 2012
Unemployed/uneducated young	Demographics	UK	Maguire, 2015
Immigrants	Demographic	Austria, UK	Reichel & Morales, 2017
Racial / ethnic minorities	Demographics	US	Terry et al, 2017
Older women, children	Transport	Australia	Ampt & Hickman, 2015
Vulnerable	Transport, migration research	Review	Riandey & Quaglia, 2009
Underserved, rural, first nation	Water	US	Younis et al (2019)
Migrants, homeless, minorities	Library Services	Slovakia, int'l	Horakova (2013)

Conducting research with non-energy HTR groups

Barriers to including such groups in research

Some studies identified difficulties sampling groups defined as 'hidden populations', consisting mostly of people who do not want to be identified such as people who use illegal substances (e.g. Barrat et al, 2015), have previously been on authorities' radar for e.g. criminal offenses (e.g. Doherty, 1999) or self-identified groups such as LBGTQ, others described difficulties sampling groups with low numbers in the population such as Indigenous people (e.g. Bonevski et al, 2014).

There are many reasons why such groups are not included in health and medical research (see Bonevski et al, 2014), and many of them are equally valid for energy research. What is a bigger consideration in energy research is the lack of focus on *equity*, which is more prevalent in the social service, education and health sectors (see VEIC, 2019). Understanding these factors is necessary for developing strategies to increase the level of involvement and participation in research for disadvantaged and hidden groups. *Population-based probability sampling* tends to be a time- and cost-inefficient strategy for sampling socially-disadvantaged and hidden groups (ibid), the same is said for *time-space probability sampling* (Agadjanian & Zotoya, 2012).

Other sampling methodologies of HTR groups

A number of alternatives to *random probability sampling* were described (Bonevski et al, 2014: Table 4) including *snowball / social network / chain-referral sampling* (see also TenHouten, 2017; Mehrsa et al, 2018; Pawelz, 2019) or *respondent-driven recruitment* (see also Kogan et al, 2011; Dankova et al, 2019), *venue based time-location sampling* (e.g. Garcia-Carmona et al, 2019), *targeted sampling, capture-recapture, adaptive sampling, using mobile phone apps* (e.g. Firchow & McGinty, 2017; Kreuter et al, 2018), *mobile games* (e.g. Sormunen & Mittienen, 2017), *and social media-driven sampling* (Wozney et al, 2019), as well as *oversampling of low prevalence population sub-groups* as well as *purposeful sampling* and the *successive approach* (both Pawelz, 2019). Except for oversampling methods for low prevalence populations, all of the other sampling strategies require formative research to identify **venues (places), times, and contact persons** to develop a targeted sampling frame for the group of interest which may impose significant time and cost to the research. *Selection bias* (e.g. Humbert & Roomy, 2018) and *gatekeeper bias* (e.g. Wilson, 2019, although see Umamaheswar, 2018 why gatekeeping is useful for studying some HTR populations like the homeless or ex-prisoners) which limit validity of the sample are the primary limitations of these strategies. While these issues may not be problematic for studies which do not require representativeness for generalisability, such as qualitative research, they do have limited use in quantitative research.

Sampling through *community organisations / community immersion* (Coleman, 2011; Mehrsa et al, 2018; Symons, 2018): One option for creating a sampling frame for specific socially-disadvantaged groups is to collaborate with community-based organisations (CBOs) with access to those groups and to draw a convenience sample through that organisation. Benoit et al (2005) variously defined community groups as "*any group with high access to the target population and partnerships that have taken three main forms: a) the community group helping researchers gain access to an otherwise hard-to-reach group; b) a reciprocal relationship in which community members and researchers have knowledge and learn from the other; and c) community-initiated research projects that seek academic partnerships and use the outcomes to direct policy and programme delivery*." While this form of convenience sampling may not be representative of the general target group, it presents pragmatic advantages for sampling large numbers of members of socially-disadvantaged groups - including in energy research.

This is borne out by multiple examples of using community organisations to help deliver efficiency and behavioural interventions in the residential sector (e.g. Coleman, 2011; Howden-Chapman et al, 2011; Cook, 2013). It is also backed up by a review of low income non-residential community programmes in the U.S., where programme implementers indicated that partnerships are key to success (Drehoble & Tanabe, 2019). They typically worked with a wide variety of partners, including local governments, community-based organisations, and chambers of commerce. These partnerships were found to foster trust and legitimacy and helped increase programme participation and customer satisfaction. They can also help support non-English speaking building owners and tenants, thus overcoming significant barriers for HTR audiences. In addition, a study on non-residential small business customers of a major U.S. utility also showed that utilising community-based organisations and industry/trade groups to assist in delivering energy efficiency programmes is advantageous (Quantum Consulting, 2001). CBOs could reach many of the underserved communities, especially smaller customers, and therefore can provide a cost- effective means for delivering energy efficiency programmes. CBOs may also be more in touch with a customer's business, therefore allowing the CBO to provide more customised, accurate information regarding energy efficiency (ibid).

Health professionals as trusted messengers: Several other studies (e.g. Ramsay & Pett, 2003; Bullen et al, 2008; Howden Chapman et al; 2011) have pointed out the importance of using trusted health professionals (GPs, public nurses, midwives, occupational therapists etc.) to both help identify vulnerable households due to risk factors such as chronic respiratory diseases from mouldy, damp and cold housing stock, and to help relay the message of various energy-efficiency interventions (like subsidies, loans, grants) that are available to improve these household's health and wellbeing (see e.g. *Healthy Homes Initiative*, NZ; *HECAction* Schemes in the UK; *Weatherization Assistance Programs* in the U.S. and Canada). Energy suppliers in the UK have long used these health networks to try and reach their HTR customers (Ramsay & Pett, 2003).

Collaboration / co-creation with the HTR audience / community: Goopy & Kassan (2018) point out that "research has tended to be conducted *on* rather than *with* harder-to-reach communities and individuals." Symons (2018) also makes a strong call for closer collaboration with actors in so-called 'hard-to-reach' communities. Local people, who initially decried being relegated as 'hard-to-reach' or 'low income' became enthusiastic about the research project after they redesigned it in collaboration with them. She calls for co-production by arguing that academic research projects should co-design their 'community engagement' phase together with their target community. Goopy & Kassan (2019) proposed one such new methodological approach - arts-based engagement ethnography (ABEE) - "*designed to support researchers who seek to engage more fully and robustly with their participants in order to attain a deeper understanding of participants' social lives and cultural practices and the context and complexity of their experiences*".

Appendix B - More detail on HTR-related concepts

Energy poverty

Critical in understanding the energy poor as HTR, and the important contribution of poor EE standards of housing to energy poverty led Fahmy (2011) to distinguish energy poverty from more general poverty in the following way: "*For any given level of income, households and individuals have an **unequal capability** to convert income into adequate warmth (and energy services) which is distinct from, and additional to, those deprivations associated with insufficient income itself*" (Fahmy, 2011). In the European Union (EU), 'poverty' is based on computing household income, adjusted with an equivalence scale, this number is then assigned to each household member and compared with a poverty line. Most commonly, the poverty line is placed at 60% of median equivalent income in a given country as observed in a given year (Gustafsson et al, 2017). Azpitarte (2012) categorised households into four groups:

1. The twice-poor (income-poor households with no or very limited net assets)
2. The protected-poor (income-poor households that have net assets)
3. The vulnerable non-poor (non-income-poor households that have no net assets)
4. The non-poor.

Recently, the UK Government changed its initial definition of fuel poverty (see Boardman, 1991), based on a review by Hills (2012). The new definition suggested by Hills is a 'Low Income High Cost' (LIHC) definition. In this definition, a household is considered to be in fuel poverty "*if the residents have fuel costs that are above average (the national median level), and were they to spend that amount (for the fuel cost) they would be left with a residual income below the official poverty line*" (DECC, 2013). This definition measures the extent of fuel poverty but it is also used with a 'fuel poverty gap' measure that measures the depth of fuel poverty (UK Power Networks, 2014). The new definition resulted in a change in the number of those people considered to be fuel poor. As UK Power Networks (2014) state: "*Notwithstanding the recent Hills Review of fuel poverty and the construction of the LIHC measure, fuel poverty remains a complicated and ill-defined concept reliant on many modelling assumptions about the construction of the properties, technology performance (e.g. boiler efficiency) and occupant behaviour. It also requires knowledge of the household income. In the absence of knowing the full details of a household's income, housing quality, energy behaviour and energy costs in advance, proxies must be used to identify the fuel poor.*" Energy poverty indicators are a combination of area-based indicators; income; and also building information (ibid).

Some commentators have more recently sought to move understanding of energy poverty away from technical and economic metrics of housing standards and EE (Middlemiss & Gillard, 2015; Scottish Government, 2017). Instead, they focus on *exposure* to energy poverty, *sensitivity* to its impacts and a household's *adaptive capacities* for coping with it (e.g. Mould & Baker, 2017). Such approaches focus on energy poverty as a matter of social justice, and bring it more into mainstream discourse on poverty and inequality in general. For example, Buzar (2007) defines energy poverty as: "*a condition in which a household lacks a socially and materially necessitated level of energy services in the home*". This approach is more in line with the *Poverty and Social Exclusion* 'consensual' approach which defines poverty as "*those whose lack of resources forces them to live below a publicly-agreed minimum standard*" (Gordon et al, 2013). Marchand (2015) argues that it is important to move away from the term 'poverty' as both EU and English legislation classifies households as poor according to a relative measure of income. It fails to reflect the needs of individuals. By moving to a *deprivation* focus, a more nuanced, regionalised, needs-driven conception of the issue can be adopted. He suggests that 'energy deprivation' is a more appropriate term, although one that is less-commonly used in the U.S. context.

The UK and NZ, for example, use data representing aspects of material and social deprivation from their censuses or from administrative data sets to construct indices designed to measure socioeconomic variation across communities, assess community needs, inform research, adjust clinical health funding, allocate community resources, and determine policy impact (Phillips et al, 2016). *Social Deprivation Indices* provide these countries with comparable data and serve as a universal language and tool set to define organising principles for population health, something desperately needed in the United States, according to Phillips et al (2016). In their study which modeled social deprivation indices for the U.S., they rank the 'dimensions of deprivation' as follows (ibid, see Exhibit 1, from highest to lowest component weighting):

- *Single parent* (Single-mother household) 0.861
- *Poor* (Population below poverty) 0.828
- *No car* (Rate of no car ownership) 0.760
- *Education* (Less than 12 years' schooling) 0.753
- *Home ownership* (Renter-occupied housing) 0.734
- *Employment* (Nonemployed) 0.704
- *Crowding* (Percent overcrowded) 0.609
- *Race* (Percent black) 0.511
- *Age* (High-need age group) 0.379

The *NZ Index of Deprivation* was built around the idea that deprivation is "*a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation*" (Townsend, 1987). It can involve both *material* (involves the goods, services, resources, amenities, physical environment, and location of life) and *social deprivation* (involves the roles, relationships, functions, customs, rights, and responsibilities of membership of society).

Bouzarovski & Petrova (2015) make two important contributions in this area. Firstly they argue that there is a need to blur the conventional definitions of 'energy poverty' and 'fuel poverty' in order to bring about meaningful discussions on energy access and affordability at the international level. Secondly, they demonstrate how 'vulnerability thinking' can challenge a focus on socio-demographic approaches to tackling the issue and open the opportunity to examine socio-technical factors that contribute and exacerbate the problem. As with Bouzarovski & Petrova (2015), Marchand (2015) also calls for interventions to move away from a focus on EE, fuel costs and household income. Instead he advocates for policy makers to understand the socially-necessitated household practices that contribute to the existence of energy deprivation. In doing so, the technical and economic factors favoured in earlier definitions (within the UK) are captured within the identified practices, resulting in a more detailed understanding of energy deprivation and an increased range of potential opportunities to intervene and eradicate the issue.

Low income is central to the concept of fuel poverty. This is explicit in the 'Low Income High Costs' definition of energy poverty in England and the new definition in Scotland within which the *Minimum Income Standard* is a central component (Hills, 2012; Scottish Government, 2017). Samarripas et al (2017) outline some of the issues with defining low-income households: "*U.S. government and EE programmes have many different definitions for what qualifies a household as low-income and thus eligible for low-income subsidies and incentives. These definitions vary not only between programmes but also across different regions of the country. Programmes that have an 'affordable housing' or 'low-income' target typically target buildings with households that have an income below a certain percentage of AMI (e.g., 60% of AMI or 80% of AMI). These households face high cost burdens for essential living expenses relative to their household income*."

Energy insecurity

One factor that contributes to energy as an ignored hardship is the lack of an appropriate label and related conceptual framing. While the term 'energy insecurity' exists in the literature, the phenomenon is not well understood. Existing studies have utilised the term to understand its connection to low socioeconomic status and other social disadvantages, negative health outcomes, and in conjunction with other economic and environmental insecurities. *Energy insecurity* is an important social, economic and environmental determinant of health, according to Hernández (2016): "*It is a manifestation of poverty consisting not only of an imbalanced ratio of household income to energy expenditures but also one that includes physical and behavioural realms of hardship. In this way, energy insecurity is akin to food insecurity*." In fact, an almost equal number of U.S. households encounter food insecurity as do experience energy insecurity (16 million versus 17 million, respectively). Many are burdened by both. Energy insecurity is determined by access to decent, efficient and affordable housing. Both, energy and food insecurities, are embedded within larger contexts of material deprivation and neighbourhood disadvantage (ibid). In addition, energy insecurity is predicated on markers of social disadvantage such as low socioeconomic status, race, ethnicity, family composition and housing tenure; all also considered key social determinants of health. It is also set within the larger context of neighbourhood disadvantage, where factors such as racial residential segregation, concentrated poverty, limited social cohesion, and deficient institutions produce a backdrop of structural challenges with direct implications for the availability of a decent housing stock. Unsafe neighborhood conditions also amplify the salience of the home environment as people stay home more often to avoid violence and danger.

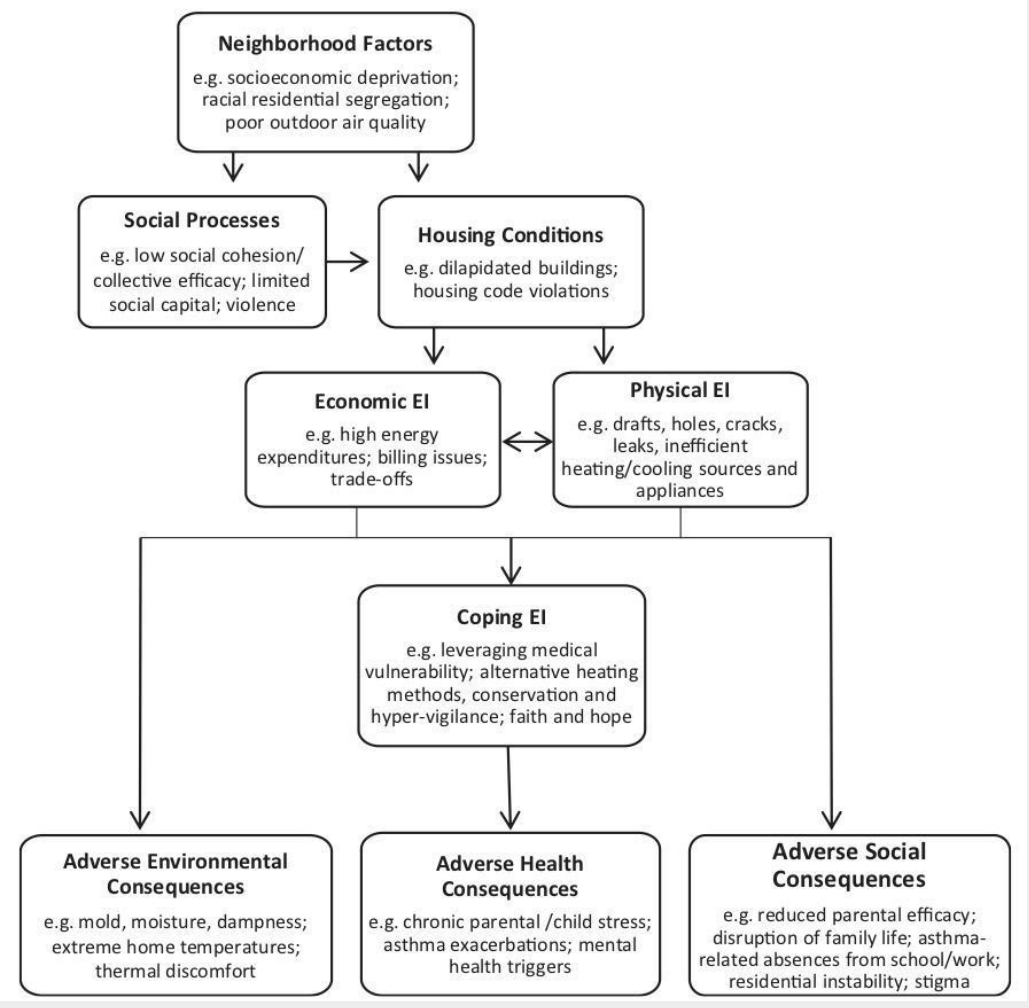

Figure 12: Energy insecurity pathways (Source: Hernández, 2016).

Hernández et al (2014) found that African Americans across the economic spectrum experienced economic energy insecurity at the highest rates, while Asian and Latino immigrants were the least burdened. Cook et al (2008) found that children in moderately and severely energy-insecure homes are more prone to food insecurity, hospitalisations, poorer health ratings, and developmental concerns than children in 'energy secure' homes. The 'heat or eat' dilemma demonstrates the trade-offs that low-income householders make in order to meet the basic necessities of life, whereby at-risk groups are forced to decide between food and energy, often sacrificing one for the other (Frank et al, 2006). Beyond these limited examples, attention to energy insecurity remains scant and research in this area is severely underdeveloped (Hernández, 2013). Figure 12 above by Hernández (2016) provides a graphical summary of the different factors that contribute to energy insecurity and the associated pathways and consequences.

Energy justice

'Energy justice' seeks equity for vulnerable populations along the energy production and consumption continuum, or, as Sari et al (2017) state: "*Energy justice seeks to embed principles of justice, fairness and social equity into energy systems and energy system transitions*". Energy justice can be local, regional, national and international in both approach and application (ibid). Hernández (2015), for example, recognises *sacrifice* and *insecurity* as central tenets of the present energy landscape in the U.S.: "*While the call for energy justice is broad and includes imperatives to move toward healthy, sustainable energy production and access to the best available energy infrastructure, the movement relates directly to energy insecurity with demands for affordable energy and uninterrupted energy service. Housing, poverty and public health advocates should consider promoting energy justice in order to address the complex social, environmental and public health problem that is energy insecurity*."

Similarly, Sovacool et al (2019), in four technological case studies at the household level in the UK, examine the 'affordability', sustainability', 'equity' and 'respect' within the energy justice framework. They show that transforming the household energy system with technological innovations creates plenty of desirable opportunities, but also complex tensions and risks that need to be actively managed. Examples they provide are "*those without the internet or a smart phone who may have less access to future energy service contracts; those who cannot comprehend the technicalities may miss out on lower energy bills, even though they pay to subsidise them; and those who cannot upgrade their heating to low carbon alternatives because they lack the capital or live in poorer quality*". Lacey-Barnacles (2020) highlights the "*interconnections between the geographies of both social inequalities and the physical siting of new energy generation infrastructures*", a form of geographic, or spatial energy injustice.

DellaValle & Sareen (2020), in their work on how nudging and behavioural economics can contribute towards achieving energy justice, write that "*Energy Justice is unlikely to be achieved of its own accord, and requires interventions at multiple levels. Energy Poverty [...] is a pertinent instance where principles of Energy Justice are routinely violated. Inequity is deeply built into most energy sectors by virtue of their specific contextual history, institutional structure, and the socio-material aspects of energy services*."

Jessel et al (2019) offer a critical analysis of the vast but disjointed literature on energy insecurity. They critique that much of it lacks an *environmental justice framework*, and they exemplify this issue by discussing the *lack of intersectional consideration* of the rising wealth gap, coupled with increasing urbanisation, and energy transitions (note, this review was published before COVID-19, which created and deepened further vulnerabilities). They also highlighted energy-related issues in the Global South, which are under-explored in the literature. They extol that the Global South must be taken into consideration when designing interventions, because energy reform anywhere has global implications.

Finally, they rightly highlight the current and future impact of the climate crisis on energy insecurity and the need for greater consideration of climate and ecological emergencies when conducting research on energy insecurity.

Sari et al (2017) and UKERC et al (2018) separate energy justice into *procedural, distributive* (or distributional) and *recognitional* justice (with Sari et al, 2017, also adding *cosmopolitan*, i.e. universal justice):

- *Procedural justice* is the ability of people to be involved in decision-making procedures around energy system infrastructures and technologies.
- *Distributional justice* falls around questions of the siting of energy infrastructure and economic issues of benefits and burdens ('who gets what').
- *Recognition justice* - is about understanding the basis for social inequalities and the acknowledgement or dismissal of marginalised and deprived communities in relation to energy systems.

In Sovacool et al (2016), energy justice is defined based on a core set of eight principles to evaluate using a decision-making framework:

(1) Availability
(2) Affordability
(3) Due process
(4) Transparency and accountability
(5) Sustainability
(6) Intra-generational equity
(7) Inter-generational equity
(8) Responsibility.

Appendix C - Audience definitions

Chapter 3 - Vulnerable Households

Rural households / geographically isolated

The U.S. Census Bureau's definition of *rural* is "any place outside of an 'urbanised area' (population of 50,000 or more) or an 'urbanised cluster' (population of at least 2,500 and less than 50,000)". When referring to 'remote' communities, Winner et al (2018) include those that are either only accessible by plane or boat at least some of the year or those that are otherwise geographically isolated from population centers. Statistics NZ defines *rural centres* by population size, having a population of 300 to 999 in a reasonably compact area that services surrounding rural areas (district territory). In Sweden, *rural areas* are within 5 – 45 minutes travel time from urban areas with more than 3000 inhabitants. *Remote rural areas* more than 45 minutes travel time away from urban areas with more than 3000 inhabitants and islands without fixed connections to the mainland[131].

A useful distinction between rural and urban households is given by the UN[132]: "*Although there is a tendency to associate rural households with the agricultural use of parcels and urban households with housing, the reality is more complex because there are frequently different types of parcel use regardless of housing. … [Rural] households are not always involved in farming production and in some cases carry out other economic activities. Similarly, urban household parcels are not solely used for dwellings; in many cases they can house various economic and commercial activities*."

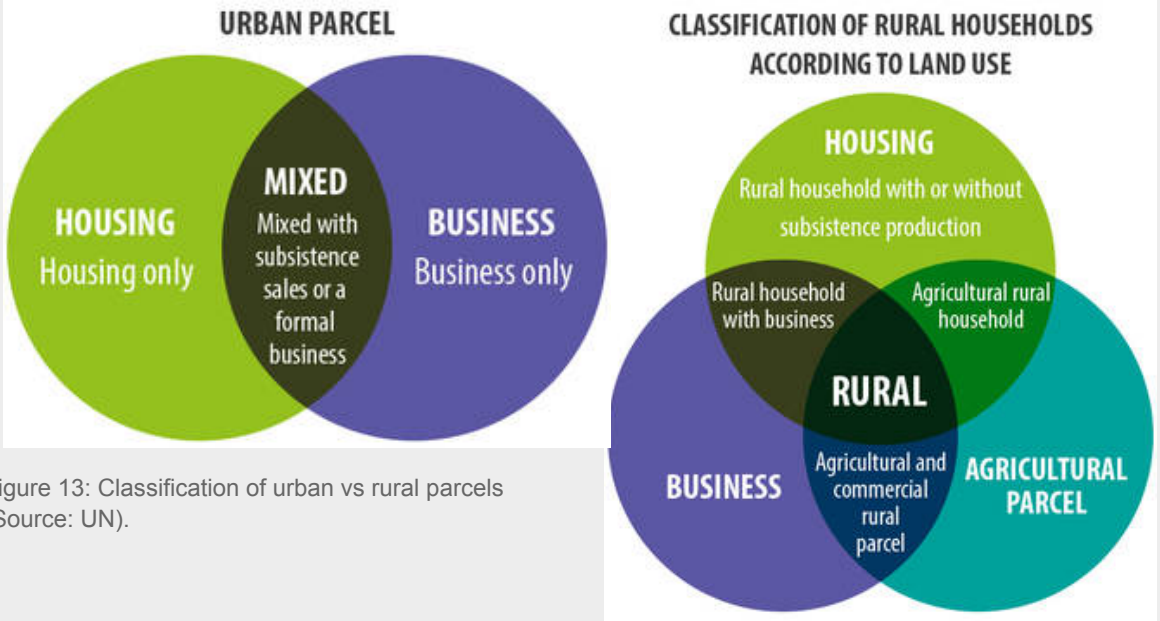

Figure 13: Classification of urban vs rural parcels (Source: UN).

Minorities

According to dictionary.com, a minority is "*a racial, ethnic, religious, or social subdivision of a society that is subordinate to the dominant group in political, financial, or social power without regard to the size of these groups*." It is important to differentiate here between the general vs academic usage of the term 'minority': Common usage of the term indicates a *statistical minority*; however, academics refer to *power differences* among groups rather than differences in population size among groups

131 https://archive.nordregio.se/en/Metameny/About-Nordregio/Journal-of-Nordregio/Journal-of-Nordregio-2010/Journal-of-Nordregio-no-2-2010/Official-defini/index.html

132 http://www.fao.org/in-action/herramienta-administracion-tierras/module-4/conceptual-framework/rural-urban-households/en/

(Barzilai, 2010). Then, there is the issue between 'voluntary' (immigrants and refugees) and 'involuntary' (people brought into a country against their will) minorities, as well as that of social identity as outlined by Liebkind (1989). Healey (1972) adds: "*In sociology, a minority group refers to a category of people who experience relative disadvantage as compared to members of a dominant social group. Minority group membership is typically based on differences in observable characteristics or practices, such as:* ethnicity *(**ethnic minority**),* race *(**racial minority**),* religion *(**religious minority**),* sexual orientation *(**sexual minority**), or* disability (***health minority***)." And, as with all of our HTR audiences, there is potential *intersectionality* between different minority or vulnerable groups. Not all minorities are automatically HTR, of course (especially with regards to energy efficiency). But some minorities, and especially their intersectionalities (e.g. Indigenous pregnant women who rent multifamily housing on a single income; recently-bereaved elderly with physical disabilities who lost their primary caregiver also responsible for paying the utility bills), will be among the hardest-to-reach audiences for energy Behaviour Changers. Here we focus on *women, racial and ethnic minorities,* which includes *migrants and refugees,* and people with *physical and mental disabilities*. The EE literature specifically mentions these minority segments as being HTR under certain circumstances or contextual factors.

Women

The definition of women here refers to a self-identified adult, female person (e.g. including trans women, although we found no literature examining transgender minorities in EE programmes). We agree with Petrova & Simcock (2019) that gender is "*a social structure that labels and legitimises particular behaviours, roles and responsibilities as 'feminine' or 'masculine', which in turn works to 'script' and bound social action in various ways*". Even though women are obviously not a minority in most countries in terms of numbers, they are often disadvantaged, including by EE programmes that do not collect, and/or differentiate between gender variables (see e.g. **Appendix D,** but also the excellent book "Invisible Women" by Criado Perez, 2019).

Racial / ethnic minorities

Indigenous / First Nations

The word 'Indigenous' refers to "*the notion of a place-based human ethnic culture that has not migrated from its homeland, and is not a settler or colonial population*" (Stewart, 2018). To be Indigenous is therefore by definition different from being of a world culture, such as the Western or Euro-American culture: "*Originating or occurring naturally in a particular place; native*." Different countries prefer to use different terminologies for Indigenous peoples, for example, in Canada and Australia, *aboriginal* is still commonly-used (though it, as well as the term *native* are now often disregarded as disrespectful terms whose use is discouraged); in Canada, *First Nations* is a common descriptor for the Indigenous peoples. In the U.S., *Native American* or Indigenous are more commonly used. Regardless, these individuals and communities are typically self-identified, and include those living both on and off reservations. In Aotearoa New Zealand, *Māori* are the Indigenous peoples; and in Sweden and the other Scandinavian nations it is the *Sami, Sámi*, or *Saami*. They are an Indigenous Finno-Ugric people inhabiting *Sápmi*, which today encompasses large northern parts of Norway, Sweden, Finland and the Kola Peninsula within the Murmansk Oblast of Russia.

Black, Asian, Hispanic minorities in participating countries

An ethnic minority is a group of people who differ in race or colour or in national, religious, or cultural origin from the dominant group - often the majority population - of the country in which they live[133]. The different identity of an ethnic minority may be displayed in any number of ways, ranging from distinctive customs, lifestyles, language or accent, dress, and food preferences to particular attitudes, moral values, and economic or political beliefs espoused by members of the group. In the United

[133] https://www.scholastic.com/teachers/articles/teaching-content/ethnic-minorities/

States, minority labels often follow the term 'American'. Even the Indigenous population is identified as 'Native American' to distinguish it from *Asian American*, *African American* etc. *BIPOC* (Black, Indigenous and people of colour) is also commonly-used in North America, as is *Black* and *Hispanic* (a person of Latin American origin or descent - though *Latinx* is now often used as a gender-neutral or non-binary alternative to Latino or Latina, however, this terminology is hardly used, liked or known within the Hispanic community[134],[135]). It is important to note that although the U.S. Census treats 'Hispanic' solely as an ethnic group, some members of Hispanic / Latino / Latinx groups, according to Parker et al (2015), see their identity as a racial category. The term 'African-American' is typically used to describe ethnicity, while 'Black' often describes race. *Person of colour* has the broadest explanation as "*a person who is not white or of European parentage*[136]." In the UK, *BAME* (Black, Asian, Minority Ethnic) is most commonly-used.

Migrants and refugees

There is an important difference between migrants and refugees: Migrants make the decision to move based on **choice**. They choose to move to better their circumstances, and are able to decide where they will migrate to. Refugees on the other hand, have **no choice**. They are forced to leave their homes due to fears of violence, starvation and/or persecution. There are also different designations of migrants, with varying levels of vulnerabilities[137] (see Gustafsson et al, 2017):

- *Economic or labour migration* is the movement of people from one country to another to benefit from greater economic opportunities. It is often assumed that such migration is primarily from less economically-developed countries to the more economically-developed countries and from former colonies to the country that was the imperial power.
- *Political migration* often encompasses refugees (but see also *environmental migration*, below). Many people are forced to migrate because of a war, civil war or state policies, which discriminate against particular groups of citizens or people who oppose those in power. These people are unable to return home because they have fears of being persecuted and are unlikely to receive any protection from their government.
- *Environmental migrants* are people (often refugees) who are forced to migrate from, or flee their home region due to sudden or long-term changes to their local environment, which adversely affects their wellbeing or livelihood.
- *Family reunion* refers to members of a family coming to join one of their relatives who is a resident in another country. This commonly includes fiancé(e)s, (proposed) civil partners, spouses, or unmarried or same-sex partners, dependent children and elderly relatives.

Mental or physical ill-health (disabilities)

Disability is generally measured on the basis of the household reference person stating someone in the household has a long-term illness or disability (Snell et al, 2015). A disability is "*a physical or mental condition that limits a person's movements, senses, or activities*", according to the Oxford Dictionary. It can lead to lack of adequate power, strength, or physical or mental ability; incapacity. It is a physical or mental handicap, especially one that hinders or prevents a person from performing tasks of daily living, carrying out work or household responsibilities, or engaging in leisure and social activities. Examples of disabilities are:

- Vision impairment

[134] https://www.washingtonpost.com/nation/2020/08/17/latinx-not-preferred-term-among-hispanics-survey-says/

[135] https://www.newyorker.com/news/daily-comment/who-are-you-calling-latinx

[136] https://www.wusa9.com/article/news/local/black-history/black-vs-african-american-the-complex-conversation-black-americans-are-having-about-identity-fortheculture/65-80dde243-23be-4cfb-9b0f-bf5898bcf069

[137] https://www.striking-women.org/main-module-page/types-migrants

- Deaf or hard-of-hearing
- Mental health conditions
- Intellectual disability
- Acquired brain injury
- Autism spectrum disorder
- Physical disability.

Some of these disabilities will cause different levels of vulnerability in terms of energy efficiency and behavioural interventions, and some (e.g. inability to access or interact with technology) will make certain disabled audiences significantly harder-to-reach than others.

Stigmatised and criminalised

To stigmatise someone is to "*describe or regard as worthy of disgrace or great disapproval*". It applies a negative societal label to groups of people, such as ex-convicts, drug users, those living in or associated with gangs and gang houses, the homeless, and sex workers. All of these groups can also be(come) criminalised, which is "*the process by which behaviors and individuals are transformed into crime and criminals*".

Homeless

Statistics NZ[138] defines homelessness as "*living situations where people with no other options to acquire safe and secure housing: are without shelter, in temporary accommodation, sharing accommodation with a household or living in uninhabitable housing*." Chronically homeless, or "people without a fixed abode" are defined as "*People sleeping, about to bed down (sitting on/in or standing next to their bedding) or actually bedded down in the open air (such as on the streets, in tents, doorways, parks, bus shelters or encampments). People in buildings or other places not designed for habitation (such as stairwells, barns, sheds, car parks, cars, derelict boats, stations, or 'bashes' which are makeshift shelters, often consisting of cardboard boxes)*" (PHE, 2020).

In Sweden, a person is homeless if they are in[139]:

- Acute homelessness ("sleeping rough" or in short-term homeless shelter)
- An institution and not having any housing prior to release, or in an institution even though they should have been released because they lack their own housing
- Long-term living arrangements organised by Social Services
- In private short-term living arrangements.

Having a strong welfare system does not automatically mean that the Swedish residents are completely insulated from homelessness, with some groups (e.g. migrants and especially Romani) hit much harder than others. There are multiple reasons such as breaking up with a significant other, escaping domestic abuse or suffering from mental illness that leads to homelessness in Sweden, but, the lack of affordable housing seems to be one of the main causes (ibid).

Toro et al (1995), when comparing the homeless in the U.S. with the very poor (but not homeless), constructed three roughly comparable groups: the *currently homeless*, the *previously (but not currently) homeless*, and the *never-homeless but poor*. They found that the never-homeless poor individuals were significantly more likely to be receiving public benefits, were less likely to have a

138 https://soupkitchen.org.nz/resources/homelessness/#:~:text=The%20NZ%20Department%20of%20Statistics,a%20household%20or%20living%20in

139 https://borgenproject.org/the-state-of-homelessnesss-in-sweden/

diagnosed mental disorder or problems with substance abuse, and showed lower levels of self-rated psychological distress.

Elderly, pregnant women, and single parents with young children

Older adults are those aged 60 years and over (World Health Organisation, 2013). Pregnant women and single parents with young children are included here, as babies and young children are particularly vulnerable to both (energy) poverty, and the impacts of energy-inefficient and unhealthy housing. We discuss age as an important, yet under-researched demographic variable more in **Appendix D**.

Chapter 4 - High-Income households

First, *income distribution* statistics are used to frame energy use disparities. Income distribution is shown or described in terms of deciles (tenths) or quintiles (fifths). Each income decile or quintile contains 10% or 20% of the population, respectively, with individuals in each decile or quintile over 20 years old. The definition of household varies across countries, however, it is often understood as the unit composed by a house, residence or dwelling, all its occupants and (part of) their income (see e.g. OECD, 2002). In addition, an 'income decile (or quintile) ratio' (sometimes also labelled as 'S90/S10' and 'S80/S20' ratios) is also used as a measure of income distribution in a country or region (Eurostat, 2020). It is defined, for example, as the ratio of the average income of the richest 10% or 20% to the average income of the poorest 10% or 20% of the population (UNDP, 2019). Absolute income categories (as included in Figure 4, for example) are also used mostly in aggregate energy / income statistics compiled by international organisations (e.g. World Bank, OECD).

Secondly, various economics terms are also used in the literature. For instance, '*household income*' is often used as the disposable income that "*consists of all income of the household members derived from economic activity, assets, property ownership and from social transfers [such as] social security and welfare benefits*" (Eurostat, 2020). In order to compare incomes from households of dissimilar sizes, household income must be standardised; this is often done by driving total household income by an equivalent factor (Eurostat, 2020)[140]. Then, the term 'expenditure' is often found in the reviewed literature (see e.g. Nässén, 2014; Oswald et al, 2020). This is frequently defined as when the "*household final consumption expenditure consists of the expenditure, including imputed expenditure, incurred by resident households on individual consumption goods and services*" (OECD, 2020). Among others, expenditure categories include energy and transport. In relation to expenditures, 'consumption segments' (or 'thresholds') are also utilised and defined on an income per capita a day basis: lowest = <U$2.97; low = <U$8.44; middle = <U$23.03; and high = > U$23.03 (World Bank, 2018).

The term '*income elasticity of demand*' is also used to analyse the response in quantity demanded (e.g. on heat consumption, electricity, travel) as a result of a change in income (e.g. increase of 1%; e.g. CEB, 2019; Oswald et al, 2020). Then, an energy-related good or service is classified as luxury / superior, essential or inferior. Likewise, '*price elasticity of demand*' (i.e. a measure of the change in the quantity demanded in relation to price change) is also used to analyse energy use among different income segments (see e.g. Alberini et al, 2011; Fan & Hyndman, 2011) .

Thirdly, '*Lorenz curves*' and '*Gini coefficients'* are also applied to examine energy use, income and (in)equity (Grubler et al, 2012; Khan & Heinecker, 2018). A Lorenz curve is basically a graphical representation of a ranked distribution of cumulative population (x-axis) versus a ranked distribution of a given cumulative resource (e.g. energy, income on the y-axis; Lawrence et al, 2013; Duan & Chen,

[140] In the European Union "the first household member has the weight of 1. For each additional person aged 14 years and over in the household, this factor is increased by 0.5, and for each child aged under 14 years, by 0.3." (Eurostat, 2020).

2018). A perfect line of equality is represented by a 45 degree line (i.e. y = x). Thus, the greater the distance of the Lorenz curve from the diagonal line, the greater the inequality in energy use or income is (Jacobson et al, 2005; Grubler et al, 2012). Then, the Gini coefficient (or index) is mathematically defined based on the Lorenz curve. It "*measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line*" (World Bank, 2020a). Gini coefficient values range from 0 to 1, where 0 represents perfect equality and 1 perfect inequality.

Based on the above-mentioned conceptual elements, and with the purpose of guiding the contextualisation of high-income households within the HTR energy discourse, we define this segment as households that belong to the top income decile (or quintile) and exhibit considerably high, unsustainable energy use patterns (or energy footprints).

Chapter 5 - Renters and Landlords

Tenants (residential and non-residential)
Landlord–tenant law generally recognises differences between residential and commercial leases on the assumption that residential leases present much more of a risk of unequal bargaining power than commercial leases (Rabin, 1984).

Residential leases are contracts that are designed for individuals or groups to live, or reside, in the leased space. Most governmental entities have "recognised the sanctity of the home." Therefore, lessees of residential spaces are generally afforded more rights and protections than commercial leases. It is also because of the presumption of unequal bargaining power that residential spaces are afforded more protections. Countries, states, counties, and cities have different laws, and likewise, varying levels of protections for the tenants and landlords of commercial spaces.

Non-residential leases are leases for spaces that are for business uses, such as industrial, office, retail, and manufacturing. Such commercial leases generally have fewer consumer protections than residential leases because they are subject to much more negotiation.

Residential tenancy and commercial tenancy each contain their own categories. We will not go into further detail of these different tenancies, here.

Residential tenants

The parties in a Residential Lease include the *landlord* or *lessor* and the *tenant* or *lessee*. The landlord is the person who owns or manages the rental property, and the tenant is the person who lives in the property in exchange for regular rent payments. Modern landlord-tenant law includes a number of other rights and duties held by both landlords and tenants.

Commercial tenants

A commercial lease is a detailed written agreement for the rental by a tenant of commercial property owned by the landlord. Commercial property differs from residential property in that the property's primary or only use is commercial (business oriented), rather than serving as a residence. The obligations of a landlord of commercial property are usually set out in the *Deed of Lease* between the landlord and tenant. There are also obligations implied by statute law.

Commercial leases are often more complex than residential leases, have longer lease terms, and may provide for the rental price to be tied to the tenant business's profitability or other factors, rather than a uniform monthly payment (though this is also quite ordinary in commercial leases).

Landlords (residential and non-residential)
A landlord is the owner of a house, apartment, condominium, land, or real estate which is rented or leased to an individual or business, who is called a tenant (also a lessee or renter). When a juristic person is in this position, the term landlord is used. Other terms include lessor and owner. An owner is one who owns (something) while the landlord is a person who owns and rents land such as a house, apartment, commercial space or condo. A landlord can rent to either residential or commercial tenants depending on zoning restrictions and type of property.

Landlords typically provide the necessary maintenance or repairs during the rental period, while the tenant is responsible for the cleanliness and general upkeep of the property. Specific duties and obligations of each party will be spelled out in a lease agreement. Landlords are responsible for maintaining their rental properties in a habitable condition, managing security deposits, and ensuring that a property is clean and empty when a new tenant moves in. The landlord must also follow all local building codes, perform prompt repairs, and keep all vital services, including plumbing, electricity, and heat, in working order.

Property Management (residential and non-residential)
Property management[141] is the overseeing of residential, commercial and/or industrial real estate, including apartments, detached houses, condominium units, and shopping centres. It typically involves the managing of property that is owned by another party or entity. The property manager acts on behalf of the owner to preserve the value of the property while generating income. Property managers help owners create budgets, advertise rental properties, qualify tenants, collect rent, comply with local landlord-tenant and real estate board laws, and maintain properties. Preventive maintenance, interior, and exterior cleaning, and construction all fall within the scope of a property management company's responsibilities. Owners pay property managers a fee or a percentage of the rent generated by a property while under management. We will generally not differentiate here between landlords and property managers.

Multi-family apartments (MFAs)
According to the last U.S. Census in 2010, *multi-family residential is a classification of housing where multiple separate housing units for residential inhabitants are contained within one building or several buildings within one complex*. The attached single-family category consists of housing units that are separated by a ground-to-roof wall, are not stacked vertically, have separate heating systems, and have separate utility meters. Conversely, the multi-family category includes all buildings containing at least two housing units which are adjacent vertically or horizontally. If built side-by-side, they (1) do not have a wall that extends from ground to roof, or (2) share a heating system, or (3) have interstructural public utilities such as water supply / sewage disposal. Units can be next to each other (side-by-side units), or stacked on top of each other (top and bottom units). A common form is an *apartment building*. Many intentional communities incorporate multifamily residences, such as in *cohousing* projects. Sometimes units in a multifamily residential building are *condominiums*, where typically the units are owned individually rather than leased from a single apartment building owner.

Chapter 6 - Commercial Sector

Sectors and subsectors (by building types)
The UK *Valuation Office Agency* (VOA) defines four high-level bulk classes of premises: *shops, offices, factories, and warehouses*. However, at the lowest level of detail, they identify as many as 400 categories (Bruhns & Wyatt, 2011). Janda et al (2014) point out that most of the energy end-use attention focuses on the first two high-level categories (*office* and *retail*), with some attention on *hotels,*

[141] From https://www.investopedia.com/terms/p/property-management.asp

schools, hospitals, and other 'major' (defined by percentage of floor area; social or economic importance; or energy intensity) building types. As Janda et al (2014) aptly say: "*However, we also know that these major sub-sectors alone do not capture the complete picture of the non-domestic market. The full picture includes a much more diverse mix of activities ranging from abattoirs (slaughterhouses), to dry ski slopes, museums, village halls, and zoos*."

Offices

The *Commercial Buildings Energy Consumption Survey* (*CBECS* by EIA, 2012) defines offices as "*Buildings used for general office space, professional office, or administrative offices*." This definition includes fields such as law, accounting, marketing, and engineering, among others. The aforementioned focus (Chester et al, 2020; **Gap Analysis Chapter 8**, above) on three overarching energy-using technologies (lights, equipment and HVAC) tends to paint the commercial sector with a single broad brush. When reviewing the literature, Chester et al (2020) found that these behaviours were intended to be applicable mostly to the office environment, not necessarily the broader 'commercial sector'. Energy use by computing in offices alone has contributed to growth of nearly 30% of final energy demand in the European services sector between 1990 and 2009 (Murtagh et al, 2013). Energy used at individual workstations was found to account for up to 88% of total office equipment energy use whilst actual utilisation of equipment by occupants, may be as low as 43% (Mulville et al, 2017). Mulville et al (2017) showed an almost 20% reduction in energy use by relatively simple energy-using behavioural changes.

Retail

Whereas the office sub-sector is relatively homogenous (despite the unique layouts, operations and business uses of an individual office), the mercantile sub-sector contains a wide and diverse set of businesses to consider (Chester et al, 2020). Retail operations may be *standalone* (defined by CBECS as "*Buildings used for the sale and display of goods other than food (e.g. beer, wine, or liquor store; rental center; dealership or showroom for vehicles or boats; studio/gallery), or they may be in a shopping mall"* (defined by CBECS as "*Shopping malls are comprised of multiple connected establishments (e.g. enclosed mall; strip shopping center*"). In addition to having different business uses, these retail buildings also have different energy needs. For example, a clothing store's energy need will be focused on lighting, whereas a grocery store's biggest energy drain will be refrigeration.

Lodging

EIA's CBECS (2012) defines the lodging sector as "*Buildings used to offer multiple accommodations for short-term or long-term residents, including skilled nursing and other residential care buildings. They include: motels or inns; hotels; dormitories, fraternities, or sororities; retirement homes; nursing homes, assisted living, or other residential care facilities; convents or monasteries; shelters, orphanages, or children's homes; and halfway houses*."

Food Service

The food service sector is described as involving the "*preparation and sale of food and beverages for consumption. Buildings include fast food restaurants or cafeterias; bars; catering services or reception halls; coffee, bagel, or doughnut shops; ice cream or frozen yogurt shops*" (EIA, 2012). Most of this type of business (but not all, e.g. hospitals) takes place in restaurants (Chester et al, 2020). Food service establishments are another commercial sub-sector of high importance, as well as noted diversity (e.g. sit-down vs. counter service, fast food vs. fine dining). We are focussing only on direct energy used in buildings used by the food service sector, here, not the entire, or indirect energy consumption along the food chain.

Health Care

Health care includes diagnostic and treatment facilities used for both *inpatient* (defined by CBECS as "*Buildings used as diagnostic and treatment facilities for inpatient care. They include hospitals; inpatient rehabilitation) and outpatient care"* (defined by EIA, 2012 as "*Buildings used as diagnostic and treatment facilities for outpatient care. Medical offices are included here if they use any type of diagnostic medical equipment (if they do not, they are categorised as an office building). Such outpatient care buildings include medical offices; clinics or other outpatient health care; outpatient rehabilitation centres and veterinarians).*" Health care frequently, but not always, takes place in hospitals. Hospitals might get overlooked within the commercial sector as people may not think of them as a traditional 'business'. However, even though they only account for 4.9% of total commercial space floor area, an immense amount of energy (10.3 % of total U.S. energy use) is used in hospitals and other medical facilities, often 24 hours per day (Bawaneh et al, 2019).

Education

CBECS describes education buildings as those "*used for academic or technical classroom instruction, such as elementary, middle, or high schools, and classroom buildings on college or university campuses*." Different educational facilities bring their own unique challenges and opportunities.

Warehouse and storage

CBECS defines warehouse and storage as "*Buildings used to store goods, manufactured products, merchandise, raw materials, or personal belongings (such as self-storage). They include refrigerated warehouses; non-refrigerated warehouses; distribution or shipping centers)*." In EIA (2012) data, the category of warehouse and storage is assigned 14% of commercial buildings, 15% of floorspace, 13% of electricity consumption, and 8% of natural gas consumption in the commercial sector.

Manufacturing industry

Defined as "*the branch of manufacture and trade based on the fabrication, processing, or preparation of products from raw materials and commodities. This includes all foods, chemicals, textiles, machines, and equipment*", the manufacturing industry accounts for about 75% of the world's yearly coal consumption, 20% of global oil consumption, and 44% of the world's natural gas consumption, as well as using 42% of all electricity produced (Rohdin & Thollander, 2006).

Community-serving institutions

Community-serving institutions were defined by Drehobl & Tanabe (2019) as "*organisations that provide local and direct services to communities and include nonprofit organisations, charitable and philanthropic organisations, religious centers, transitional centers and shelters, clinics and hospitals, municipal buildings, community centres, educational institutions (e.g., K–12 schools, community colleges, trade schools, vocational schools), and small commercial businesses (e.g., food service, retail, food sales, offices, entertainment), especially those that are locally owned or operated*".

Other non-residential sectors

Other sectors, for which no specific publications related to efficiency behaviours were found by Chester et al (2020), include food sales, public assembly, public order and safety, religious worship, services, other and vacant buildings. They are defined in more detail below**.** Although there are some clear definitions of various commercial sub-sectors, they get conflated with the building types they generally occur in. For example, some of these buildings' primary usage may be that of a commercial sub-sector, but these buildings can also be used *secondarily* by other, quite different sub-sectors. A good example are religious worship buildings that are often also used for community gatherings or even sports or retail (e.g. during church fares) activities. We further explore these issues in the **Gap Analysis Chapter 8**.

More commercial sector definitions

Definitions from CBECS (EIA, 2012):

- *Food sales* ("Buildings used for retail or wholesale of food. They include grocery stores or food markets; gas stations with a convenience store; convenience stores")
- *Public assembly* ("Buildings in which people gather for social or recreational activities, whether in private or non-private meeting halls. They include social or meeting places (e.g. community center, lodge, meeting hall, convention center,senior center); recreational facilities (e.g. gymnasium, health club, bowling alley, ice rink, field house, indoor racquet sports); entertainment or culture (e.g. museum, theater, cinema, sports arena, casino, night club); libraries; funeral homes; student activities centers; armories; exhibition halls; broadcasting studios and transportation terminals)
- *Public order and safety* ("Buildings used for the preservation of law and order or public safety. They include police stations; fire stations; jails, reformatories, or penitentiaries; courthouses or probation offices")
- *Religious worship* ("Buildings in which people gather for religious activities, such as chapels, churches, mosques, synagogues, and temples")
- *Services* ("Buildings in which some type of service is provided, other than food service or retail sales of goods. These include vehicle service or vehicle repair shops; vehicle storage / maintenance (car barns); repair shops; dry cleaners or laundromats; post offices or postal centers; car washes; gas stations; photo processing shops; beauty parlor or barber shops; tanning salons; copy centers or printing shops; kennels")
- *Other* ("Buildings that are industrial or agricultural with some retail space; buildings having several different commercial activities that, together, comprise 50 percent or more of the floorspace, but whose largest single activity is agricultural, industrial / manufacturing, or residential; and all other miscellaneous buildings that do not fit into any other category. They include airplane hangars; crematoriums; laboratories; telephone switching; agricultural with some retail space; manufacturing or industrial with some retail space; data centers or server farms")
- *Vacant Buildings* in which "more floor space was vacant than was used for any single commercial activity at the time of interview. Therefore, a vacant building may have some occupied floorspace".

Chapter 7 - SMEs

Traditionally, 500kW annual energy consumption has been used as the cutoff to differentiate between 'large' and 'small / medium' customers in the U.S. (Quantum Consulting, 2001). In other countries, like Aotearoa and the UK, the cut-off is based on employee numbers, rather than energy consumption. A small business in NZ and Australia, for example, is one below 20 employees (MBIE, 2017), the UK and EU differentiate between micro (0-9 employees), small (10-49 employees), medium (50-249 employees) and large (>250 employees, UK Government, 2019). A large NZ business is regarded as one with more than 50 employees, which differs to the U.S. where only businesses >500 employees are regarded as 'large'[142]. SMEs comprise <97% of all NZ businesses (ibid), in the UK 96% have fewer than 10 employees (UK Government, 2019) and in the U.S. 99% of all businesses are classified as SMEs (but note the difference in employee numbers as cut-off).

An analysis into HTR non-residential customers of PG&E (Quantum Consulting, 2001) showed that "of the categories identified by CPUC, the two most significant segments are *renters* and *businesses with less than 10 employees*, which combined comprise over 60% of the small / medium non-residential population in terms of annual energy consumption. Furthermore, these two segments overlap significantly with *strip malls, convenience stores* and *local chain / single-location restaurants*."

[142] https://www.bizjournals.com/bizjournals/on-numbers/scott-thomas/2012/07/16055-companies-fit-the-definition-of.html

Drehobl & Tanabe (2019) discuss methods programme implementers use to better reach underserved organisations, which are usually around criteria based on energy use or building size (see Table 4 in their paper for a list of definitions used by programmes). Meyers & Guthrie (2006) also underline the importance of identifying the right target audience. They suggest identifying HTR customers by analysing the *Customer Information System* (CIS) of the utility or a partnering CBO. When available, they recommend prioritising these customers by geography, energy intensity, or business type (NAICS Code).

Appendix D. Demographic residential research gaps

Gender

We have seen from the studies focusing on HTR audiences outside the energy sector (see Table in **Appendix A**) that there is often a focus on *gender* as a qualifier of specific HTR audience groups. For example, predominantly male-focused data is collected on young fathers (Osborne, 2015; Davies, 2016), ex-prisoners (Sugie, 2018; Ogbonnaya-Ogburu et al, 2019), and working class men in sports clubs (Hulton et al, 2016; Lewis et al, 2017), whereas predominantly female-focused data is collected around single mothers (Ampt & Hickman, 2015; Morgan, 2016), immigrants / refugees (Agadjanian & Zotova, 2012; Mehrsa et al, 2018; McNicoll, 2019) and sex workers (Crawford, 2016; Thorburn & deHaan, 2017). However, the energy literature does not often focus on gender, specifically, with some exceptions which we outline below. It is important to note that not all of the examples given below necessarily imply that (all) women are HTR, more is it to highlight the gaps in gender data information and where gender differences may potentially lead to biased sampling (e.g. Waitt, 2017) or where specifically targeting women audiences may be appropriate (e.g. Sernhed, 2008).

Influence over, and attitudes to household energy behaviour

Domestic behaviour (and thus domestic energy use) and behaviour change may not fall equally to all household members (Carlsson-Kanyama & Lindén, 2007; Robinson, 2019) but many studies on domestic energy feedback, and economic models of domestic energy use, tend to treat the household as a single unit: differences within households remain largely underexplored (Waitt, 2017; Petrova & Simcock, 2019). Pachauri & Rao (2013), Petrova & Simcock (2019), Robinson (2019) highlight gender differences in household practices of responding to, and resisting energy poverty, and the emotional labour of living with energy poverty. Listo (2018) speculates that the energy poverty literature's reluctance to associate gender inequality with energy poverty because "*it can reinforce detrimental discourses that have characterised women as vulnerable, submissive and repressed, and fail to reflect individual agency*". Murtagh et al (2014) and Petrova & Simcock (2019) found that women were particularly influential on energy use through their primary responsibility for domestic labour on behalf of the household. In their UK-based study with 15 households, Hargreaves et al (2010) found that the in-home devices (IHDs) in their study appeared to have gendered appeal and to have one main user, usually a male. In addition to observing the negotiations generated within the household by the IHD, their insightful study noted quite dramatic variation in energy use that the different genders characterised as necessity, ranging from comfort and warmth to fish tanks.

Murtagh et al (2014) described full-time mothers who linked their energy conservation efforts with contributing towards the home. They viewed their efforts as making a financial contribution, important for them as they were not earning an income, and taking responsibility for this domain. The fathers in several interviews demonstrated an internal argument in which they were aware of their desire to save energy but had to negotiate the conflict this generates with their desire to attend to their children's perceived needs. With respect to use of the IHD, a number of households demonstrated the same gendered pattern noted in other studies (see also Rotmann, 2014 on gender differences in smart homes in NZ): the husband was interested in the monitor, the wife did not get involved but was averse to any automation of her heating or hot water devices.

When it came to caring about electricity use in the home, Murtagh et al (2014), Rotmann (2014) and Petrova & Simcock (2019) also found that women were slightly more likely to care more and attempt to save energy (as opposed to EE installations). However, it usually was that the person who cared more also paid the bills and it was not necessarily the main wage earner who took responsibility for bill paying. There appeared to be an accepted division of responsibilities within couples: one person, often the woman, was responsible for home administration tasks which included paying bills. A clear

difference emerged when it came to use of electricity. In ten households studied by Murtagh et al (2014), the participants felt the woman used the most, because she took primary or full responsibility for domestic chores including cooking, clothes washing and vacuuming. Thus, in carrying the major load of domestic work (see Dixon & Weatherell, 2004), women may be the primary consumer of electricity on behalf of the household.

One important issue Murtagh et al (2014) raised bears quoting: "*In seeking to increase engagement of householders in energy conservation, although men have influence in the home, we argue that it is more important to address women's lives and concerns. [...] The evidence here demonstrates how such assumptions neglect the embeddedness of energy use in social practices and relationships, and in domestic routines. Questioning such assumptions may lead to a broader conceptualisation and understanding of energy use and of opportunities for energy saving and Wajcman (2010) argues that women's involvement in technological innovation is 'imperative' in order to ensure the 'appropriation' of technologies in the home*." Recent feminist research on gender and energy poverty by Wiatt (2017), Listo (2018), Petrova & Simcock (2019), and Robinson (2019) underpins the importance to not treat EE as a 'masculine' intervention and acknowledge the disproportionate impacts of energy poverty (and now also, COVID-19) on women and children.

Boomsma et al (2019) agreed that energy-saving behaviour (ESB) studies which focused on gender suggest that women tend to be more concerned about energy use and are more likely to save energy compared to men (Barr et al, 2005; Carlsson-Kanyama & Lindén, 2007). However, they raise that some evidence suggests that this relationship depends on the specific ESBs that are being measured and the specific context. In a European study across four countries, men were found to consume more direct and indirect energy compared to women, but this difference was largest in the transport sector and smaller for household energy use (Räty & Carlsson-Kanyama, 2010). Also, in an organisational setting, males were found to have stronger intentions to conserve energy compared to females (Chen & Knight, 2014), although females were found more willing to adapt to uncomfortable thermal situations than males at work (Hatvani-Kovacs et al, 2016).

Gender differences in thermal comfort

Karjalainen (2007) conducted a quantitative interview survey to identify the difference between thermal comfort for males and females. He found that females preferred a higher room temperature than their male counterparts. This finding was also supported by Li et al (2008), who confirmed that with no difference in the neutral temperature, females preferred a slightly warmer environment than males mainly because their skin temperature is constantly lower than males. Hatvani-Kovacs et al (2016) showed that females perceived heat waves stronger than males. Marí-Dell'Olmo et al (2017) found possible positive effects of façade insulation interventions on cold-related mortality in women living in social housing, but not in men. Brounen et al (2012), however, found no evidence on the influence of gender on temperature preferences of individuals. The average annual electricity consumption in the households with a female head of household (HoH) was higher than those with a male HoH. In some cases, the households with a female HoH consumed up to 3.4 times more electricity than the households with a male HoH (Esmaeilimoakher et al, 2016).

Sernhed (2008) provides a lot of interesting insights into gender differences around home energy use in Sweden - including how it changes with age. She makes this important point: "*The differences between women and men drag up the subject if it would not be better to focus on female experiences in some research questions and on male experiences in others. The problem is that the households are treated as a unit of analysis in research. Methodologically, it would be possible to, for example, make more than one interview in households with more than one individual. The benefits from taking this concern must nevertheless be put in relation to the additional costs in time, money and other*

resources that would be required, and the aim of the study must determine whether this approach would be worthwhile or not."

There are several points to raise with regards to HTR research and audience characteristics as defined by gender. For example:

- *Are women more HTR than men when it comes to requiring changes in thermal comfort?* The literature seems to be ambiguous on this topic, and there may be differences between the residential (Li et al, 2008) vs commercial sector (Hatvani-Kovacs et al, 2016).
- *Does a higher energy service demand automatically make women (or men) a HTR audience?* This is also ambiguous and the HTR literature has not tested this assumption. However, as COVID-19 has disproportionately affected women (e.g. Fawcett Society, 2020; PHE 2020; Wenham et al, 2020), and highly-vulnerable populations like single mothers with children will suffer even more from prolonged lockdowns, school closures and unemployment, it is an important demographic variable to assess.
- *In general, does gender qualify as an HTR element or selection criterion?* To Sernhed's (2008) point, above, it seems that gender is an exceedingly important demographic to include and test for in HTR research, however, this will also raise research costs and may need specialised gender researcher advice in the interpretation of any data.

Age

Age is an extremely important socio-demographic and the elderly are often found to be specifically vulnerable (see **Vulnerable Households Chapter 3**), and HTR e.g. due to technological inaccessibility (see e.g. Brown & Markusson, 2019) or frailty and disability. However, research on the effect of age on ESB is somewhat mixed (Boomsma et al, 2019). It has been studied well related to energy use in housing (see Esmaeilimoakher et al, 2016; Willand et al, 2017; Karatasoua et al, 2018; van den Brom et al, 2018; Guerra-Santin et al, 2018; Boomsma et al, 2019), as well as fuel poverty and health in young people and children (e.g. Howden-Chapman et al, 2008; Aguirre-Bielschowsky et al, 2015; O'Sullivan et al, 2017; Shorter et al, 2018), as well as the elderly (e.g. Howden-Chapman et al, 1999; Preval et al, 2017; Johnson et al, 2018). However, it usually refers only to the age of the head of household (HoH), rather than the age composition of the entire household (Bhattacharjee & Reichard, 2011).

Karatasoua et al (2018) showed, in a major review of socio-demographics determining energy use in social housing in Europe, that neither children nor teenagers have a major influence over energy consumption, but that elderly (>65yo) consume, on average, less electricity (however, cf. that with Guerra-Santin et al (2018) and van den Brom et al (2018) who showed the highest energy consumption levels in senior MFA households). That was speculated to be because households with older residents tend to traditionally engage in more ESBs (Barr et al, 2005; Willand et al, 2017; Brown & Markusson, 2019). Older households also often own fewer household appliances compared to younger households, and less energy is consumed when using these appliances due to a difference in usage (for instance by turning them off when not in use; Carlsson-Kanyama and Lindén, 2007; Jones & Lomas, 2016). However, there is also research to suggest that older households use more energy compared to younger households when it comes to heating, as they tend to prefer a higher ambient temperature, partly due to health reasons (Wei et al, 2014), and spend more time inside their homes (Guerra-Santin et al, 2018).

On the other hand, occupants between 40 and 50 years in the UK and NL demand the highest comfort and also have the highest average net income (Yohanis, 2011; van den Brom et al, 2018). This stands in contrast with Bhattacharjee & Reichard (2011) finding a positive correlation between householder level of education, age and energy conservation. Qualitative research has shown that older people on

low incomes (a group prevalent in the social housing sector) often struggle to afford keeping warm at home and cope by adjusting their heating behaviour. For instance, they may adjust the length of time for which their home is heated or only heating part of the home, or by wearing warm clothes indoors or going to bed early to keep warm while keeping the heating off or low (Chard & Walker, 2016).

One aspect of aging that the energy HTR literature does not seem to have addressed at all, is the impact of *bereavement* on the elderly (e.g. Rosenzweig et al, 1997). Bereavement and spousal loss is especially common in later life with 24.7% of adults ages 65 and older being widowed, which has significant mental and physical health implications (Jacobson et al, 2017). In addition to the health implications, it can also cause additional issues with (utility) bill payments or being able to afford e.g. heating a large home for only one person. This issue of elderly who are asset-rich but income-poor may be a blind spot for policy makers (DEMHOW, 2009), even in countries with low fuel poverty like Sweden (Gustafsson et al, 2017). This issue is even more pronounced for elderly immigrants and older women (ibid).

Race

The measure of *ethnicity* is based on self-perception and it is possible to belong to more than one ethnic group. In NZ census data, and other official statistics, a person identifying with more than one ethnic group will be counted once in each group. In countries with Indigenous populations and/or highly-diverse populations (like the U.S., Canada and Aotearoa), ethnicity or race is a relatively-common demographic measure. In others, like most western European countries, it is not very commonly-measured (Simon, 2012). This is partly due to legal prohibitions attached to data protection provisions and also due to a political reluctance to recognise and emphasise ethnic diversity in official statistics (ibid).

Aotearoa is one of the few countries that undertakes a significant amount of EE and behavioural research related to housing, poverty, inequality and vulnerable populations, particularly Māori and Pacific Islanders (also called *Pasifika*, those Polynesians who now call Aotearoa their home; see e.g. Howden-Chapman et al, 2007; Pene et al, 2009; Baker et al, 2010; Hales et al, 2010; Johnson et al, 2018). Rising housing costs have contributed to declining home ownership rates, greater housing instability, and Māori and Pacific peoples living in poor quality housing (Johnson et al, 2018). This often leads to overcrowding (Pene et al, 2009), thus further increasing vulnerability to e.g. infectious diseases (rates of these diseases for Māori and Pacific peoples are double those for Europeans, ibid), and often also homelessness, where Aotearoa is a sad leader in the OECD statistics (although this may have changed following COVID-19 responses) - almost 1% of all Kiwis are homeless[143]. In addition, negative health, childhood / early death statistics and the proportion of incarcerated felons also skew predominantly towards Māori and Pasifika, who make up only 15% and 7.4% of the population, respectively (Marriott & Sim, 2014).

A substantial amount of research is aimed at understanding the causes and consequences of residential segregation (a criterion for identifying potential HTR subjects, according to VEIC, 2019) in the U.S., primarily from the fields of sociology and public health (Reames, 2016). However, in the energy sector, very little research focuses on those demographic inequalities (ibid; VEIC, 2019). Low-income communities and communities of colour often experience higher energy burdens and less affordable energy (Drehobl & Tanabe, 2019). Research found that limited-income residential households - and particularly limited-income African-American and Latino/Latina households - experienced higher energy burdens than other households (i.e., they spend a disproportionately high share of their income on energy bills; Drehobl & Ross, 2016; Ross et al, 2016). These households also had higher energy costs per square foot, which suggests that they may live in less-efficient

[143] https://www.newshub.co.nz/home/politics/2017/07/nz-s-homelessness-the-worst-in-oecd-by-far.html

buildings. Higher energy burdens are correlated with long-term impacts on health and well-being, such as greater risk for respiratory diseases, increased stress and economic hardship, and difficulty in moving out of poverty (Drehobl & Ross, 2016).

Reames (2016) undertook a study in Kansas exploring spatial, racial / ethnic and socioeconomic disparities in urban residential heating EE. He found that block groups with lower median incomes, a greater percentage of households below poverty, a greater percentage of racial / ethnic minority headed-households, and a larger percentage of adults with less than a high-school education were, on average, less energy efficient. Results also implied that racial segregation, which continues to influence urban housing choices (see also VEIC, 2019), exposes Black and Hispanic households to increased fuel poverty vulnerability.

It is thus important for Behaviour Changers to not shy away from ‘difficult’ demographic enquiries, such as those related to gender, age and race. Even though collecting audience data pertaining to these demographics, and designing field research and behavioural interventions specifically targeting various demographics will increase cost and complexity of HTR behaviour change research, the implications for not doing so will ensure inequities and other blindspots when trying to engage all energy users in EE and conservation programmes.