# Embedding net zero practice and managing the decarbonising of built environments: domains of nudging, tugging and mooring change

**Embedding net zero practice and managing the decarbonising of built environments: Domains of nudging, tugging and mooring change**

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## ABSTRACT

Decarbonising the economy has drawn more academic management research attention in recent years. Policy practitioners such as the UK Climate Change Commission (2022) frequently review and report on the net zero transition. Significantly, it is identified that scarce changes and progress has been made on the transition towards the decarbonising of built environments. There is therefore a significant challenge for the built environment such as the retail and distribution trades to reduce both *carbon in build* and also *carbon in use*. The immense complexity and related gaps in knowledge on 'how to do this' for moderately heated/cooled built environment stock makes it vital to understand strategic pathway frameworks. This paper contributes to the scientific net zero conversation and the need to embed net zero practice as well as manage the strategic change associated with the decarbonisation challenge. Our findings underline the opportunity for strategically orientating towards the institutional market transition, including *technology cycle, collective mobilization, affirmation and innovation*. We develop an overarching practice framework of how efforts to embed and manage net zero practice form and reflect domains and those generate *pushing (nudges), pulling (tugs) and mooring (ties)* practice in the overall market transition challenges.



**Keywords**: Decarbonisation, retail-built environment

**Track**: Sustainable and Responsible Business Track

**Paper form/stage**: Full paper/empirical

**Word count**: 6006

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## INTRODUCTION

Transitions advancing a low-carbon future are imperative to meet the demands of the Paris Agreement and stay below 1.5 °C of global temperature rise. All business sectors and public institutions have been legally mandated to address this net zero imperative. All business sectors and public institutions are facing into the issue of decarbonising their environments. All business sectors and public institutions are considering how to engage with and undertake sector plans on how to do low-carbon transitions. The conclusions are writ large for all business sectors and public institutions. Yet there is no easy or single solution to the decarbonising puzzle. Policy and academic literature are in agreement on that point. Policy practitioners such as the UK Climate Change Commission (2022) frequently review and report on the net zero transition. Significantly, it is identified that scarce changes and progress has been made on the transition towards the decarbonising of built environments. Decarbonising the built environment requires a widespread adoption and embedding of Low and Zero Carbon (LZC) technological solutions such as solar, wind, hydrogen and geothermal energy (Ferreira *et al*., 2019; Molavi and McDaniel, 2016). However, decarbonising established energy systems brings with it uncertainty and much complexity (Boehm *et al*., 2015; Grubb *et al*., 2015). Carbon intensive energy systems have been long established and are entwined in many structures across large built environment portfolios such as those within the retail sector (e.g., from distribution activities to physical outlet stores). Indeed, the decarbonisation of the built environment in retail and distribution trades requires the institutional acceptance of multiple stakeholders such as policy experts and wider confidence-building actions with stakeholders such as consumers to develop the renewable sector in the long run (Boehm *et al*., 2015; Ramoglou *et al*., 2021). This difficult to abate industry can play a key part in the decarbonisation puzzle, leading the way to decrease energy consumption and Green House Gas (GHG) emissions (Climate Change Committee, 2021; Schönberger, 2013) but also showcasing this decarbonising practice to the wider publics. The environmental footprint and impact by retail firms is a substantial challenge – particularly related gaps in knowledge on 'how to do this' for moderately heated/cooled built environment stock.

Some retailers can be seen as a driving force behind a move to net zero through establishing retail consortiums. As an example, one trade association this sector, the British Retail Consortium (BRC), have put into place a Climate Action Roadmap to deliver net zero in their own operations and the products that they sell by 2040 (BRC, 2022). In their study into the regime dynamics in a Dutch energy transition, Bosman *et al*. (2014) explain that access to secure, affordable and clean energy is high on the political agenda in European countries (e.g., COP26 and the Paris Agreement). These moves are principally driven by concerns over energy supply, climate change and the environmental implications of energy production and consumption (Climate Change Commission, 2021). This further highlights the importance of decarbonising the retail and distribution trades. Our study contributes to the wider debates upon sustainability in management studies (Boehm *et al*., 2015; Grubb *et al*., 2015). This paper contributes to the scientific net zero conversation and the need to embed net zero practice as well as manage the strategic change associated with the decarbonisation challenge.

Management research and social scientists more generally can work at and contribute to the scientific net zero conversation not least because this challenge is complex and involves much change. Traditionally situated within field of management, theories of change and mostly institutional thinking, we argue, can contribute much to understanding the embedding of new practice and energy system transitions (Grubb *et al*., 2015). There exists domains of change in the energy system transitions that overlap with the decarbonising of the built environment. In this regard, we contribute to the existing literature on sustainability studies by providing strategic domain insight into decarbonising the built environments. We draw upon firms operating within the retail and distribution sector, not least because of the significant ownership and/or lease arrangement of this sector. For example, Tesco PLC is one of the largest real estate owners in Europe and have a large portfolio/bank of built environment space. More generally, there is a significant challenge for the retail and distribution trades to reduce both *carbon in build* and also *carbon in use*. We structure our study around two main research questions.

Research question 1: How do you further embed net zero practice within the distribution and retail trades?

Research question 2: How does retail and distribution trades strategically manage the built environment transition through technology solutions?

In order to answer these questions, this paper contributes a practice framework for orientating firms towards decarbonising the built environment. We develop an overarching practice framework of how efforts to embed and manage net zero practice form and reflect domains and those generate *pushing (nudges), pulling (tugs) and mooring (ties)* practice in the overall market transition challenges.

**Decarbonising the retail and distribution trades**

Within the retail and distribution sector, much of the existing literature has provided insights into greenwashing activities, principally due to over reliance upon 'old' fossil fuel energy systems (Boehm *et al*., 2015). In particular, the clothing industry has been highlighted in the literature as enacting unsustainable practices throughout its supply chain activities, from unethical manufacturing processes, to how cotton is produced and the environmental concerns around dying fabrics (Moran *et al*., 2021). Porter and van der Linde (1995; 1999) regarded pollution is a sign of inefficient resource use, arguing that competitive advantages can be sought from innovation and national policies related to reducing environmental impacts. As an emerging LZC technology, geothermal energy is becoming an increasingly important component in the wider LZC energy story, despite high initial installation costs (Molavi and McDaniel, 2016). It is especially relevant when considering heating, ventilation, and air conditioning (HVAC) in the retail sector. In their study of geothermal deployment in retail building projects in the United States, Molavi and McDaniel (2016) suggest that a shift in mindset is required by retail actors. Contrary to dominant logics embedded in economic ways of thought, companies who reduce their Green House Gas (GHG) emissions can in fact increase their productivity whilst reducing energy costs.

In addition, Ramanathan *et al*. (2014) argue that a more collaborative approach to transitioning to LZC technologies in supply chains is needed. This research suggests that collaboration in production, logistics and operations is required to achieve green objectives set by the UK government. The pressure on retailers to 'green' supply chains stems from various central and distal stakeholder groups, such as the government, consumers, and the media (Ramanathan, 2014). Investment into sustainable supply chains in greening the retail sector is a priority, particularly when considering efficient logistics (Ferreira *et al*., 2019).

## Energy transition towards net zero

As a starting point for providing a conceptual understanding of decarbonisation in the retail environment, we draw on the 'Three Domains' of socioeconomic decision-making advanced by Grubb *et al*. (2015). They suggest that the development of energy systems involves three domains of satisficing, optimizing and transforming in the socio-economic process of decision making. The first domain concerns the behavioural, social and contractual characteristics that influence and frequently impede the adoption of even existing, cost-effective technologies. Consumers and organizations do not act according to the principles of economics and therefore an 'efficiency gap' is perceived. Within the context of attempting to decarbonise the retail environment, these behavioural traits mean that 'best practice' is rarely attained in real life scenarios i.e., carbon resources are not being used as efficiently as they ought to be within retail and distribution trades. This suggests that by simply utilizing carbon resources more efficiently, this would result in a decrease in carbon emissions for the short term, providing an apparent potential for improvement in carbon use, apparently without any economic trade off (Grubb *et al*., 2015). In practice this could equate to simply switching off appliances or lighting when not in use within retail buildings for example. This domain draws upon many of the ideas written in the retail marketing field, particularly buyer risk aversion, habits, myopia and vicarious learning (e.g. Kahneman, 2012), and the bounded nature of what institutionalists term 'satisficing' behaviour – the term used to reflect situation in which people appear to be 'satisfied enough' not to change demonstrably sub-optimal conditions.

The second domain characterizes optimizing behaviours. This is the world in which agents, consumers, firms and others act according to the principles of neoclassical economics, with behaviour approximating to the implications of conscious, evaluated decisions to minimize costs and maximize personal or organizational benefits. In second domain processes, innovating activity and investments occur but mostly within an acknowledged 'innovation possibilities frontier'. Innovation is constrained by existing infrastructures and institutions. Policy prescriptions emerging from this domain tend to relate most to markets and relative prices, with interventions justified with reference to market failures and direct externalities (Staub-Kaminski, 2014). The third domain encompasses evolutionary and institutional processes. This embodies more explicit theories of innovation systems and transformation. This domain takes into account the role not only of innovation in discrete technologies, but also the roles of infrastructure, institutions, network effects, learning-by-doing and path-dependencies. As a gatekeeper of the provision of goods and services, the retail industry is influential in shaping the behaviour and consumption patterns of consumers (Ferreira, 2019).

By considering decarbonisation of the retail environment both in build and in use, from a three domains perspective (Grubb *et al*., 2014; 2015), we can shed light upon decarbonisation as a multi-stakeholder breakthrough activity which involves a patchwork of LZC energy solutions-both established and new. It also enables us to highlight many of the processes of (and impediments to) the diffusion of technologies, beyond the purely cost/market-driven perspective through establishing a multi-dimensional push and pull framework.

# METHODOLOGY

***Research Design.*** We employed a qualitative approach to provide an in depth understanding of the decarbonisation of the retail and distribution sector (Eisenhardt and Graebner, 2007; Gioia, 2013). This approach provided an in-depth, rich exploration of the nature of an institutional energy transition towards net zero, specifically the emerging Geothermal energy sector in Northern Ireland. An interpretative, qualitative methodology was employed, where the main data collection method was a series of in-depth interviews with leading policy, trade

associations and geo-scientists. This was further re-enforced by analysis of Retail and Trade Association and climate action reports and web sources. Our qualitative approach provides a fine-grained understanding of the understudied area of the decarbonisation of the retail sector, paying specific attention to distribution and the built environment. This sector was chosen to explore the decarbonisation phenomenon as it is a diverse and highly concentrated industry which is cited as being a major polluter in terms of carbon emissions (Climate Change Committee, 2021; RILA, 2017; Schönberger, 2013). Initiatives such as those put into place by the British Retail Consortium (BRC, 2022) to deliver net zero in their own operations and the products that they sell by 2040, further prompt investigation into this influential sector (Ferreira, 2019). This research context also allowed us to further investigate decarbonisation challenges in the built environment as retail often own or lease large spaces, enabling us to understand how retailors may go about decarbonisation- both in terms of *carbon in build* and also *carbon in us*e. The forthcoming section provides an in-depth account of our methods of data collection.

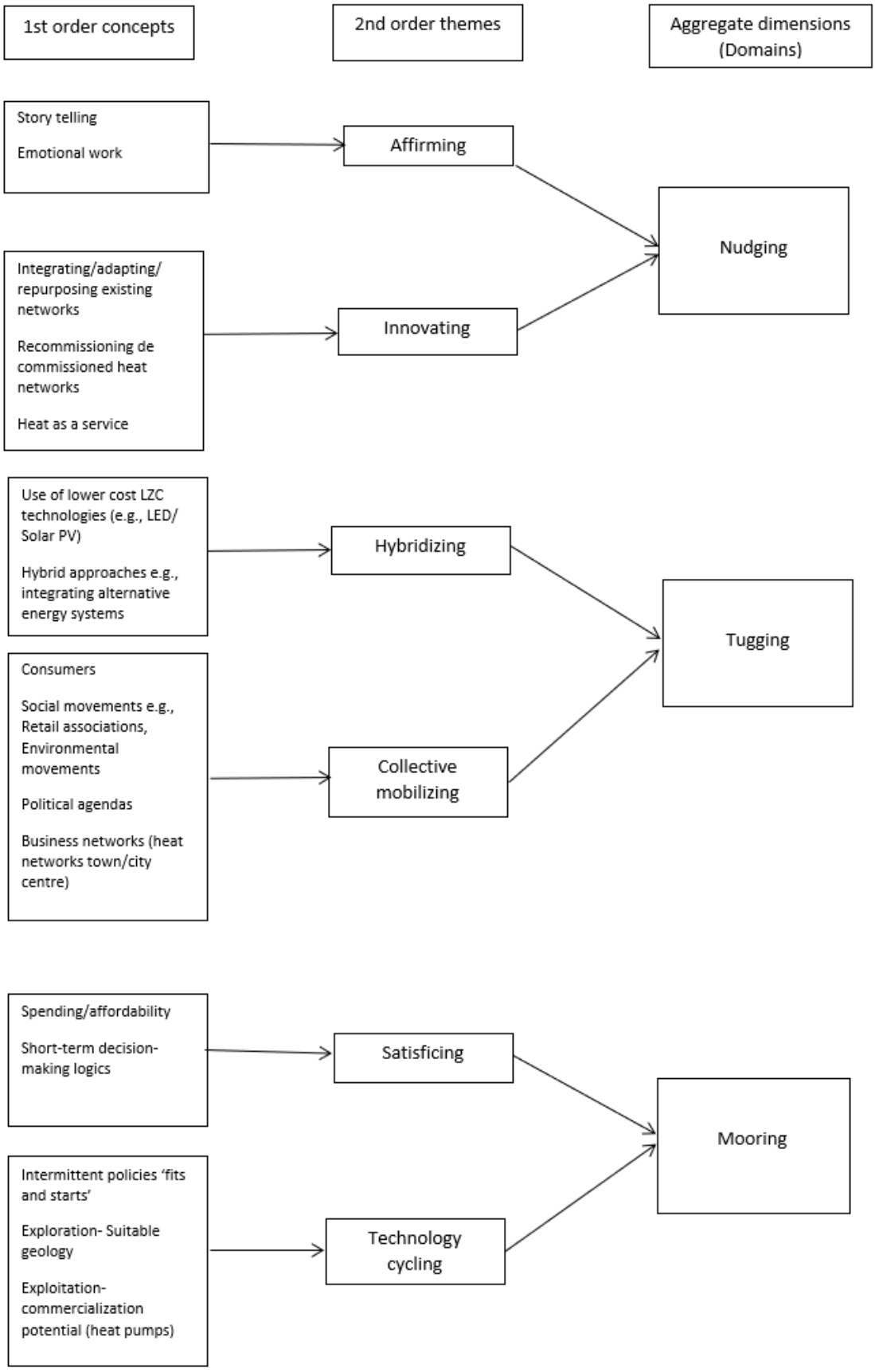
***Interviews.*** In order to generate a rich data set, we undertook a series of in-depth interviews with leading experts in the area of sustainability and green energy transitions to help us to understand this under explored area of research (Gioia *et al*., 2013; Yin, 2013). The basic assumptions underlying our research are that organizations are socially constructed by individuals who have organizational aims and objectives and are able to articulate and report them to researchers. Therefore, our role as researchers in data collection was to collect adequate accounts of the perceptions and experiences of our participants (Gioia *et al*., 2013). In total 37 in-depth interviews were undertaken with various stakeholders in the area of geothermal energy (e.g. geologists, academics, government representatives). The interviews were recorded and ranged from 40 to 120 minutes in length. In planning the interviews, particular attention was given to the danger of the interviewees presenting biased views and opinions. We consciously aimed throughout the data collection process to use the same terms as used by respondents in order to help us to further understand their experiences (Gioia *et al*., 2013).

***Documentary data.*** In addition to interviews, we drew upon Retail Trade Association websites and climate action reports such as Retail NI, Climate Change Committee (2021), RILA (2017), British Retail Consortium (2022) in order to triangulate our data and provide robustness in our methodology.

**Data Analysis.**

We used a thematic approach to analyse our data (Nowell *et al*., 2017). This enabled us to include established theoretical concepts present in the literature on systems transitions (Grubb, *et al*., 2015), and add to existing theory using insights from our empirical evidence. Firstly, we became familiar with the data through transcribing all interviews. This was followed by reading through all the materials (transcripts, reports, websites). Then we collated and analysed the interviews provided by our participants alongside the additional documents. The coding process itself involved iterating backwards and forwards between the literature and our empirical data (Nowell *et al*., 2017). Our initial coding process involved grouping our initial codes into categories and overarching aggregate dimensions. Figure 1 demonstrates our coding process. In the next section, we present an emergent framework, derived from our research and the existing literature.

**Figure 1: Coding process**



## FINDINGS

In this section, we present the findings derived from our analysis of decarbonisation in the retail and distribution sector. Upon exploring decarbonisation efforts within the built environment in retail and distribution trades, and existing literature on energy system transitions (Grubb *et al*., 2015), we have uncovered domains and those generate *pushing (nudges), pulling (tugs) and mooring (ties)* practice in the overall market transition challenges. Secondly, we explore those domains and the related practice (as themes) to help us organise and structure the data. These themes include technology cycle and satisficing, collective mobilising and optimising and lastly, affirming and innovating. This is presented in our framework presented in figure 2.

**Mooring practice: Technology cycling, satisficing, and limited stakeholder engagement.**

***Technology cycling.*** Addressing the decarbonisation puzzle requires multiple approaches and perspectives. Our findings suggest that there needs to be more consensus between two principal technology groups- one relating to the exploration of technology (e.g. the community which approaches the geological side), while another technological community relating to the exploitation- tends to approach the geothermal energy transition from a perspective from about (relating to the above the surface with the work of heat pumps). A cycling between these two technological groups and their perspectives can cause early-stage LZC energy solutions which are applicable to the retail sector to stall. We also found evidence of intermittent policies that are 'fits and starts' in nature. More clarity, commitment, and persistent policy by governments is required around the adoption of LZC energy solutions if they are to become part of the retail decarbonisation puzzle. Intermittent policies create uncertainty and have left the retail sector unclear whether to act at all; how much effort to make, and where to direct the effort. This is further evidenced by one of our respondents; *"We believe that, above all a consistent policy creates installer confidence. It creates visibility for investment and having a blended and balanced mix of measures, funds, legal clarity, standards etc (GE 27)*

***Satisficing.*** Satisficing can impede adoption of seemingly cost-effective technologies. For example, despite benefits, geothermal heat networks met with some resistance. In advanced capitalist societies there is an over-reliance upon carbon intensive methods of energy production, as suggested by one of our respondents; *"The decision-making of the corporations is driven by first, spend/affordability; cashflows, Return on Investment, Net Present Value." (GE 13).* In particular, incumbent actors, such as utility regulators are able to dominate the pace and direction of the energy transition and mainly promote a 'greening' of the fossil-based centralized system instead of a more radical departure from the existing energy regime and rely upon more short-term decision-making logics. Ultimately, governments can enforce standards and help to coordinate local and national infrastructure plans of low-carbon heat networks as suggested by one of our respondents; *"The Utility Regulator is a blocker to long run thinking on renewable technology deployment. It is mandated in a particular direction, and we need primary legislation to change this mandate." (GE 35).* The expansion of LZC heat networks which can be utilized by the retail sector relies on local authorities, who may lack the capabilities and resources to take suitable action steps during energy transitions (Climate Change Committee, 2021). As a potential solution, Palmer *et al*. (2022) advocates a shielding policy intervention for NI geothermal projects and advocates the use of nonmonetary criteria which are used by developmental banks such as the World Bank, FMO (Dutch Government Development Bank) which draw on social impact-based United National General Assembly's (UNGA) Sustainable Development Goals (SDGs).

***Limited stakeholder engagement.*** Various stakeholders, commercial actors, consumers and the wider community need feel that they are informed, networked, empowered and active in the construction of LZC transitions (Prahalad and Ramaswamy, 2004; Ramoglou *et al*., 2021). More recently, research suggests that building upon stakeholder analysis and exploring what communities understand as 'public value' and 'public good' for energy futures is important These exercises can help retailers understand public preferences and acceptance or disapproval of LZC adoption more widely. Sustainable development aims to maintain economic advancement and progress whilst also protecting the long-term value of the environment (United Nations, 2015). Wider reassurances are needed around creating a LZC energy transition which is accessible, fair and without adverse effects on peoples' jobs and quality of life (Palmer *et al*., 2022). To support this, an ecosystem in which governments can work together with business, society and knowledge bases to deliver a market-focused approach for net zero energy futures with the aim to unlock LZC business and environmental efficiencies and create a market-oriented and strategic approach to the adoption of LZC energy systems. This requires the co-creation of policies and economic value which spans across multiple domains (Osborne *et al*., 2016). As explored in our next section, consumers are one of the many groups which are instrumental to collective mobilization efforts in creating a market pull for decarbonisation in retail and distribution sectors.

**Tugging practice: Collective mobilising and hybridising approaches.**

***Collective mobilising.*** Collective mobilising relates to and recognizes the benefits of working together to enact collective outcomes. Within the context of decarbonisation of retail and distribution trades, this can take the form of shared heat networks, business networks within complexes and trade parks and working closely to create carbon efficiency within supply networks. However, retailers may also come across a collective actor problem of consent to long-term social, economic and technical interdependencies - If larger partners in heat networks e.g., hospitals do not participate in the heat network it can make them less profitable in terms of economic value and long-term feasibility in terms of carbon savings. Organisations may be reluctant to sign up to collective, long run collective energy contracts, undermining carbon savings and wider societal benefits. This will depend upon the organizations and their capacity for collaboration and the extent to which regulatory institutions enforce or incentivise collective heat network creation.

*"We have pivoted away from the internal perspective on geothermal and moved towards a more extraverted and market-facing perspective to engage the public more with our activities, just as solar and wind technologies have done. We are looking at it much more holistically… opening conversations with all of the communities."* (GE 26)

Overall, co-operation of retailers to progress to the LZC energy transitions has led to the creation of a number of retail consortiums (e.g., coalitions such as the Fashion Industry Charter for Climate Action, and the British Retail Consortium Net Zero roadmap). In particular, the retail sector has a key position in the construction industry, as it can influence the supply stream of materials and technologies used in this sector (Ferreira *et al*., 2019). More green energy alternatives such as hydrogen and biomass are being used as alternatives to fossil fuels in production processes. Key stakeholders in the decarbonisation which support the Net Zero move include representatives from the UN, COP26, architectural firms such as Gensler and the World Business Council for Sustainable Development. Considering a dialogue between a wide range of stakeholders in the concrete sector enables the decarbonisation of the concrete value chain, whilst ensuring legitimacy in the Net Zero ambitions and actions taken by the GCCA.

"*WBCSD commends the launch of the 2050 Climate Ambition by the cement and concrete sector and we will actively support companies in this sector to engage with the full value chain to decarbonise the built environment as a system. As this ambition statement highlights, it is critical to foster dialogue and collaboration with investors, developers, architects and construction companies to drive the demand for low-carbon solutions and achieve a net-zero built environment.*"

Peter Bakker, President and CEO World Business Council for Sustainable Development (GCCA, 2022)

Similarly, the Fashion Charter for Climate Action is guided by its mission to drive the fashion industry to net-zero Greenhouse Gas emissions no later than 2050. In addition, the BRC, in partnership with twenty leading retailers, developed a Climate Action Roadmap to guide UK retailers on the steps necessary for the industry to achieve Net Zero by 2040. This collaborative effort includes the involvement of central stakeholders (in excess of 80 retailers), who have committed to taking action under the Climate Action Roadmap (BRC Climate Action Roadmap, 2022). As part of the strategy, retailers are focusing upon three areas to reduce carbon; 1) direct emissions, 2) associated emissions and 3) indirect emissions. Indirect emissions are the biggest challenge faced by retailers, as they are generated within global supply chains and are not under the retailers' direct control (BRC Climate Action Roadmap, 2022).

In terms of retail distribution, there are transport decarbonisation plans for zero-emission HGVs, and the UK government has recently allocated the first funding for pre- deployment testing and small-scale trials of zero-carbon heavy-goods vehicles (Climate Change Commission, 2021). Fuel efficiency is a major concern amongst retailers and is likely to be a key driver in the shift from traditional fuels in HGVs to alternative sources such as biofuels and hydrogen. In an effort to control indirect emissions, retailers can define environmentally oriented policies internally and for suppliers (British Retail Consortium Climate Action Roadmap, 2022). Some leading retailers such as Tesco, Debenhams and Lidl have attempted to transition to LZC technologies in their retail logistics and have aimed to reduce packaging in their operations. Leading by example, Lidl became first retailer in UK and Ireland to power HGVs with bio-methane, generated by in-store food waste. When operating on bio-methane carbon emissions are reduced by up to 93%. This initiative was achieved through a partnership with HGV firm McCulla in Ireland.

*"We're thrilled to now be the first supermarket retailer to successfully integrate the first waste-to-energy sustainable transport model. McCulla's fleet covers more than 2,300 road miles per day, ensuring the safe and timely delivery of fresh and chilled foods to more than 300,000 weekly customers across our regional store network. The introduction of this new 'green fleet' operating on fully renewable biomethane as its primary fuel source will save* more than 93% in carbon emissions *due per bio-methane truck." (McCulla, 2019).*

Furthermore, in a move to create energy efficiency in freight movement, the Global Green Freight Action Plan the calls upon multiple stakeholders including governments, private sector, civil society, and other actors to work together to develop and support new green freight programs and reduce diesel-powered transport and black carbon emissions (Climate and Clean Air Coalition, 2015). The report suggests that in order to be implemented effectively, a range of financing and incentive schemes are necessary. In particular, it highlights key areas for improvement, that governments need to develop the capacity and resources to run and manage such a program, carriers need financing options to purchase technology and implement

strategies promoted by green freight programs, and incentives are needed to encourage increased participation (Climate and Clean Air Coalition, 2015).

***Hybridising approaches.*** Incorporating LZC technology involves adopting a hybrid approach to decarbonising the built environment in the retail and distribution sector. Energy efficient building design is one way in which retail firms can differentiate themselves to customers and provide social value. In particular, building design and management from a life-cycle perspective, incorporating energy-efficiency, renewable energy, and natural refrigerants, and suggest that at the point-of-sale they can showcase sustainable built stores and educate consumers. This illustrates how the uptake of LZC technologies by retail firms can build brand reputation and social awareness. Therefore, the benefits of retail firms enacting LZC technologies extends past the owner to distal stakeholders such as the local community. Accreditation systems such as LEED for Retail and BREEAM building performance can be used as confidence building mechanisms in LZC adoption, through modelling the energy performance, construction and user needs of the development.

*"I believe that all public buildings should be mandated to consider geothermal energy. We need to make geothermal more recognisable and everyday, signs, measuring success, symbols – walking the talk. So when I bring the kids to the swimming pool, they understand where the pool heating is coming from."* (GE13)

Retailers use a patchwork of LZC technologies to address the decarbonisation puzzle, as there is no one solution fits all approach. For retailers, energy consumption centres upon the provision of lighting, HVAC systems and electric appliances remain the three most important energy consumption calling for a hybrid approach to energy consumption including solar panels and LED lighting. In addition, heating and cooling processes are particularly costly in the retail sector and costs can be offset by innovations such as horizontal or vertical loop geothermal heat pump instillation. This is further evidenced by one of our respondents; *"The lines are all blurring in energy and so there is going to a mix of solutions."* (GE 35).

**Nudging practice: Affirming and innovating**

***Affirming.*** Emotion work and storytelling are the main processes in terms of behavioural and organizational characteristics. Persuasive storytelling can help to showcase the LZC activities and help to emotionally engage and include multiple stakeholders. Storytelling is particularly important when attempting to build market acceptance. Storytelling depends upon end-user choices, backgrounds, audiences, and contextual conditions and can be useful in re-assuring actors which are uncertain of the impacts LZC technology may have upon their local communities and how new LZC technology actually works, as evidenced by GE 25.

*"It is difficult walking across the land and explaining this technology to farmers. I pointed to high temperature countries such as Iceland and how energy was in our own backyard. I also used the analogy of the fridge and how geothermal acted like a reverse fridge."*

Narrative approaches must be open with broader market-spanning stakeholder and community engagement ranging from local communities, to NGO's, retail associations and private investors. Framed as *public value* and public good when attempting to engage local communities.

***Innovating.*** Our findings suggest that more innovation is required especially around the area of early-stage LZC energy transitions such as geothermal. In particular, our findings have highlighted that the ability to provide *heat as a service* is especially relevant as highlighted by one of our respondents.

*"The issue is that firms don't want the capital tied in and locked down but want "heat has a service" – like mobile phones, they don't want to buy the handsets, but would like the choice and service. So we need infrastructure providers."* (GE 13)

Repurposing gas networks and recommissioning decommissioned heat networks is also an innovative strategy which is leveraged in transitioning towards geothermal energy provision for use by the retail sector. However, heat networks remain underfunded in comparison to some other LZC initiatives, for example, the development of EV charging infrastructure (Climate Change Commission, 2021). Low carbon heat network infrastructure requires inter-dependence between various actors within the local heat network is required if it is to be carbon efficient and economically viable for actors. As a case in point, disused coal mines in Glasgow are being investigated as a low carbon heat source for businesses and residential purposes. Confidence-building around geothermal energy using disused coal mines as a heat source is being mobilized through creation of geo-observatories. A £31 million UK Geoenergy Observatories research site commissioned by NERC and operated by the BGS will enable scientists to create knowledge of new low-carbon energy technologies in the UK and internationally (BGS Press, 2018). Growing and transitioning the LZC sector will require a more inclusive approach, and advancement of conversations beyond the 'do ability' or establishment of R&D infrastructure side of LZC solutions and into markets further afield e.g., considering the impact of LZC technology upon retailers.

## DISCUSSION

We now develop our findings into a domain and multi-dimensional push and pull framework for understanding the institutional energy transition towards net zero (see figure 2). Our framework highlights how holistic agency from both the push technology (geology, efficiency) and technology pull (consumers, retailers, environmental movements, associations) are vital for transitioning the market. Our findings have highlighted that decarbonisation of the retail environment, both in build and in use, is institutionally complex. Within the existing literature there has been little attention paid to the reduction of carbon in use and build in the retail environment-in particular little attention has been paid to early-stage LZC technological solutions as a behavioural breakthrough activity involving multiple stakeholders (Grubb *et al*., 2015; Ramoglou *et al*., 2021). Our study has uncovered three key explanatory practices relating to decarbonisation of the retail-built environment.

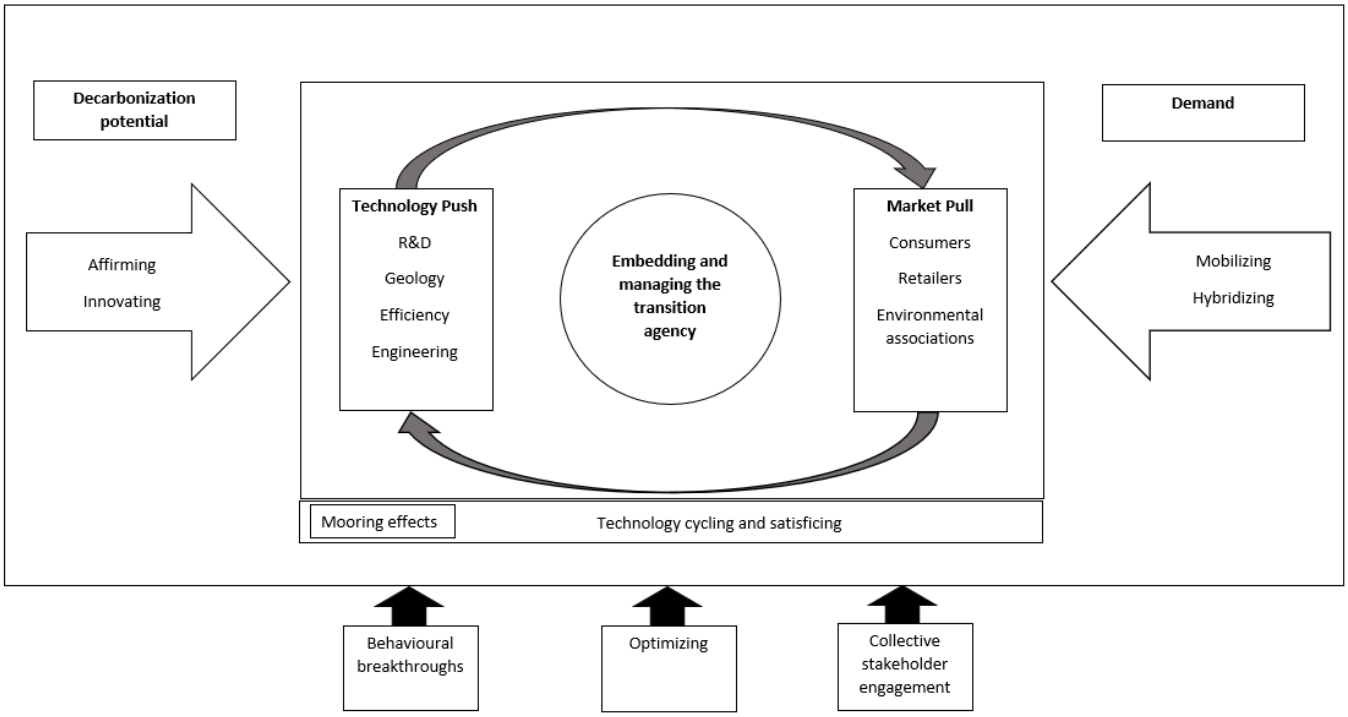
***Behavioural breakthroughs.*** The existing literature has demonstrated that there have been clear efforts towards the greenwashing of established energy regimes (Boehm *et al*., 2015; Bosman *et al*., 2014). Recently, there has been a noticeable movement of *consumers who care* in a conscious attempt to shape retail decarbonisation strategy for future benefit. From the retail side, there is an active framing of LZC energy adoption for *public good*. However, dominant actors such as utility regulators may impede this behavioural breakthrough activity through relying upon prior logics related to short term decision-making and financial gains. Recent literature on energy transitions in the Netherlands has shown that despite dominant discourses calling for a shift from existing energy regimes, the regime remains stubborn (Bosman *et al*., 2014; Kern and Smith, 2008; Van der Loo and Loorbach, 2012). Various reports into the transition to LZC technology have highlighted that incentives and traditional financial measurements do not afford a smooth energy transition (Climate Change Commission; Climate and Clean Air Coalition, 2015; Palmer *et al*., 2022). These reports advocate non-monetary measurements of appraisal such as alignment with the UN Sustainable Development Goals and green credential metrics. Furthermore, the Climate Change Commission (2021) argues that the

Treasury should build on the Net Zero Review to set out how it will use the tax system to support the transition to Net Zero (Climate Change Commission, 2021).

***Optimising.*** The decarbonisation of the retail environment demands a patchwork quilt of LZC technologies. A move away from fossil fuels within this sector involves the integration of alternative energy systems such as PV solar panels within building design. This can provide an avenue for more sustainable methods for construction across the board (Climate Change Commission, 2021; Molavi and McDaniel, 2016; Rydin, 2013). In addition to the provision of LED lighting in build, retailers may also consider integrating less known, innovative early-stage LZC technologies such as geothermal energy systems for heating and cooling processes. Within the UK and Ireland, relatively little attention has been paid to the role of this technology and what it can potentially offer the retail sector, particularly in build. The apparently slow uptake of such new LZC solutions may be due to new and established technologies *vying with separate vested interests* (GE 35).

***Collective stakeholder engagement.*** The co-creation of value in LZC energy transitions spans across multiple boundaries within the retail sector (Ramoglou *et al*., 2021; Ramaswamy and Prahalad, 2004). Within the retail sector itself, central actors such as managers can incorporate CSR related policies within their organizations to help in the transition towards LZC technology. In addition, consumers can exercise their buying power to support low carbon retail initiatives. During the planning process interactions with key actors such as policymakers, planners, construction are central to regulating the processes associated with the uptake of LZC technology in retail buildings. Despite building accreditations being put in place to aid storytelling (Rydin, 2013), owners, tenants and users of the buildings also have an obligation to consume energy responsibly- that is carbon in use is also an important factor. It is also important to take into account the role of distal actors in the uptake of LZC technology. Our research has helped to highlight that wider community groups, social movements and associations can be instrumental to legitimizing, particularly early stage LZC technology which may form an important part of the decarbonisation puzzle.

**Figure 2: Embedding net zero practice and managing the decarbonising of built environments**




## CONCLUSION

As outlined in this paper, the adoption of LZC energy in the retail sector is both a behavioural and technological breakthrough activity, which has the ability to co-create social and economic value within wider society. Our research has highlighted some of the benefits and opportunities which the patchwork of LZC technologies can present to the wider retail sector, whilst also highlighting some of the institutional voids which may hinder its uptake. It is likely that more established LZC technologies may be more readily accepted into the retail sector e.g., PV solar panels, principally due to concerns over initial cost outlays and the social acceptance of familiarity which comes along with established technology. In contrast, other LZC technologies such as geothermal energy, despite being specifically useful to the retail sector, are lagging behind. For example, Palmer *et al*. (2022) argues that there is little evidence in the application of geothermal energy in retail horticulture within Northern Ireland. The net zero journey will rely on building confidence with LZC technology as well as with central and distal communities. A market transition depends on people living in communities where the ownership of the issues can be understood, particularly where concepts seem far removed from end user day-to-day activities. We suggest that steps forward to decarbonising the retail-built environment include closing the carbon loop in business practice- both in build and in use- through progressing towards a more circular approach to retail operations.

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