

Middle Matters:
Intermediaries and the practice of home energy retrofit

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List of Abbreviations

AEE	Agency for Energy Conservation
AFOLU	Agriculture, forestry and other land use, land-use
AEA	Atomic Energy Agency
BCUC	British Columbia Utilities Commission
BCBC	British Columbia Building Code
CMHC	Canada Mortgage and Housing Corporation
CHBA	Canadian Home Builders' Association
CO ₂	Carbon dioxide
CEA	Certified Energy Advisor
CEA	Community Energy Association
UN COP	United Nations Conference of the Parties
CCE	Cost of conserved energy
DIY	Do-it yourself
ECM	Energy conservation measure
EPC	Energy performance certificates
GVHBA	Greater Vancouver Home Builders' Association
GHG	Greenhouse gas
HRV	Heat recovery ventilation
HERO	Home Energy Rebate Offer
HERP	Home Renovation Rebate Program
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IEA	International Energy Agency
kWh	Kilowatt-hour
LED	Light-Emitting Diode
MLP	Multi-level perspective
NRcan	Natural Resources Canada
NEB	Non-energy benefits
NGO	Non-governmental organization
NRCan OEE	NRCan Office of Energy Efficiency

OECD	Organization for Economic Cooperation and Development
RAP	Regulatory Assistance Project
RMI	Repair, maintenance and improvement
STS	Socio-technical system
STSP	Socio-technical system of provision
StatCan	Statistics Canada
TECA	Thermal Environmental Comfort Association
TCO ₂ e	Tonnes of CO ₂ equivalent
UNFCCC	United Nations Framework Convention on Climate Change
VBBL	Vancouver Building By-law
WMO	World Meteorological Organization

Abstract

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Mitigating climate change requires accelerated upgrades to the energy efficiency of entire housing stocks. Designed to shift homeowner behaviours through dissemination of gadgets like LEDs and solar panels, overly techno-economic public policy approaches have failed to engage with the complex socio-technical landscape within which home energy retrofits take place. Moreover, they have helped create spaces where meanings and values regarding climate change and housing energy efficiency remain fluid and uncertain. As a result, confusion reigns and retrofit targets continue to be missed.

This thesis challenges traditional home energy retrofit framings by actively engaging with the daily practices and relations of a complex network of building trades people, energy advisors, designers, consultants and NGOs. The research re-orientates home retrofits as an essentially social phenomenon, materially influenced by the tacit know-how, understandings, skills, motivations and materialities of these networked intermediary actors who operate along a complex policy chain between the governed household and governing public institutions. The study proposes that retrofit intermediaries are materially implicated in the evolution of a new home energy retrofit practice, distinct from other practices related to the built environment, not only via their discrete technical products and services, but also via influential intermediation processes of interpretation, translation and negotiation that occur between the often times opposing interests of the homeowner and the policy-maker.

Vancouver, Canada, a city with a strong green building ethic, serves as an ideal critical case. Applying a theoretical framework grounded in social practices and intermediary dynamics, this thesis focuses on the daily and mundane practices and relations among retrofit intermediaries. The work contributes to a fuller understanding of how intermediaries knowingly (and unknowingly) work to make sense of fuzzy concepts related to climate change, energy efficiency, and the home, and how in doing so, they can contribute to the construction and conveyance of powerful normative understandings of what these mean for society. It concludes that the taken-for-granted practices of retrofit intermediaries provide a useful unit of study for those interested in reducing emissions from existing homes.

Declaration

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

Alastair Moore

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For my three ladies,
Dominica, Ailish and Isabella

Chapter 1 Introduction

1.1 Retrofitting the retrofit paradigm

Climate change is one of the greatest challenges of our time and its adverse impacts undermine the ability of all countries to achieve sustainable development. The survival of many societies, and of the biological support systems of the planet, is at risk [...] We can be the first generation to succeed in ending poverty; just as we may be the last to have a chance of saving the planet. The world will be a better place in 2030 if we succeed in our objectives. (UN General Assembly, Resolution adopted by the General Assembly on 25 September 2015).

The invisible middle

"Fifty-year-old post-and-beam now an award-winning energy-saver" reads the subtitle on the article in the February 2010 edition of Home Makeover Magazine (p. 7). At the time, the monthly periodical had a circulation of over 50,000 readers in Vancouver so the word was sure to get out that improving the energy efficiency of one's home was possible, rewarding, perhaps even smart. I thought that at the very least, those in attendance at the District of North Vancouver council meeting one year earlier, would be aware of our home's remarkable 50 percent increase in energy efficiency and its climate-friendly character. It was at that meeting that my wife and I were officially recognized by the Mayor for our "*Major Sustainable Restoration*". Hundreds more curious people, often chaperoned by non-governmental organizations and university professors, visited our award-winning home in the months following its energy makeover. Everyone in attendance at those open houses was eager to see for themselves how to transform an existing home so that they too could start dreaming about their own home's low-carbon and energy efficient future. Reading the visitors' notes at the end of each tour, my wife and I soon realized the significance of our undertaking; by materially improving the energy performance of our old home we had achieved something really quite rare and out of the ordinary.

As I read those notes of appreciation, I was compelled to reflect more deeply on the retrofit challenge, and specifically on those levers that materially determine the fate of global and local efforts to combat climate change by improving the energy efficiency of existing housing stocks. For my wife and I, the decision to upgrade the

energy performance of our home during a major renovation sat comfortably within a complex web of personal dreams, practical objectives, and physical and financial constraints. With two young daughters to care for, we wanted to create a safe, healthy, durable, efficient and climate-friendly home where our family could grow and prosper. A few years earlier I had co-founded Canada's first eco-building supply store which meant I worked in that unique space between homeowners and green building public policy. My business provided me with privileged access to suppliers and their innovative materials and technologies, and my own green building expertise allowed me to assemble and guide a team of builders, trades people and professionals to undertake our green renovation. But it was not always easy. On many occasions I encountered conventional construction practices that discounted energy efficiency investments and green building techniques, and denied any material connections between home energy consumption and anthropogenic climate change. With the exception of the energy advisor and the solar hot water contractor, none of the people that worked on our home, self-identified as energy efficiency expert, green building specialist, or environmental champion. I thus needed to raise awareness about the importance of energy efficiency among most of the parties that worked on our home, and thanks to their skills, expertise and willingness to learn, we were able to transform our family home from a typical energy inefficient dwelling into one that could stand as an exemplar of best practice.

In a word, I was in a preferential position to respond to the many calls for energy retrofits sounded by policy experts concerned with climate change and energy conservation. But what about the thousands of other individuals and organizations that regularly provide home improvement and construction services and products in Vancouver, but who might not consider themselves passionate about green buildings or implicated in any meaningful way in climate mitigation efforts? How do these actors' routine business practices contribute to the energy performance of the homes they work on, either directly or indirectly? How are energy efficiency and climate policies understood by these important actor groups, and how, if at all, are these understandings subsequently transmitted to homeowners? How do these

middle actors respond when asked by their clients about energy efficient technologies, materials or construction techniques? What is the net effect of these actors' collective messaging concerning energy efficiency and climate action on home energy performance. Are these actors fostering or inhibiting improvements to the overall energy performance of Vancouver's housing stock? These are the questions that motivate the present research.

The Community Energy Association's (2014) review of home energy retrofit programme effectiveness in the province of British Columbia (BC) indicates that less than two percent of homes are undergoing retrofits each year. They also conclude that traditional environmental psychology and rational choice approaches to policy design are not increasing market penetration rates and that a policy re-think is needed (*ibid.*). Programmes that focus on furnishing homeowners with information about the merits of energy efficiency, or that offer financial incentives in the belief that a lack of awareness and money are the primary barriers to sustainable lifestyles, are certainly common, but commonly fail. I suspect this is why my family received the award from our local Mayor, why magazine articles were written about our project, and why so many people spent hours touring our home and asking how we did it all. In retrospect, I think we were the ultimate policy darlings, we did exactly what retrofit policy is theoretically designed to encourage. But while we appeared to be climate policy heroes, and worthy of public attention, I knew that retrofit policies and incentives had very little to do with our decision to retrofit. Over and above my own energy efficiency and climate action objectives, what did significantly influence our home's energy upgrades were the skills and opinions of the dozens of trades people, suppliers, designers, builders and consultants who were involved in our renovation. The names of these many important actors are not on the plaque we received from the Mayor ten years ago, however, my suspicion - and thus the hypothesis underpinning this thesis - is that perhaps they should be if climate goals are to be met and home energy retrofit is to become normal practice in our communities.

Nested climate challenges

Climate change represents a wicked (Rittel and Webber, 1973) socio-ecological problem, a common concern for humankind, and an *"urgent and potentially irreversible threat to human societies and the planet"* (UNFCCC, 2015, p. 1). For humanity, the challenge of mitigating and adapting to rapid global warming is indivisible from our sustainable development aspirations, contained in the 17 United Nations (UN) Sustainable Development Goals (SDG) (UN General Assembly, 2015). Underscoring the gravity of the existential threats posed by climate change and unsustainable development, then UN Secretary-General Ki-moon, proclaimed *"we don't have plan B because there is no planet B"* ("Ki-moon (UN Secretary-General) COP21 Press Conference (7 December 2015)"). And, for the first time in history, technological fixes have a deadline to operate within. The United Nations Intergovernmental Panel on Climate Change (IPCC) predicts that the global carbon budget linked to a 2°C global average surface temperature increase will be consumed by 2033 under a business-as-usual scenario (IPCC, 2008). The urgency of the climate challenge, and the high-level context within which the research is situated, is reiterated by Ki-moon's warning that,

the global thermostat is rising [and] science tells us that the window could soon close on our ability to prevent severe and irreversible climate impacts (Ki-moon (UN Secretary-General) comments at COP21 - Press Conference (7 December 2015)).

Greenhouse gas (GHG) emissions - which can be released by individuals, organizations, communities, or entire countries - build up over time and do not respect political or even geographical boundaries. As a consequence, climate change is characterised as a collective action problem at the global scale, and a challenge requiring a 'glocal' (Collier and Löfstedt, 1997; Gupta et al., 2007) (simultaneously global and local) response. Moreover, avoiding the suite of deleterious impacts associated with a rapidly warming planet requires concurrent global action be taken by individuals and organizations. The United Nations Framework Convention on Climate Change (UNFCCC) (2015) stresses that strategic and accelerated actions are needed across all sectors of the economy, if the required reductions in GHG emissions are to be achieved. Nested within this geo-

political context are a series of meso- and micro-level, technical and non-technical challenges related to the way climate change, and responses to it, are framed in everyday discourse. As one drills down through these challenges, the specific problematique and aims of the present project become clear.

The first challenge is to reach a global consensus regarding the role of humans in rapid global warming. While the signing and adoption of the Paris Agreement by 195 nations in November 2015 suggests that there is global political agreement that cumulative anthropogenic GHG emissions and global average temperature change are causally linked, consensus among broader publics regarding the strength of these links remains elusive. The second challenge relates to the importance of apportioning responsibility for taking action fairly and efficiently among nations and economic sectors. This implicates a set of guiding principles concerning social equity, effectiveness, and legal and moral responsibility, many of which have been enshrined in multilateral agreements signed under the UNFCCC (2015). The third challenge sits at the interface between macro- and meso-levels and involves the socio-technical system conditions and tightly entangled relations between energy supply and consumer demand that drive overall GHG emissions. A system is considered socio-technical when it "*emerges through the conjunction and co-evolution of [both] 'technical' and 'social' entities and process*" (Bulkeley et al., 2010, p. 3). Infused within these three challenges is the global challenge of ensuring sustainable development and recognising that "*limiting the effects of climate change is necessary to achieve sustainable development and equity, including poverty eradication.*" (IPCC, 2014, p. 4). The fourth challenge goes deeper still and provides the entry point for the current research endeavour. It centres on the need to actually mobilise agents (either individually or as collectives) to reduce emissions within a particular sector or sub-sector of society. Climate policy developed by sub-national authorities (e.g. cities, regions, states) is often concerned with this fourth, more micro-level challenge.

Harmful GHG emissions come from five broad human development categories: buildings; transport; industry; energy; and, agriculture, forestry and other land use (AFOLU). Although not the largest source of emissions, buildings account for 19

percent of global energy-related GHGs (IPCC, 2014a). Achieving reductions in the GHG emissions intensity of existing housing stocks is a real and pressing policy challenge for government at all levels (Globe Advisors, 2013a; OECD, 2010). This is because some estimates put the percentage of 2050 buildings already built at 75 percent, thus to have any chance of reducing their collective emissions requires these buildings be made more energy efficient in the near-term (Lucon et al., 2014; Ravetz, 2008). UN Sustainable Development Goal No. 7.1 calls for a doubling by 2030 of the global rate of improvement in energy efficiency (UN General Assembly, 2015), and residential housing stocks are seen by many to represent a key source upon which to focus efficiency efforts (Crilly et al., 2012; Dowson et al., 2012; IPCC, 2007; Swan and Brown, 2013; WBCSD, 2009).

From repeating the solution to (re)thinking the challenge

Upgrading the energy efficiency of a house generally involves interventions like insulating walls and roofs, sealing air leaks, minimizing water use, and installing high-performance windows and space-conditioning appliances (RAP, 2011). Local governments are particularly interested in home energy retrofits as the latter are integral to the linked goals of low-carbon development, sustainable communities, and local energy security. There is a general consensus among public policy makers that homeowner behaviours and decisions to undertake energy efficiency upgrades are determined by individual cognitive processes. As a consequence, policy responses to the fused *home energy retrofit - climate change - sustainability* challenge triad have tended to target the individual and have been dominated by rational choice (Becker, 1976), attitude-behaviour-choice (Shove, 2010a) based policies, and overly positivist and technocratic interventions (Kelly, 2009). This generalized way of understanding the relations between collective environmental problems and the individual is common, and similar examples of this dynamic can be seen in the shift toward more sustainable modes of transport (Transportation Research Board, 2005), newspaper recycling (Boldero, 1995), and reduced water consumption (DEFRA, 2013). However, despite significant efforts over the past two decades to kick-start a housing energy retrofit revolution, authorities at all

jurisdictional levels have struggled to achieve even a two percent annual market penetration rate, well below the five percent target (RAP, 2011).

Combined with ideological and political debates related to what should be done, who should pay, and who should benefit from home energy upgrades, the retrofit challenge has remained largely unmoved by policy efforts that fail to recognize its multifaceted nature. Local policymakers often broadcast their energy efficiency goals to homeowners directly, with few other actors figuring in the policy model. Curiously, the literature on retrofits reveals a dearth of thinking about the product and service providers that make home energy efficiency improvements real, in concrete terms that is. The individuals and organizations that design homes, promote building energy efficiency, sell products, install windows and insulation, upgrade boilers, or do simple things like caulk door jambs and pot light recesses, are so vital to the energy performance of homes, yet these actors are largely black-boxed in the literature. As a result, very little is known about their individual or collective nature. The result is that local authorities expect that the target (homeowner) audience will respond positively to repeated messaging and proceed with home energy performance improvements, and that the intermediary actors sitting between policy circles and homeowners are either facilitative or benign with respect to policy outcomes. Unfortunately, the lacklustre rate of home energy upgrades suggests this assumption may be unjustified, hence there is a real need to re-think the retrofit challenge (Ma et al., 2012; RAP, 2010; Sustainable Prosperity, 2013).

The general approach taken in the present research sidesteps the traditional positivist, technocratic view of home energy retrofits, and re-presents them as a social practice that can be analyzed as such. Counter to conventional reasoning, this thesis seeks to place home energy upgrades at the centre of a still-forming socio-technical system (STS). A system made up of numerous actor groups and infrastructures. The actors in the retrofit space provide products and services in support of home energy performance improvements, and are seen to be connected to one another via more and less defined network relations which themselves are co-constituted by collective norms and rules. The socio-technical context referred

to here maps closely on to other socio-technical systems related to urban infrastructures (Guy et al., 2011), and residential housing stocks (Vergragt and Brown, 2012a). These more mature systems are constituted by formal institutions, infrastructures, technologies, and markets, all glued together by a set of relations between key actors with shared know-how and rule-following tendencies (Vergragt and Brown, 2012a).

This thesis seeks to conceptualize a distinct housing retrofit socio-technical system that is nested first within the housing socio-technical system, and then within still larger construction and energy supply socio-technical systems. It goes further to propose that the housing retrofit STS comprises a wide array of interrelated actors and actor groups (or intermediaries) which vary in form, function, motivation, and scale of operation. The research is interested in the network relations that organize and constitute intermediaries and the routine activities of these actors. Spaargaren and Van Vliet's (2000) work on 'systems-of-provision' provides a useful conceptual enhancement to socio-technical system framings. Thus, the present project mobilizes the notion of a retrofit socio-technical system of provision (STSP) within which the practice of retrofit circulates. Re-defining the energy retrofit challenge in these terms, requires policy makers pay greater attention to the practice of retrofit (rather than homeowner values and choices), and to the intermediary relations and activities that foster the collective retrofit understandings and principles among these actors that in turn influence whether or not the practice becomes widely adopted.

1.2 Research questions and aims

The principal aim of the research is to better understand why the practice of home energy retrofit remains a relatively rare urban phenomenon despite significant political will to the contrary. The thesis argues for a fundamental re-defining of the retrofit challenge. That is, from the current model that emphasizes the omnipotency of individual choice and behaviour, toward an alternate conceptualization that engages more vigorously with the variegated and mundane daily activities of sometimes invisible and (un)usual suspects in the retrofit space. These routine, taken-for-granted activities are argued to take place within an

evolving home energy retrofit socio-technical system of provision that itself is nested within a contested policy context and a dominant construction socio-technical system. I argue that relations of trust, learning and collaboration between intermediary actors give structure to the retrofit STSP, but most importantly, they constitute the mechanisms by which shared values, principles and normative ways of saying and doing are altered or sustained within the system. This thesis positions the daily activities of important intermediaries, expressed via their routine work-related activities and processes of translation and interpretation, as key sites wherein the practice known as energy retrofit can best be understood. More will be said on this in the next chapter, but for now, it is important to understand two types of practice: practice-as-entity and practice-as-performance (Schatzki, 2001a). The first of these is understood to comprise a spatially dispersed, but organized suite of sayings and doings. These sayings and doings constitute a nexus that persists through space and time, and this nexus is structured by relational linkages based on understandings of how to act in a particular situation, explicit rules and principles underpinning these actions, and the motivations, beliefs and purposes that are satisfied as a result. The second type of practice, a practice as a more discrete performance is achieved by combining elements (i.e. skills, objects, imagery) to form a recognizable act. These two practice types are related as the former is co-constituted by repeated performances of the latter. In the context of the present research, the practice of home energy retrofit is constituted by assemblages of more foundational activities such as sealing cracks with caulking and installing insulation in wall cavities. The research aim and the ideas that this conceptualization embodies are buttressed by the following objectives and empirical questions.

Objective: Understand the broader climate and energy efficiency policy contexts and socio-technical system conditions within which the home energy retrofit practice is expected to emerge.

- To what extent are climate-induced retrofit policies, programmes and incentives aligned with the generalized energy-related motives, values

and understandings of homeowners, and what influence does this alignment play in the emergence of the retrofit practice?

Objective: Explore an existing retrofit socio-technical system and describe the form, function, and relations of the intermediary actors implicated in its operation.

- Which actors can usefully be considered intermediaries in the retrofit system of provision and where are they situated within the system?
- What forms do these actors take, what intermediation functions do they perform (where negotiating concepts of energy efficiency and climate action are concerned), and what is the nature of the relations between these actors?

Objective: Challenge the way retrofit policy is framed by demonstrating how intermediary actors contribute meaningfully to the establishment and maintenance of retrofit norms, values and meanings through visible and invisible processes of intermediation.

- How do retrofit intermediaries translate and interpret the coupled issues of climate change, home energy efficiency and the home, and how do these processes intersect with the emergence of a home energy retrofit practice?

1.3 Unpacking the theoretical luggage

A key aspect of the research is its rejection of the notion of a clockwork, deterministic universe and a single social reality, and its subsequent engagement with the ontological proposition that the social world is inherently chaotic, and that there may be multiple and variable social realities. Tensions from this philosophical bifurcation figure in the present research and emerge as a struggle between positivist understandings of energy retrofits in an ordered world, and retrofits as socially constructed and highly interpretive acts. These framings collide with two closely linked relativist, and highly fluid agendas that are often subject to multiple framings, namely climate change and sustainability. Shove (2011) concurs and

asserts that complex sustainability challenges (like home energy retrofits) are slippery and can often be defined in more than one way as problem definitions are rooted in specific, and particular world views. The proposition that multiple social realities may exist rightly raises questions about the nature of those realities and how they can be accessed and understood. The approach taken here builds on the idea that social reality, including the social phenomenon known as an energy retrofit, is a social construction produced and re-produced by social actors, and only knowable by these same actors. Accordingly, the research assumes an interpretivist stance that seeks to understand the social world of retrofits on its own terms, whatever these happen to be, by accessing the daily language, skills, concepts, and meanings of the actors at its centre.

The research seeks to find points of overlap between the ontological positions of practice theories, socio-technical systems thinking, and intermediaries. The rationale for doing so is to be able to bridge between the diverse entities (i.e. individual and institutional actors and their unique interests), and social phenomena (i.e. practices of retrofit and intermediation) co-constituting the retrofit socio-technical system. The tensions between the hierarchical nature of systems approaches and ontologically flat practices are mitigated by the recognition that subjective behaviours and system structures exist in a recursive relationship.

Theories of social practice are a key ontological resource used in the research. These theories are concerned with what Ortner (1984) refers to as those

mundane, daily performances that engage humans, but which [study] can reveal important insights about social behaviour, and the genesis, reproduction, and change of form and meaning of a given social/cultural whole (p. 149).

It is in practices, the nexus of interconnected human activities, that we find the drivers of social life. A practice-based theoretical approach offers a useful empirical frame that embodies the idea that energy retrofits are constituted by repeated, and the often mundane, practice performances of intermediary actors, and the practice entity these constitute. Rather than relying purely on human cognitions based on rational choice and objectivity, daily social interactions and activities are instead

constituted by arrangements of three foundational elements: competences (i.e. explicit and tacit know-how, and shared understanding), symbols (i.e. imagery and representational meanings), and materials (i.e. objects, equipment, technologies and tangible, physical entities including human bodies) (Shove et al., 2012).

The practice ontology helps us to understand that what we see when we examine the dynamics of the retrofit process is more than simply a series of rational economic choices among actors. In contrast, energy retrofitting a dwelling is more about the daily activities of a multitude of actors connected via an interdependent chain that runs from senior governments, through intermediaries, and ends with homeowners and their families. The retrofit practice for example, requires stable relations and shared logics take shape between co-constituting actions. In a practice oriented world, energy retrofits are materially determined by neither humans nor exogenous structures alone, but rather by the reproduction of sayings and doings which intermediaries are predisposed to perform. In this way, the present project rejects traditional retrofit approaches, which Shove (2012) points out are left to rely on nudging homeowner attitudes and behaviours, in the hope that individuals will make greener, more sustainable choices, whether they are in a position to do so or not.

While often criticized for being too concerned with local actions in the present, theories of practice also emphasize the importance of shared meanings and symbolic structures of knowledge for understanding the 'social' in social change. In practice-based research, the central unit of social scientific study is the practice, rather than the cognitions of subjects, and practices recruit people as loyal carriers to ensure the survival of the former. Practices comprise groupings of more and less complex actions involved in complex activities like designing buildings or constructing houses. In the context of the present project, home energy retrofit is the practice of interest and examples of constituting actions might include air sealing, insulating or energy modelling. While such a broad definition risks making practice-based research too abstract, doing so does facilitates a novel way of understanding the linkages between the mundane details and rhythms of human life and collective societal transformations and change.

Rather than continuing the tradition of indicting the individual for environmentally un-friendly behaviours and energy inefficient homes, the research seeks to shift the focus from the homeowner toward the daily activities of those for whom materially altering the physical character of homes, whether directly or indirectly, constitutes a routine activity. This means broadening the system boundaries and engaging meaningfully with retrofit intermediary actors that sit between homeowners and policy circles. These actors are diverse and include: builders, contractors, utilities, architects, plumbers, electricians, insulators, energy advisors, consultants, educators, suppliers, green building NGOs, interior designers, trades associations and others.

The spatial and institutional dynamics which backdrop retrofit policy and practice align with a socio-technical system framing which sees system change emerging via "*realignments between [analytical] levels of niche, regime, and landscape*" (Rip and Kemp, 1998). The conceptualization of a retrofit socio-technical system of provision builds on ideas borrowed from research related to the multi-level perspective on transitions (Geels, 2005). Hughes (1986) adds technology to this conceptualization, proposing the notion of a 'seamless web' to explain how,

"different elements (artifacts, entrepreneurs, networks, banks, regulations, users) join together in technological developments, in particular in large technical systems such as electricity networks" (Hughes, 1986, cited in Rip and Kemp, 1998, p. 337).

The diverse nature of the actors, infrastructures, institutions, artefacts and rules 'organized' by home energy retrofits exemplifies a system of scalar interactions and a seamless web of elements. The varied policy actor clusterings revealed in this project hint at the kinds of actor relations that Spaargaren and Van Vliet suggest unite "*a particular pattern of production with a particular pattern of consumption*" (Spaargaren and Van Vliet, 2000, p. 59). These scholars delineate between horizontal and vertical dynamics of consumer behaviour, concluding that broader contextual factors better account for consumer behaviour than concern over that product which distinguishes one consumer from his or her neighbour. Spaargaren and Van Vliet (2000) thus derive the 'system-of-provision' perspective to reflect the 'vertical', or contextual determinants of consumer choice.

The research aims to re-present the challenge of catalyzing broad-scale home energy performance improvements, and proposes that home energy retrofits be understood as a social practice constituted by intermediary actors through their expert performances and acts of intermediation. An additional argument made in this work is that the diverse networks of actors implicated in the retrofit practice are often hidden from the view of policy makers. Theoretical debates concerning theories of practice, retrofit and intermediation are advanced by engaging with contested notions of efficient resource use or climate unfriendly activity, and the routine activities of intermediaries through which these silent but powerful sentiments are appropriated, disseminated and infused within building sector conventions. Following this interpretive approach, the research endeavours to reveal the ways in which those actors implicated in the practice of retrofit do what they do, even though what they do is often taken-for-granted and not routinely articulated. This approach also permits one to access the social practices of retrofit intermediaries from the 'inside', where their nature can be best seen (Blaikie, 2000).

1.4 Study location

The urban case selected for this study is Vancouver, Canada, a self-declared 'global green city' with aspirations to be the greenest city in the world by 2020 (City of Vancouver, 2015a), and a 'renewable energy' city by 2030 (City of Vancouver, 2015b). This urban centre provides a critical case due to its notable environmental ethos, its current sustainability goals, the prevalence of fossil-fuel based home heating, and the predominance of single family detached homes as the preferred housing type. It is in Vancouver that one expects to encounter a high level of awareness regarding the links between energy efficiency upgrades and climate change, as well as a dynamic group of intermediary actors working to make homes more energy efficient.

Table 1-1 Residential energy use characteristics by country

Country	Total # homes (millions)	% single family	% fossil heat	% electric heat
Australia	7.9	84	33	32
Canada	12.8	67	61	34
Denmark	2.6	63	25	21
France	26.7	59	51	30
Germany	39.9	62	65	20
Italy	22.9	41	65	21
Japan	49.6	N/A	58	42
Netherlands	7.2	69	73	23
Norway	2.1	64	5	78
Sweden	4.5	45	3	33
United States	128.2	68	64	34

Adapted from RAP (2010, p. 1)

Table 1-2 Carbon dioxide (CO₂) profile by country

Country	Average residential CO ₂ emissions (Mt) per household
Australia	1.3
Canada	6.0
Denmark	4.3
France	3.3
Germany	6.4
Italy	2.9
Japan	1.3
Netherlands	3.6
Norway	0.7
Sweden	0.3
United States	9.6

Adapted from RAP (2010, p. 1)

Vancouver is the country's third largest urban centre behind Toronto and Montreal. This city of 663,000 inhabitants is the most populace of 21 municipalities that together comprise the Metro Vancouver Region that itself has a population of 2.5 million. The city and its namesake region sit squeezed into a small triangle of land in the southwest corner of the country. Uncompromising geological and political barriers, including the Pacific Ocean to the west, coastal mountains to the east and north, and the Canada-U.S. border to the south, successfully (and practically) keep the city and its people perched on a conceptual ledge. Together with its many other sustainability 'firsts' and its alignment with UN climate and sustainability goals, Vancouver has firmly established itself as a 'green city' zeitgeist (Tamanini, 2016). Moreover, it is one of hundreds of other OECD cities that aspire to catalyzing wide scale home energy retrofits to help reach sustainability goals (OECD, 2010). Its reputation as a global thought and action leader on climate and sustainability issues

means that research findings may be more likely to be taken up by other urban centres. Any generalizations resulting from the research are expected to be of significant interest to other cities, especially in North America.

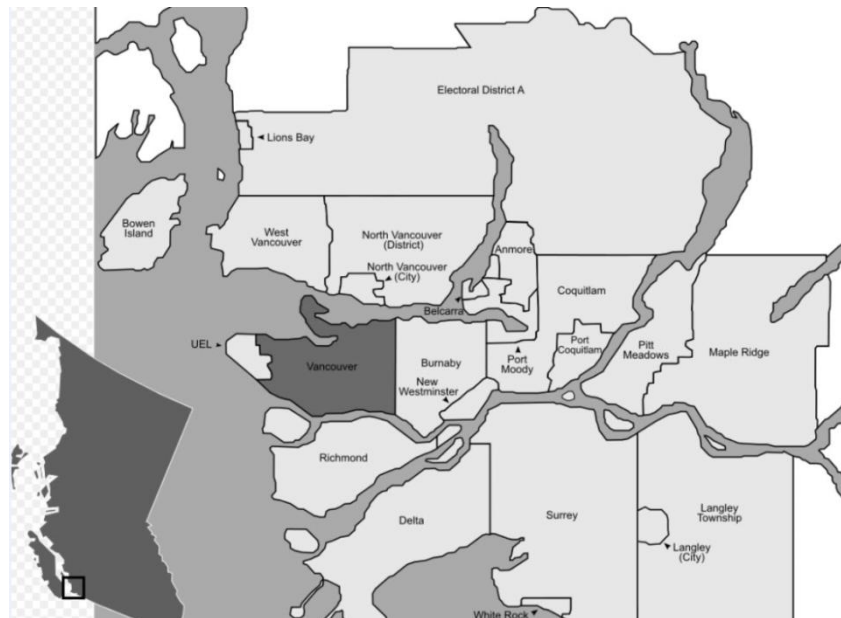


Figure 1-1 City of Vancouver (shaded) sitting among other municipalities in Metro Vancouver Region, and in relation to province of British Columbia.
Source: 'Vancouver Wikipedia' (27 July 2017), *Vancouver*, available at: <https://en.wikipedia.org/wiki/Vancouver> (Accessed 27 July 2017)

1.5 Thesis structure and organization

In broad terms, this thesis is divided into seven chapters. The second of these begins by contextualizing the home energy retrofit challenge, and introducing the reader to three bodies of literature dealing with energy retrofits, intermediaries and social practices. Chapter 3 explains the methods employed to execute the research and contextualizes the case study city of Vancouver. Chapters four, five and six are empirical; each responds in sequence to the research objectives listed above. The project's findings and contributions are then discussed in the final chapter.

In detail, the monograph is organized as follows. Chapter 2, 'Making old new, from the middle out', explores three domains of study that have rarely been considered

alongside one another: home energy retrofits, intermediaries, and theories of social practice. It starts by opening up the walls of the retrofit 'house' to reveal their internal logics, concerns and associated construction practices. A review of traditional intermediary form and function introduces the reader to these important social actors, and sets the stage for an exploration of the roles they play in sustaining routine construction practices. Theories of social practice are explored at the end of this chapter, rounding off the tour of the project's ontological toolkit.

Chapter 3, 'Methods', begins with a discussion that outlines the research design, and the ways in which a mixed methods approach is employed to collect and analyze field data. This is followed by a more nuanced introduction to the case study city of Vancouver, as both a geographically definable place and the locus of a powerful set of ecological imaginaries reflecting the city's historic relation to nature.

In Chapter 4, 'The co-construction of retrofit policy', a critical review of local retrofit and climate policies demonstrates the ways in which they are nested within broader policy contexts. The analysis suggests that retrofit and climate values, beliefs, and norms embodied in Vancouver's retrofit socio-technical system of provision are co-produced by a web of more and less interconnected (hence influential) institutions and actor groups, each operating at various geographical scales and levels of governance, and acting in accordance with a unique set of interests and motivations. The reader will see how Vancouver is striving to be the 'greenest' city in the world, and how this aspiration is being translated by intermediaries to create dissensus.

The fifth chapter, 'Retrofit landscape', reveals points of misalignment between retrofit policy and the stakeholders these target, and thus offers some reasons for retrofit policy failure. The reader is taken on a tour of the interstitial spaces in the city's current retrofit STSP to examine the diverse intermediary actors circulating in the contested space between policy circles and homeowners. This includes explorations of the lived experiences of 'Bob' the builder and 'George' the electrician, two typical intermediary actors operating in Vancouver. The chapter

then explores both new and existing intermediary forms and functions implicated in the retrofit space, and proposes a conceptualization of these middle actors that characterizes them as either *in-situ* or *ex-situ* intermediaries. The third part of the chapter identifies an expanded community of retrofit intermediaries, and maps its members relative to each other to reveal their spheres of influence, power dynamics and circles of trust. I posit that relations of trust, information exchange and proximity among intermediaries underpin shared understandings and symbolic meanings that shape normative ways of saying and doing. The chapter closes by reflecting on the potential for these actors to materially affect the creation of a stable retrofit practice bundle.

The sixth chapter, 'From intermediaries to practices and back again', contributes to the literatures on practice dynamics and intermediation by linking the two in the context of the practice of home energy retrofit. It picks up where the previous chapter leaves off by analyzing individual accounts to identify examples of active and passive processes of translation and interpretation by intermediaries. These examples offer insights into the ways in which these middle actors are creating a collective vision, for themselves and homeowners, of climate action and home energy efficiency. The discussion seeks to better understand how intermediary actors internalize, interpret and re-deploy rules, values and norms in the course of their normal working routines, and how their taken-for-granted doings and sayings are used to make sense of climate change and energy efficiency. Several examples from the field reveal how intermediaries re-shape relations and meaning in the retrofit socio-technical system, and how these alterations are influencing a still-forming retrofit practice bundle.

Chapter 7, 'Conclusions' reflects on main findings, which come from thoroughly exploring a retrofit socio-technical system as it works to create new meanings concerning energy efficiency, climate change and home improvement. The discussion focuses on the value of raising the profile of intermediaries in the retrofit story, as well as the question of whether an examination of the everyday activities and functional networks of these actors offers a new avenue for policy to follow. This chapter closes by offering policy recommendations and discussing research

contributions. The latter include: building on previous efforts to re-orient policy responses to environmental crises by de-centering the individual; demonstrating the value that social scientists can play in addressing a wicked problem like climate change; highlighting the influence that otherwise invisible intermediary actors can have on public policy; and, conceiving of the retrofit sector as a socio-technical system of provision in its own right, and part of a series of larger scale socio-technical systems providing home construction and maintenance products and services.

Chapter 2 Making old new from the middle out

2.1 Introduction

To better understand today's retrofit culture, this chapter examines research conducted on home energy retrofits and intermediaries in the context of construction practices, mostly in the EU, Canada, Australia and the United States. These countries map most closely to Organization for Economic Co-operation and Development (OECD) countries where mitigating global warming through building energy performance improvements has been identified as a key strategic action (RAP, 2010).

The chapter explores three bodies of literature: home energy retrofit, intermediaries, and theories of practice. The discussion on retrofits begins with a review of historical drivers related to home improvement and repair, then launches into a critical examination of more recent climate-induced retrofits. The section on intermediaries explores the traditional form and function of these typically silent operators, and questions the role of intent in processes of intermediation. Key definitions and concepts held by theories of practice are explored in section 2.6, followed by a discussion aimed at reconciling the tensions that arise when deploying a hierarchical systems approach alongside a non-hierarchical ontology such as practice theory.

In section 2.2 the evolution of the meaning of home retrofit is explored to show the reader how, prior to the present climate-action policy era which started with vigour in the 1990s, the retrofit was imagined as a rather technical, pre- and post-war act of home modernization, updating and efficiency. An exploration of key objectives of the residential energy retrofit agenda is also discussed and followed by a critique of different retrofit philosophies and strategies. In section 2.3, this traditional view is contrasted to the present, climate-era in which home retrofits emphasize energy upgrades and thus have become more politically blurry affairs buffeted by variable and multi-directional forces including individual cost savings, public policy goals related to climate mitigation and environmental ethics, and fluid notions of home. In section 2.4, 'Cracks in the plaster', key socio-ecological debates are unpacked to

show how issues related to social and spatial equity and notions of 'home' can disrupt the hegemonic view that retrofits are simply techno-economic acts. Section 2.5 examines the literature on intermediaries to explore their fundamental nature and examine the ways in which these middle actors help construct shared visions and understandings underpinning the current practice of energy retrofit. In the section that follows, the key ideas embedded in theories of practice are defined and discussed. The chapter concludes that in the present era of climate-related energy retrofits, considering dwelling retrofits as purely rational and technical endeavours, without accounting for the increasingly important work of intermediaries who sit between retrofit policy and households, will continue to frustrate efforts to achieve mass-scale upgrades of the housing stock.

2.2 Window sashes to open-plan kitchens: the changing retrofit landscape

Where improving the energy efficiency of existing buildings is concerned, retrofits involve reducing the amount of heat lost via attics, walls, windows and floors, and increasing the performance efficiency of systems used to heat, cool and light space. The word retrofit has a very definitive meaning in etymological terms; it reflects the union of retroactive (i.e. referring to the past) and fit (i.e. to equip) (Dixon and Eames, 2013). According to the Oxford English Dictionary retrofit is defined, in its verb form, as:

To provide (something) with a component or feature not fitted during manufacture; to add (a component or feature) to something that did not have it when first constructed ("Oxford Online" 2015).

As Dixon and Eames (2013) note, as it pertains to the built environment, the word 'retrofit' is often aligned with substantive physical changes to a building or clusters of buildings including improved energy efficiency. Wilkinson (2012) laments the interchangeability of the terms 'refurbishment', 'renovation', 'refit' and 'conversion' with retrofit due to the confusion these terms create. Hodson and Marvin (2010, p. 429) define retrofits as, "*installing or fitting a building with new devices not in existence or available at the time of development.*" Karvonen (2013) adds the idea of foresight, presenting residential retrofits as upgrades to existing dwellings to meet contemporary norms and standards or to prepare for future conditions. Brand

(1995) argues that retrofits can be distinguished from traditional renovation, rehabilitation or restoration work which tends to arise from motivations related to financial gain, improved amenities, fashion, change of use, historical preservation, and asset management. A still larger scale of retrofits is contemplated by Bouzarovski (2015, p. 5) who explores the many ways in which "*inner-city households 'practise' an alternative form of urbanism by altering buildings over time*". For the purposes of this thesis however, retrofits – at a broad level – are defined as those activities that involve upgrading old with new (materials, technologies and designs), rather than simply routine maintenance and repairs.

In addition, retrofits can also be defined by their degree of complexity or comprehensiveness. Single interventions that target low hanging fruit (e.g. installation of low-flow showerheads), differ substantially from more comprehensive, *whole-house*, or *deep* retrofit projects that target several different building systems and blend improvements of varying difficulty and payback periods to produce optimal, long-term results (e.g. insulating the exterior walls and installing high efficiency windows at the same time as upgrading the boiler) (Crilly et al., 2012; Less and Walker, 2014). Such deep retrofits typically target energy savings well beyond those resulting from weatherisation or utility retrofit programmes (Less and Walker, 2014).

Hodson and Marvin (2010) draw our attention to yet another distinguishing feature of residential retrofits. That is, they are often largely invisible from view (i.e. hidden in walls, on roofs, or under kitchen cabinets), hence they are difficult to measure and manage, and they are often undertaken by a vast number of actors within a "*persistent background [of] repair, maintenance and updating*" which further increases their complexity (Hodson and Marvin, 2010, p. 429).

2.2.1 Retrofits from pre- to post-war

In the early part of the twentieth century, leading up to World War II, most homes tended to reflect local vernaculars and were constructed from locally available materials and skilled labour. Moreover, they provided relatively utilitarian functions – security and shelter from the elements (Elliott and Mac Crone, 1982). While

modifications to homes were common, these were constrained by limited access to novel or exotic building materials owing to prohibitive transportation costs and a lack of trades people familiar with the installation and maintenance these foreign materials (Brand, 1995). Brand (1995) also points out that upgrading homes with new materials often followed economic boom times and changing family fortunes, reflecting the early influence of market dynamics. Ramsey (2009) expands on this point by analysing the ascendance and popularization of the sash window through an analysis of eighteenth century literature, revealing the social status that this novel piece of fenestration afforded its owners.

In the same era, rather than focusing on the building envelope, structure or services, the majority of retrofits involved domestic artefacts (e.g. furniture, and superficial furnishings) as the majority of people lived in private rental homes with only upper middle- and upper-class people owning their own homes (Thorns, 2002). However, technologies like indoor plumbing, gas distribution systems, electricity and telephony also catalyzed profound alterations to not only the homes themselves, but also to the lives of those living in them (Brand, 1995; M. Hand et al., 2007; Ramsey, 2009). The introduction of city-wide utility services like electricity, water and gas marks another key retrofit era. Utilities were typically privately owned companies (Thorns, 2002), and the drive to expand customer bases dovetailed with the community's desires for improved quality of life (Elliott and Mac Crone, 1982). Given the scale of the undertaking, retrofitting homes to accommodate these services was allowed to take many decades and followed natural rates of market penetration, maintenance, refurbishment and new construction (Thorns, 2002). The principal drivers behind retrofits during this time were simply affordable improvements to household amenities and occupant comfort, with public policy playing rather a support role to private capitalist interests (ibid.).

Post-war dwelling retrofits in many ways reflect state and economic support for Fordism and its central goal of increased individualism, private property rights, accumulation and consumerism (Thorns, 2002). Economic reforms in support of consumerism gave rise to higher wages, mass commodity production and

consumption (Manfredini and Leardini, 2012). The subsequent availability of relatively inexpensive transportation options – trains, trams, buses and eventually cars – spurred suburban development and new privately owned housing for thousands of former renters (Thorns, 2002). Thus marked the beginning of an important tenure shift from renter to owner, and the beginning of our present day consumer society in which owning a home signals one's status as much as it does one's shelter preferences (Manfredini and Leardini, 2012).

Higher levels of disposable income, more secure housing tenure, and more leisure time, after the War re-shaped definitions of home; that is, from immutable utilitarian objects, to more transformable, market-based possessions symbolizing personal progress and status (Page and Ryan, 2010). Investing in upgrades to the home increased its market, or exchange value, and in some cases the upward social mobility of the occupants, yet simultaneously reduced the use-value of the home (Clapson, 1998). In most post-War Western capitalist countries, state institutions and market activities supported the involvement of individuals in the cycle of mass production and consumption of goods, and new commodified homes in suburban developments offered an ideal vehicle to drive the consumption of a host of consumer goods including materials and technologies for home retrofits (Thorns, 2002). Housing has historically figured prominently in social equity issues such as wealth distribution, spatial patterns of settlements, social exclusion, and access to resources, and the post-War push to ramp up the commodification of home, amplified these relationships (Thorns, 2002). Then, as now, a house or flat contained the lives of its inhabitants (Brand, 1995) and imparted a sense of identity upon them. Moreover, the house often represented the largest financial investment likely to be undertaken by the owner (Manfredini and Leardini, 2012). The home in many ways came to represent the metaphorical intersection between the individual, society and the free market.

2.2.2 From individual to state motives

According to Brand (1995, p. 5), dwellings, as buildings, are "*constantly being pushed around by three irresistible forces – money, technology and fashion*". Perhaps the most popular motivation for retrofits, according to Brand (1995) and

Halifax (2009) has been, and largely continues to be, improved household utility and amenities rather than style. Bell and Lowe (2000) include kitchen, bathroom and space thermal conditioning under the rubric of amenities, arguing that the most common retrofits involve these high-traffic areas within the home where moving parts and appliances are most likely to be found. The availability of new innovative products is not, according to Watson and Shove (2008), sufficient to trigger dwelling upgrades, what is also needed is what they describe as a stable triad of *stuff*, *images* and *skills* that help make sense of new practice-material assemblages. Goldstein (Goldstein, 1998) argues that World War II provided new manufacturing capacity and everyday people with the material skills to retrofit and bring novel technologies and materials to the consumer. Manfredini and Leardini, (2012) posit that property capital gains provide the primary driver for homeowners to retrofit as these investments represent an integral part of long-term household financial strategies. Goodsell (2008) adds to the discussion on motivations by flagging the role that community building can play in catalysing dwelling upgrades. The advent of open-plan kitchen-living areas and back porch enclosures as fashion trends are further examples of a new design aesthetic encouraging widespread alterations to homes. Homeowner autonomy and will is central to all of these motives. The 1973 oil crisis stands out as one example where the state provided the rationale for energy conservation and efficiency. President Carter framed energy conservation as a moral imperative on par with war efforts (“President’s Address to the Nation on Proposed National Energy Policy,” 1977). France’s response to the oil crisis included the establishment of the government’s Agency for Energy Conservation (AEC), which like other European countries, introduced the notion of a national energy conservation ethic.

2.3 That was then, this is now: Retrofits in a 'climate' climate

As described in the introductory chapter, climate change is a global collective action problem that often requires individual actions to redress. This is a rather different situation compared to traditional retrofit scenarios wherein it is only the individual who, as Brand (1995) suggests, 'pushes' their home around as he or she pursues either financial rewards, technological novelties or fashion trends. In a climate

action context, the motive for making alterations to the physical aspects of private dwellings, reducing energy consumption and avoiding negative climate impacts, is expressed primarily by collectives including national governments, supra- and sub-national actors (e.g. state, regional and provincial governments), and environmental NGOs, rather than individual actors.

As discussed earlier, current anthropogenic climate change, caused by an excessive release of carbon dioxide (CO₂) (and other carbon-based emissions) to the atmosphere through the burning of fossil fuels and other human activities (IPCC, 2014b), is considered by many to represent the "*most overriding environmental issue of our time, and the single greatest challenge facing environmental regulators*" (UNEP, 2014, p. 8). Greenhouse gas emissions emanating from the residential housing stock have been assessed in terms of their contribution to overall emissions and are now seen by all OECD countries to represent a key source upon which to focus energy efficiency efforts, and hence a strategic opportunity to mitigate climate change (Crilly et al., 2012; Dowson et al., 2012; IPCC, 2007; Swan and Brown, 2013; UNEP, 2009).

The discussion to this point presents retrofits as largely individual utility-seeking endeavours, distinctly material in nature, in response to modernization trends and energy scarcity issues. This was indeed the case up until the 1990's when the Rio Earth Summit took place. Near the end of the last century housing retrofits entered a new 'climate era'; a time when concerns over climate change and energy efficiency began to merge and provide the impetus, albeit fuzzy, for upgrading the energy performance of housing stocks (IPCC, 2007; Swan and Brown, 2013). The time at which this unique policy period commenced marks an important inflection point in the evolution of building energy retrofits. It was at this point that the meanings and motives underlying these home alteration events began to blur as climate science more firmly established the likelihood of causal linkages between the burning of fossil fuels by humans and global warming (IPCC, 1990).

There is a growing body of literature concerning energy retrofits that serves to delineate the empirical boundaries of this field of study and highlights its main

debates and concerns. These include studies on barriers to widespread retrofits (Dowson et al., 2012; Mallaband et al., 2012; Smith and Swan, 2012; Webber et al., 2015), financial issues (Amann, 2006; Chapman et al., 2009; Clinch and Healy, 2003; Harvey, 2013; Sustainable Prosperity, 2013), the influence of occupant behaviour (Aspden et al., 2012; Burch, 2010; Gee and Chiappetta, 2012; Ingle et al., 2014; Owens and Wilhite, 1988; Southwell and Murphy, 2014; Gamtessa, 2013), and retrofit programme design (Community Energy Association, 2014; Cre et al., 2012; Crilly et al., 2012; Killip, 2012; Manfredini and Leardini, 2012; Marchand et al., 2015a). Several key themes can be distilled from a review of this body of relatively recent literature including: the choice of retrofit strategy, policy goals and approaches, and measures and metrics. Before unpacking each of these themes, a brief discussion about the fluid motives held by both individual and collective bodies that backdrop the discussion is needed.

Emission reduction targets tend to be collective in nature as they are often established by governments and sometimes corporate bodies. Hence, responsibility and thus the motivation to meet GHG emission reduction obligations can be geographically dissociated from those communities or actors that are necessarily implicated in efforts to actually achieve those targets, whether these are economic sectors (e.g. transport, forestry, housing, manufacturing, energy), states, regions, cities or even homeowners (Jordan et al., 2015; Parker and Rowlands, 2007). Targets and policies can also be characterised in different ways: legally binding versus voluntary; adopted by national or sub-national bodies such as cities; and, defined singularly as climate policy or fused with more traditional policy areas (e.g. industry, resource management, transport, etc.) (Jordan et al., 2015). The motives for action can thus be inherited or assigned, from near and far, rather than endogenous to the actor.

Further blurring the logic underpinning climate-induced retrofits are complex arguments about the relative climate impacts of primary fuel sources. These include: natural gas as a transition fuel given its lower warming potential compared to coal and oil (Earth Policy Institute, 2017); low GHG emission but toxic nuclear energy; intermittency of renewables; clean but costly hydrogen; and, capacity limits

of existing electricity grids. There are also intersecting public and private concerns and aspirations regarding increased energy security, reduced air pollution and overall community sustainability and resilience. With the exception of air pollution, the other two issues are burdened by slippery debates regarding peak oil and definitions of sustainable development, which themselves are underpinned by subjective value judgments and moral arguments (Bridge, 2010; Lovell et al., 2009). Much has been written on the role of moral suasion in catalysing climate action, including building retrofits, (Government of Canada, 2016a), yet the moral imperative for action where these types of upgrades are concerned is almost always buttressed by a push for more rational ends related to utility maximization (York et al., 2013) or economic arguments (Moezzi and Janda, 2014; World Bank, 2012). Moral suasion is also impeded by the high degree of uncertainty regarding the timing and uneven spatial distribution of climate impacts (IPCC, 2014b), leading many to file them under "*someone else's problem*" or "*problem[s] I will deal with in the future*" (Uzzell, 2008, p. 3). In the middle of the motive spectrum is a hybridized package of reasons for home energy upgrades which fuse the practical goal of reducing the size of the monthly energy bill with concerns for a healthy planet for all (Figure 2-1). Despite policy aims to the contrary, Less and Walker (2014) conclude that driving market demand for comprehensive energy retrofits is very difficult when homeowners are required to pay the majority of costs. Thus, for homeowners the act of upgrading the energy performance of their homes is determined by different strategic decisions, which themselves are linked to different motives. Ultimately, this fluid set of motives results in an uncomfortable tug-of-war between collective and individual interests.

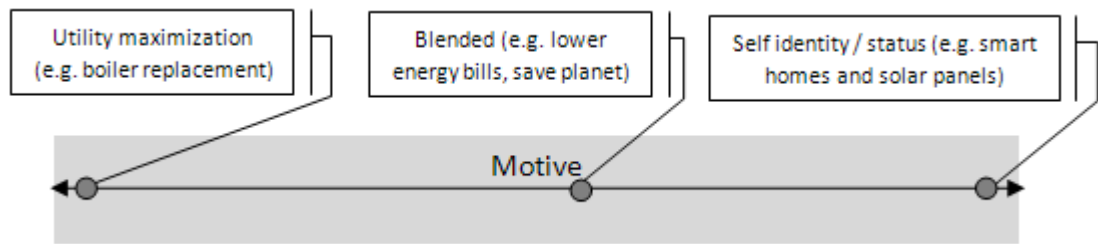


Figure 2-1 Continuum of homeowner motives

2.3.1 Zone of turbulence: where retrofit policy meets homeowner choice

As discussed earlier, climate-induced retrofits unfold at the sites where both individual and collective interests collide, hence they are often imbued with discord. When speaking about traditional approaches to retrofits it is important to distinguish between two actor groups, policy makers and homeowners, as both hold their own set of retrofit-related meanings, images and goals. There are also practical issues regarding the strategic and practical approaches underlying the actually doing of retrofits by both of these groups. The discussion here explores the respective retrofit paradigms of policy makers and homeowners to reveal zones of agreement and dissension.

Policy parameters

There are four unique issues to consider when exploring climate-related energy retrofit policies, issues that until now were of no concern. One relates to urgency; the window of opportunity to dramatically overhaul the energy performance of the housing stock is limited as concentrations of CO₂ in the atmosphere are rising quickly toward dangerous levels beyond which scientists predict positive feedback impacts (IPCC, 2014a). The second highlights the need for the timely and integrated response of millions of autonomous homeowners to pay for the wholesale transformation of the housing stock's energy performance in return for uncertain personal rewards. The third arises from the argument that reducing the consumption of any product or service, especially energy, represents a profound challenge to traditional neoliberal ideals and the traditional coupling of economic growth and energy use (Seyfang, 2010). The last issue emerges from the correlation

between fossil-fuel based energy consumption and carbon emissions which are at the centre of the climate-energy efficiency agenda.

Policies in support of home energy retrofits must navigate between these highly contested issues and the practical necessity of altering the way a home is constructed and operated. Efforts to reduce a home's energy consumption and its climate emissions can target improvements in the building's envelope, its mechanical systems, its appliances, and the behaviour of occupants (York et al., 2013). Selecting from among these interventions is often, but not solely, the concern of homeowners. Government preferences concerning retrofit messaging, regulations and incentives strive to align with what actually goes on in the home, yet they are not always successful (Community Energy Association, 2014).

Government policy tools to encourage home energy conservation measures (ECM) lie on a carrot and stick spectrum and generally fall into five categories (Meijer et al., 2009; Wilson et al., 2015) including:

- information campaigns and awareness raising (e.g. energy audits/assessments);
- industry training (e.g. certification or training for contractors);
- building labeling (e.g. energy performance certificates or labels at point of sale);
- regulations (e.g. energy requirements in building codes, solar-ready by-laws, zero-carbon or renewable energy requirements); and,
- financial mechanisms (e.g. grants, subsidies, tax credits, low-interest loans, third party financing).

Interestingly, governments have been found by several researchers to be reluctant to impose strict regulations on homeowners, preferring instead to encourage voluntary retrofits (Castán Broto and Bulkeley, 2013; Marchand et al., 2015b; OECD, 2010). Such a policy orientation is consistent with neoliberal sensibilities as Seyfang (2010) finds.

A scan of OECD countries suggests these policy strategies are quite universal, but to this list can be added other innovative, yet less common approaches. Examples include: 'fee-bates' for green or energy efficiency renovations, property tax-linked energy efficiency financing, and access to personal 'energy' coaches (BC Government, 2015; City Green Solutions, 2014; "One Planet Sutton Retrofit," 2017). Programme designers can also encounter additional strategic issues defined by geographical, temporal and quantitative attributes of the overall housing stock within their jurisdictions including:

- geographical characteristics - e.g. prioritizing neighbourhoods served by impoverished energy infrastructures;
- temporal features - e.g. targeting dwellings older than 40 years; and,
- quantitative - e.g. categorizing households by income level or construction type.

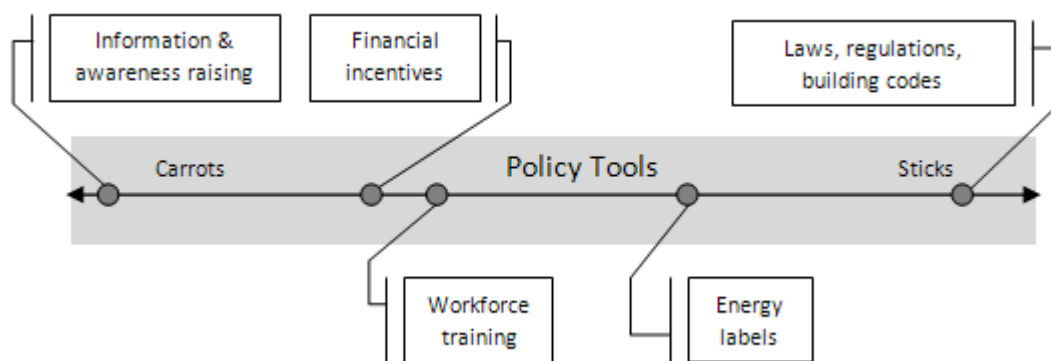


Figure 2-2 Continuum of public policy tools

These strategies span the length of the carrot and stick continuum (Figure 2-2) and reflect traditional push-pull tensions between environmental protection and free market accommodations. They also do not signal the existence of any hierarchy of efficacy among GHG reduction interventions or strategies; such decisions about impact potential, synergistic interventions, and returns on energy efficiency investments are often left up to homeowners and participants in the retrofit workforce. There are also important issues regarding the appropriateness of area-

wide retrofit campaigns where geographically defined regions are targeted for retrofit incentives and subsidies. While such campaigns offer economies of scale, albeit unachievable by programmes that target one home at a time, they are typically guided by generalisations regarding the housing stock quality and age, and not definitive data on existing home energy performance (Boardman, 2012; Coyne, 2012). In this way they can result in sub-optimal programme investments.

2.3.1.1 Retrofit policy toolbox

Workforce training

The need to 'retrofit' the existing construction sector workforce is frequently highlighted in the literature (BC Government, 2015; Better Buildings Partnership (BPP), 2010; Community Energy Association, 2014; Eames, 2012; IPCC, 2014a; Mallaband et al., 2012; Marchand et al., 2015a; RAP, 2011; Üрге-Vorsatz, 2010; WBCSD, 2010). Who constitutes the 'workforce' is a question that the literature does not tackle head-on, but when mentioned, it generally tends to point to construction-related actor groups (e.g. builders, installers, contractors) (Haavik et al., 2012; Janda et al., 2013; Janda and Parag, 2013; Killip, 2012; Sundberg, 2015); the folks that actually install windows and insulation, or replace system components. Some researchers see utility in expanding the membership of this actor group to include energy auditors (Neme et al., 2011), architects (Fischer and Guy, 2011), and energy efficiency consultants (Feser and Runst, 2016). Neme et al. (2011) point out researchers' relative neglect of vendors in allied trades despite the numerous opportunities these actors have to interact with homeowners. These points of contact represent "*natural 'on-ramps' to simultaneously sell consumers on efficiency retrofits*" (Neme et al., 2011, p. 21).

Construction-related training and certification requirements vary tremendously, both within and between countries. Training can be provided by industry associations, government agencies, third-party actors, or via 'over the shoulder' techniques (Globe Advisors, 2013a). Practically speaking, the type of workforce training and development envisaged includes particular construction skills related to ensuring airtight envelopes and adequate wall cavity insulation, minimizing

thermal bridging, carefully navigating wall opening details, maintaining continuous vapour barriers, making appropriate fenestration and technology choices, and lastly, thoroughly commissioning home systems. Woven tightly through these hands-on skills, as envisaged, is a firm understanding of,

- house-as-a-system principles
- energy efficient design options
- fuel-based carbon intensities
- material performance specifications
- available energy efficient technologies.

'House-as-a-system' is a best practice framework that recognizes the integrated relations between house components. The performance of one component is reciprocally linked with other components in the same system via established relations. As an example, a home's heating and ventilation components, wall assemblies, construction materials, and occupant behaviour all interact; changing the parameters of one can affect some or all of the others. Although some countries are engaging with the workforce training agenda, most are struggling to do so. For Neme et al. (2011), the worry is that the existing workforce capacity to undertake successful energy retrofits is only a fraction of that required to achieve the housing stock transformation required.

Information campaigns

This approach reflects the rational choice view that when presented with the right information, agents will alter their behaviours accordingly. In the case of energy efficiency upgrades to residential dwellings, information campaigns deliver information about the imperative to reduce reliance on fossil fuels, and the downstream energy cost savings, under the assumption that homeowners will voluntarily apply the government's financial logic. While the OECD (2010) is optimistic about their positive impacts, Shove (2010a) and many others point out, these programmes are achieving spectacularly low results due to their inability to reflect the structural determinants of individual actions. Moreover, they are often based on standardized assumptions about people's access to information and

resources, housing types and styles, actual in-use performance of energy efficient technologies and materials, socio-economic demographics, and occupant behaviour (Jackson, 2005; Ravetz, 2008). Perhaps most importantly, campaigns designed to raise awareness in the population often place greater emphasis on the near-term personal benefits of energy retrofits (e.g. reduced energy bills, improved indoor comfort, energy resilience) than those longer-term benefits likely to accrue to the environment or humans in general (Karvonen, 2013; Maller et al., 2012). In doing so, information campaigns do not reconcile the tensions that arise when a common property crisis like climate change require altruistic behaviours and expenditures among individual actors. In these cases, the homeowner is often left feeling that society at large is a free-rider benefitting from their discretionary act of benevolence.

Regulations

In general terms, the regulatory basket of tools includes laws, regulations, and building codes, all of which establish thresholds which those engaged in building alterations (or new construction) must meet. Given their direct links to home systems and components, building codes are often on the front lines of energy efficiency strategies, and hence home energy retrofits. At the same time, prescriptive building codes that specify standards, send loud signals to those who follow them; that is, a clearly defined 'minimum' level that is acceptable, rather than something that represents high quality. Raman and Shove (2000, p. 143) suggest that building regulations are designed to control "*laggards' rather than [push] the entire industry 'forward'*" toward more progressive standards. Historically, codes have addressed issues related to building health and safety, fire and structural protection, and sometimes accessibility. After the 1970s oil crises most codes were updated to require greater energy efficiency. Codes can be either developed by national or sub-national authorities (e.g. municipalities, regional governments, states, provinces), hence there can be tremendous variability between codes and jurisdictional struggles over implementation, interpretation, compliance and enforcement.

Minimum energy efficiency requirements, when included in a building code, can be either prescriptive or performance based, with the former dictating things like envelope insulation levels, system efficiencies, and air tightness, and the latter leaving such details up to designers and builders so long as an overall energy performance objective is achieved (Raman and Shove, 2000). Building codes must be followed for all new construction and sometimes, alterations to existing buildings. Whether or not the code must be followed during a renovation tends to depend on the nature of the renovation. Altering structural components, electric system modifications, most plumbing changes, and envelope alterations often necessitate a building permit and compliance with the local code. In the context of shallow retrofits, the building code is rarely consulted, and even some deep retrofits, which by definition involve more significant alterations, sidestep code requirements when building permits are not obtained from local authorities. Some estimates suggest that 30 percent of energy consumed in buildings is wasted due to code non-compliance (Globe Advisors, 2013a). Raman and Shove (2000) raise the possibility of inspectors becoming overtaxed in a regulatory regime that adds energy efficiency requirements to existing fire and structural safety regulations.

Building energy labelling using energy performance certificate 'A-G Bands', is another example of regulation that contributes to improved home energy performance (Figure 2-3). It does so by highlighting the relative energy consumption (hence cost) of one house compared to another (RAP, 2010). Denmark's labelling system requires all homeowners to publish, according to a standardized scoring system, the energy performance and CO₂ intensity of their homes at time of sale or new rental of the house (RAP, 2010). Perhaps because of its longer history and experience with energy labelling, Denmark concludes "*that labelling the energy consumption of homes has been found to be insufficient to ensure that a significant proportion of the proven and economically attractive savings are realized*" (ibid., p. 52).

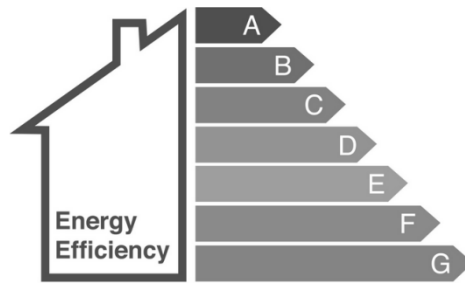


Figure 2-3 Energy Performance Certificates - A to G Bands
Source: Globe Advisors, 2013a

Financial incentives

There is a proliferation of financial incentive programmes aimed at motivating homeowners to upgrade the energy performance of their building envelopes (e.g. loft and wall insulation, window upgrades, draught-proofing), in-home services (e.g. boiler replacements, lighting retrofits, heating controls, drain-water heat recovery, solar hot water heating, solar photovoltaic arrays, low-flow fixtures), and appliances (e.g. high efficiency white goods and consumer electronics) (BC Government, 2015; Community Energy Association, 2014; RAP, 2010). Incentives come in a variety of forms (e.g. tax credits, direct grants, guaranteed loans, feed-in-tariffs, fee-bates) and are designed based on the assumption that financing is the main obstacle for homeowners (Boardman, 2012).

These programmes, while aligned with market processes, struggle on a number of fronts. They fail to discriminate between high- and low-priority dwellings, and therefore do not necessarily redistribute public funds to those most in need (i.e. those who live in or close to fuel poverty), or to those living in poor quality and unhealthy housing, or to particularly energy inefficient dwellings that if retrofitted, would contribute above average benefits to overall reduction efforts. Boardman (1991) identifies causal pathways between older, energy inefficient buildings and their heating systems, and fuel poverty, and notes that these are often the hardest to reach and the hardest to retrofit.

Incentive levels vary, but on average they tend to contribute between five and twenty-five percent of total project costs. However, Neme et al. (RAP, 2011)

conclude that incentives closer to seventy percent of total project costs are necessary to motivate typical consumers. In addition, incentive programmes can also be consumed by free-riders, or those who are motivated to upgrade the energy efficiency of their homes without incentives (RAP, 2010). In this case, the programmes fail to achieve that which they were designed to; that is, homeowner behaviour change. These types of programmes also rely heavily on engineering estimates of technological efficacy and occupant competence during the appropriation phase. For instance, there are examples of homeowners unplugging noisy mechanical heat recovery ventilators rather than maintaining or adjusting them, and subsequently creating indoor air quality problems in their airtight, energy efficient homes. Timing problems can also plague these programmes as government funding can often have a limited shelf-life, in contrast to home retrofit projects which can often extend beyond the window of time wherein rebates or tax credits can be successfully claimed (Globe Advisors, 2013b).

Programmes based on geography and housing form

Many argue that to achieve our climate targets, mass-scale community retrofitting campaigns need to be deployed (Hodson and Marvin, 2010; Mulugetta et al., 2010). The area-based approach delivers energy upgrades within a spatially defined area, which can represent a street, a neighbourhood, a local authority area, or even a group of local authority areas. It can either be deployed in a blanket, "pepper-potting" style (Energy Saving Trust, 2009), or in a targeted manner. Detailed knowledge of dwelling types and ages, as well as socio-economic conditions within area households can help identify priority households and improve programme outcomes (ibid.). Although the cost of profiling neighbourhoods increases CO₂ abatement costs, these are potentially offset by the social benefits of reduced energy costs, improved thermal comfort, and overall housing quality (ibid.). Moreover, the area-based approach can potentially result in rapid changes to the housing stock, and lower per unit costs due to bulk-buying opportunities and the ability to engage one contractor more efficiently (UK Green Building Council, 2008; US Department of Energy, 2013). Evaluation of these initiatives by the UK Green Building Council has shown that they are one of the most proactive and cost

effective methods for achieving significant CO₂ reductions, and in turn can help local authorities and local delivery agencies make significant cuts in emissions (ibid.). Area-based approaches have been proven to be much more effective than costly blanket approaches that use little marketing intelligence to inform their delivery. Despite the financial incentives offered, dwelling occupants often decline participation in these programmes. The reasons for this warrant further research, but could reflect overarching structural forces reflecting an imbalance of power between agent and state, "*spatially uneven patterns of energy justice*" (Bouzarovski and Simcock, 2017, p. 646), or a misalignment of project objectives (i.e. energy savings and CO₂ reductions) and actual household priorities (i.e. health and safety, space layout, secure tenure, family crises, etc.). All of these works highlight the energy injustices (and their respective underlying structural dynamics) that area-based policy approaches can unwittingly exacerbate.

2.3.1.2 Homeowner choices

Understanding retrofit policy tools and constraints is important, but it tells only half of the story. Regarding homeowner reasons for undertaking actual ECMs, there are two main schools of thought that each mark an extreme on a spectrum (figure 2-4).

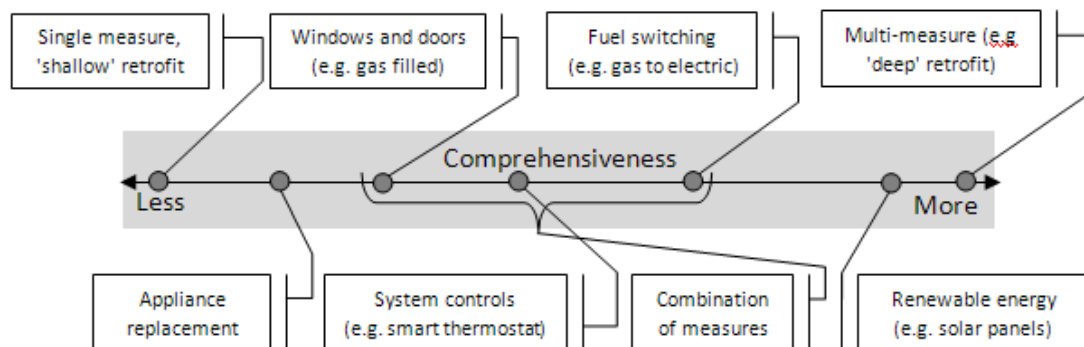


Figure 2-4 Continuum of energy conservation (retrofit) measures

The first favours single measure ('shallow' retrofit), short-term, easily performed and financially rational measures (e.g. weatherization, appliance upgrades, lighting replacements, etc.), while the second highlights the benefits of deeper, more

comprehensive retrofit packages that take a more long-term view of financial returns and feature multiple, and accentuated benefits from a suite of synergistic interventions (Figure 2-4) (IPCC, 2014a; Marchand et al., 2015a; Webber et al., 2015). In between these poles are more and less bundled and interventionist measures. Financial considerations are closely related to the comprehensiveness of a retrofit undertaking, and as depicted in Figure 2-5, these can range from self-funded, small-scale projects, to whole-house energy renovations supported by public programme funding. The payback period is commonly the most important delimiter for homeowners, although Gates (1983) criticizes this metric as it does not reflect changes in energy prices or the lifespan of a particular intervention. He points out for example that if weather-stripping pays for itself in one year but needs to be replaced each year, it generates no return (ibid.). Staged retrofits present another approach, this time allowing for actions to be implemented over time, potentially in sync with standard repair or renovation activities, and according to available budget (Less and Walker, 2014). However, this approach is critiqued by some researchers and practitioners (Fawcett, 2013) (Community Energy Association, 2014) who suggest that one of the largest impediments to home energy retrofits and other sorts of home alterations is the prospect of prolonged dust and disarray in the home, something that can arise in staged efforts.

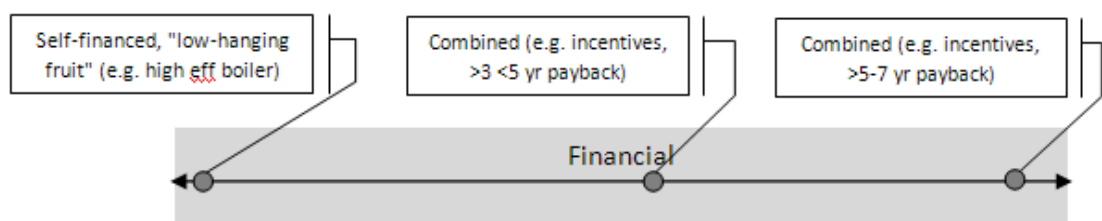


Figure 2-5 Continuum of homeowner financing scenarios for retrofits

Shallow retrofits

It is very common for homeowners to undertake single ECMs like draught-proofing windows and doors, replacing the boiler, or insulating the attic or loft. The

attractiveness of this approach from the homeowner's perspective is that costs are relatively fixed, and the hassle factor, while not removed, is at least of usually known quality and duration (Globe Advisors, 2013c). Also, for homeowners with high discount rates, quick payback ECMs can be preferentially selected resulting in only the low-hanging fruit being picked (Lutzenhiser, 2014). However, once the cherries near the ground have all been picked, getting at the harder-to-reach cherries requires a ladder (i.e. money and time) and possible clambering through a maze of branches (i.e. inconvenience). The principle criticism of the shallow approach is that it often negates the possibility of achieving the full energy savings potential of the dwelling (Crilly et al., 2012; Globe Advisors, 2013c; Lucon et al., 2014). Although it might fit well with occupant needs (i.e. time and resources) it may keep more complicated, but effective, energy reduction measures from being undertaken in the future because their payback periods remain beyond acceptable financial time horizons. Critics argue that long payback interventions must be bundled with short payback interventions at the outset, to make the former more palatable for homeowners, and to give the more complex energy conservation measure a chance at ever being accomplished (Crilly et al., 2012; Globe Advisors, 2013c; Sovacool, 2009). As *Retrofit for the Future* states, cherry picking the easy actions “will leave too much efficiency ‘on the table’—and with it, untapped economic benefits” (RAP, 2011).

Lucon et al. refer to 'shallow' retrofits (e.g. single measure interventions) as those that achieve energy use reductions of between 10 and 30 percent, and 'deep' retrofits as those that can achieve reductions of between 50 and 75 percent. Further, Lucon et al. (2014) suggest that energy savings of this nature are readily achievable in existing detached single-family homes using established technologies and know-how.

Deep retrofits

At the other end of the spectrum is the deep retrofit approach which increases project complexity, and the number of stakeholders, in addition to greater energy savings. As has already been argued, upgrading several building components at the same time provides for greater energy and emission reductions, increased cost

effectiveness, and the likely avoidance of follow-up retrofits (i.e. hassle and inconvenience) through time. For instance, the Canada Mortgage and Housing Corporation (CMHC) (2012) warns how upgrading a home's boiler before insulating the walls and draught-proofing windows and doors can result in a needlessly powerful boiler (i.e. more expensive) being installed. The advantage of deep retrofits is that they are far more likely to achieve absolute energy savings and carbon reductions sooner than if the piecemeal approach is taken. Furthermore, as the number of ECMs increases so too does the likelihood that one or more public financial incentives will be available to help offset costs. The challenges with this approach include a necessity to understand house-as-a-system principles, increased project scope and hence financing requirements, and longer periods of inconvenience for occupants.

Staged retrofits

An interesting idea is provided by Fawcett (2013) regarding the possible merits of staged retrofits. The concept revolves around their cost delay implications when compared to a *one-shot deal* retrofit project, as well as the potential for benefitting from improved energy innovations that come with the passing of time. The advantage of this approach is that it distributes the cost burden of retrofits over a period of several years thereby dulling the financial blow for homeowners. Plus, it allows for the completion of a step-wise series of interconnected (and potentially more comprehensive) interventions that, given their temporal spacing, can allow for in-use monitoring and adaptive responses. The other attraction embodied in this approach is that it can increase the chance that homeowners will be able to reap the benefits of higher efficiency materials and technologies. The downside to this approach is that it requires strong commitment on the part of dwelling occupants as the process of retrofitting will extend over several years, and consequently might conflict with unforeseen life events or priorities. Government financial incentives also often have limited staying power, which further imperils the staged approach as later phases may not have access to funding opportunities available earlier.

2.3.1.3 Metrics and measures

Measuring conservation

As Yudelson (2007) and (Lucon et al., 2014) lament, housing stocks in the majority of industrialized countries consume far more energy, and hence emit far more GHGs, than is necessary as a result of relying on cheap fossil fuels to compensate for building homes that deny local geo-climatic conditions. All OECD countries have committed to GHG reductions. Examples of these commitments include: Canada, 17 percent below 2005 levels by 2020 (Environment Canada, 2012), Australia, 26 to 28 percent below 2005 levels by 2030 (Australian Government, 2016), and the EU-27, 20 percent below 1990 levels by 2020 (EEA, 2017). Achieving targets like these requires substantial retrofits to the majority of the housing stock (i.e. millions of homes) within a relatively short period time, as well as a system-wide transformation of the energy infrastructure (Shorrock et al., 2005). No disaggregated GHG reduction targets specifically for home energy performance improvements were found in the literature, instead potential energy and emissions reductions are attributed to energy retrofits generally, with little recognition of the range of possible interventions (IPCC, 2014a). Energy infrastructure transformation, beyond the dwelling, is beyond the scope of this work, but Bulkeley et al. (2014), Miller et al. (2015) and Rutter and Keirstead (2012) do explore the implications.

The total average energy intensity of residential dwellings vary by country and climate. The average Canadian home consumes roughly 210 kWh/m²/year which is relatively high when compared to China where the energy intensity ranges from about 60 kWh/m²/year (urban) to 150 kWh/m²/year (rural), or the U.S. where homes consume between 125-160 kWh/m²/year on average, depending on whether they are located in mild or cold regions.

While energy and GHG reduction objectives appear straightforward, there is one technical issue in particular that complicates them. The issue of direct and indirect emissions is important as electricity consumed in a home can be generated by various means. These can range from relatively climate-friendly hydro-electric dams and reservoirs (dominant in British Columbia) and nuclear power stations, to coal-

and gas-fired generating plants. While energy conservation, cost savings, and possibly energy security concerns can be met by encouraging home energy efficiency improvements, climate protection aims require greater consideration be given to greenhouse gas emissions, both direct (i.e. in-home natural gas or oil consumption for space heating or cooking) and indirect emissions (i.e. from electricity generating plants). When deciding on energy efficiency interventions in a climate context, it is necessary to consider the primary sources of energy (e.g. coal, hydro-electric, nuclear, natural gas, oil, renewables). Adding further complexity to the picture is power trading between power utilities connected via trans-border grid connectors, which can significantly alter the emissions intensity of the electricity a utility sells to its customers (BC Hydro, 2016).

Conservation measures

In response to occupant behaviour, dwellings consume energy as they heat, cool, dehumidify, ventilate, produce hot water for personal hygiene purposes, and satisfy various plug loads. Energy conservation measures can address three of the six layers [in bold] below that Duffy and Henney (1989) and Brand (1995) refer to when considering the house, specifically:

1. **Site:** geographical setting of building
2. **Structure:** foundations and load-bearing elements, and insulating materials
3. **Skin:** building fabric or envelope, fenestration and solar exposure
4. **Services:** working elements of building including space heating and cooling systems, electrical wiring, plumbing
5. **Space plan:** interior layout (i.e. where walls, ceilings, floors and doors go)
6. **Stuff:** appliances and other plug-loads, building materials

Passive ECMs include increasing levels of insulation, replacing windows, improving air tightness, enhancing ventilation, and encouraging behaviour change. Active measures include upgrading boilers and lighting, or producing energy from wind, biomass, solar, and other sources (Roberts, 2008). Insulating the building fabric or envelope by adding insulation to roofs, exterior walls, or ground floors above

unheated basements are often the most cost effective interventions. Replacing single pane windows with advanced technology windows (i.e. double- or triple-glazing, gas-filled, low-emissivity films, soft spacers, etc.) is a very common retrofit measure despite the fact that it has a payback period beyond the average human's life expectancy (Dowson et al., 2012). The lifestyle benefits that windows offer (i.e. quieter rooms, reduced draughts, ergonomic hardware, etc.) appear to ameliorate, to a significant extent, the financial unattractiveness of this investment.

To better understand the more practical side of energy retrofits, Table 2-1 has been adapted from analyses conducted by Shorrocks et al (2005) and DCLG (2006), and provides a list of the most common retrofit measures, their UK calculated capital costs, simple payback period, and the key debates of each. Unfortunately, similar data for the Canadian context do not exist. Dowson et al. (2012) have made a valuable contribution to this discussion with a comprehensive examination of retrofit options, barriers, incentives and costs. Together, these works help to paint a picture of what substantial energy retrofits entail, yet the variability in some of the savings estimates confirms how difficult it is to make generalizations across the housing stock. It also reinforces the principle that bundling ECMs leads to more comprehensive retrofits with optimized payback periods as relatively cost-effective interventions help to counterbalance some of the longer payback actions.

Table 2-1 Comparison of common energy efficiency measures and costs

Measure	Capital Cost * (£)		Cost Saved (£/yr)	CO ₂ Avoided (kg/yr)**	Simple Payback (yrs)***	Description	Key Debates
	Low	High					
Loft insulation	138	273	3 - 80	190	3 - 91	DIY & installer cost	Cost effective when < 150 mm already installed
Cavity wall insulation	300	325	44 - 75	242	4 - 7	Grant aided & typical cost	Highly cost effective
Solid wall insulation	1309	3272	136	694	24	Marginal & full cost	Difficult to install; cost effective as a marginal cost measure
Floor insulation	50	1000	31	No data	32	Marginal & full cost	Effective measure but as a marginal cost measure
Low-emissivity double glazing	0	4000	38	26	105	Marginal & approximate cost	Not cost effective, but provides non-pecuniary aesthetic and acoustic/thermal improvements
Draught proofing	85	110	5	43	22	DIY & installer cost	Very cost effective, but low cost savings; provides positive thermal comfort improvements
Cylinder (water tank) insulation	8	20	3 - 30	53	1 - 7	Low & high DIY cost	Highly cost effective
Condensing boilers	100	300	43	177	7	Low & high marginal cost	Highly cost effective
Better controls	125	250	55	77	5	Low & high installer cost	Cost effective
Energy efficient lighting	85	200	22	No data	9	Low & high purchase cost (for 17 lamps)	Cost effective despite reduced heating benefits
Energy efficient appliances	0	114	1 - 18	No data	6 - 114	Range of marginal costs covering all appliances	Cost effective; can also reduce water consumption
Solar water heating	1650	2475	30	88	83	Grant aided & typical costs	Not cost effective; good potential for carbon savings
Photovoltaic power generation	6900	13300	99	249	134	Grant aided & typical costs	Not cost effective; good potential for carbon savings
Heat pumps	No	Data	available	990		Cost effective	Ground source heat pumps more expensive & more efficient than air source heat pumps, & may require significant land area
Fuel switching	No	Data	available	No data			Biomass boilers can be effective where fuel sources readily available but wood burning not always permitted. From nat. Gas to hydro-electric benefits emissions but may not be cost effective

Adapted from: Shorrocks et al., 2005: p. 21

* Low = gross cost - grants avail, or marginal cost where work is needed anyway; high = gross cost for intentional project

** Source: (DCLG, 2006)

*** Assumes high cost estimate divided by high range of annual savings

The cost of conserved energy (CCE) often figures prominently in retrofit decisions. Harvey (2013) reviews data from Europe and Canada and concludes that reducing single-family home heating loads from averages closer to 150 to as low as 40 kWh/m²/year is often feasible at costs of between \$CDN 100 and \$CDN 250/m², or 30€ and 200€/m² in Europe. For European and Canadian houses built prior to 1970 this typically represents a three- to five-fold reduction in heating loads (ibid.). The CCE, calculated by Harvey in his survey of retrofit projects, ranges from \$CDN 0.02 to \$CDN 0.05/kWh (sometimes greater than \$CDN 0.1/kWh). These costs of energy conservation (Table 2-2, far right-hand column) can be comparable to local energy costs which means that justification for home energy retrofits often need to incorporate non-financial and non-energy benefits (NEB) (e.g. enhanced indoor acoustics or reduced draughts, or availability of government subsidies, grants and rebates), all of which are not readily quantifiable or objectively measurable.

Table 2-2 Estimated or measured energy savings and costs resulting from retrofits of existing dwellings

Case	Energy use (kWh/m ² yr): before→after (abs. change, % savings)	Investment cost converted to 2010 currency value	CCE (2010 US\$/kWh)
Terrace and detached housing, Belgium	304→137 (167, 55%)	49 €/m ² (optimal upgrade)	0.018
1925 SFH, Denmark	149 saved	45 €/m ²	0.013
1970 SFH, Denmark	54 saved	83 €/m ²	0.089
Rural SFH, Ireland, constructed before 1997, or 1978-1982	219→80 (137, 63%)	112 €/m ²	0.047
1983-1993	107→72 (35, 33%)	116 €/m ²	0.189
1994-2004	91→72 (19, 21%)	113 €/m ²	0.340
	82→66 (16, 20%)	96 €/m ²	0.344
SFH, Norway, constructed during the 1980s	145→49 (96, 66%)	73 €/m ²	0.043
	145→24 (121, 83%)	186 €/m ²	0.087
SFH, Switzerland, constructed between 1948-1975	194→164 (30, 15%)	Std renovation 32-39 CHF/m ²	0.061
	194→140 (54, 28%)	102-132 CHF/m ²	0.073
	194→97 (97, 50%)	161-200 CHF/m ²	0.079
	194→69 (125, 64%)	219-321 CHF/m ²	0.106
	194→57 (137, 71%)		
1945-1964 semi-detached house, UK	100→48 (52, 52%)	£30/m ²	0.039
	100→32 (68, 68%)	£155/m ²	0.153
	100→26 (74, 74%)	£192/m ²	0.173
Pre-1914 detached house, UK	176→116 (60, 34%)	£26/m ²	0.029
	176→73 (103, 59%)	£193/m ²	0.125
	176→44 (132, 75%)	£238/m ²	0.121
European terraced houses	Savings:		
Cold climate	97	161 €/m ²	0.095
Moderate climate, std	234	95 €/m ²	0.023
Moderate climate, adv	257	114 €/m ²	0.025
Warm climate, pre-1975	210	70 €/m ²	0.020
Warm climate, 1975-1900	75	63 €/m ²	0.048

European terraced houses			
Baltics, standard	267→83 (184, 69%)	75 €/m ²	0.023
Baltics, advanced	267→72 (195, 73%)	84 €/m ²	0.025
Poland, standard	334→94 (240, 72%)	74 €/m ²	0.018
Poland, advanced	334→67 (266, 80%)	84 €/m ²	0.018
CZ, HU, SL, SK, no ins.	370→79 (291, 79%)	74 €/m ²	0.015
CZ, HU, SL, SK, 1975-1990	244→79 (165, 68%)	71 €/m ²	0.025
US southeast SFH	81→57 (24, 30%)	\$22-34/m ²	0.039-0.059
1987-2005 vintage	63→41 (19, 30%)	\$22-122/m ²	0.061-0.279
post 2005 vintage			
Austrian SFH, conventional renovation	280→86 (194, 69%)	201 €/m ² extra	0.162
Passive House renovation	280→15 (265, 95%)	compared to conventional renovation	
Large sample of Swiss houses renovated to different standards	83→56 (27, 33%)	31 CHF/m ²	0.048
	83→28 (55, 66%)	316 CHF/m ²	0.239
	83→14 (69, 83%)	713 CHF/m ²	0.430
	83→11 (72, 87%)	1075 CHF/m ²	0.621
15 houses in pilot 'Home Performance' program houses in California, USA	25% reduction in cooling energy use, 65% reduction in heating energy use (and 35% reduction in peak electricity demand)	\$15000-40000 per house, probably \$75-200/m ²	
335 m ² 1915 house in Massachusetts, USA	190→60 (130, 68%) 50→12 (38, 76%)	\$235/m ²	0.061
Nine SFHs, various locations, USA	30-50% heating season savings	\$90-170/m ²	0.10-0.35

Adapted from (Harvey, 2013, p. 40 Supplement)

2.4 Cracks in the plaster: a critical view of retrofit policy and practice

Climate-induced retrofits are not a straightforward technical issue. Instead, they constitute complex socio-technical activities, defined by their own particular histories. The shortcomings of traditional conceptualizations of home energy retrofits are examined in this section by applying a critical lens to the beliefs, approaches and practices embedded in the retrofit enterprise. This lens is informed by concepts taken from socio-technical systems, intermediaries, and theories of practice. The objective is to move toward a new understanding of home energy retrofits that gives more credence to the inherently social and bifurcated nature of homes, and recognizing that retrofits are a deeply embedded social phenomena that unfold within a complex housing socio-technical system.

2.4.1 Sanding against the retrofit grain: key socio-ecological debates

Several thinkers urge policy makers to be more mindful of socio-cultural contexts (Hodson and Marvin, 2010), sensitive to everyday household practices (Moloney et al., 2010) and the cultural construction of 'home' (Stephenson et al., 2010) when designing retrofit policies and programmes. Currently, climate action reflects

cultural conditionings and is framed as an individual, rather than a collective issue (Seyfang, 2010). Consequently, political elites and institutions are largely absolved, and instead human nature is indicted for climate woes (Hobson, 2003; Shove, 2010a). Responsibility thus passes to individuals to change behaviour, which then leads to policy focused on moral persuasion or cost saving incentives (Moloney et al., 2010). Public policy and programmes to accelerate upgrades to existing housing stocks and reduce carbon emissions, when mandated, conflict with neoliberal understandings of consumption and home retrofit as an issue of personal choice and lifestyle preference. In considering strategies to upgrade the energy performance of entire national housing stocks, many questions arise regarding distributional and procedural justice (Bulkeley and Fuller, 2012), specifically, those related to housing tenure (Joerges and Muller, 1983; Ravetz, 2008), state of the stock (Webber et al., 2015), demographics (Thorns, 2002), social fragmentation (Dale and Newman, 2009), duty to act versus the ability to pay, and applying the polluter-pays principle (Bulkeley and Fuller, 2012). In addition, there are risks of potential conflicts with efforts to reduce fuel poverty (Bouzarovski, 2015), preserve homes representing heritage value, maintain energy affordability, and improve housing quality (Moore, 2012; UK DECC, 2013).

Newly retrofitted neighbourhoods can precipitate social exclusion and fragmentation of existing neighbourhood social structures. This can happen when upgrades to the stock render housing unaffordable or undesirable for the original inhabitants (Llewellyn, 2004). Retrofits, as proxies for investment, can also alter the demographic makeup of a street or neighbourhood, thereby altering the style and culture of the area and making it more welcoming for some – who value the improvements – and less welcoming for others (Goodsell, 2008; Thorns, 2002).

Hodson and Marvin (2010, p. 431) note a strong social policy dimension to recent energy retrofit programmes (e.g. improving energy performance of low-income households or upgrading infrastructure in derelict neighbourhoods), but point out these actions are often "*done to the inhabitants who usually cannot say 'no'*". Whether or not government retrofit programmes can be imposed on wealthier and more politically astute individuals remains an unanswered question (Hodson and

Marvin, 2010). There are other social issues associated with a low-carbon transition, such as the marginalization of certain carbon-unfriendly interests, coercive mechanisms of punishment on non-deserving carbon users (e.g. deluxe/rapid service 'green-lines' for residents applying for green renovation building permits), and the emergence of a further means of state surveillance via stricter carbon monitoring (While et al., 2010).

Theories of practice highlight further concerns related to the introduction of new low-carbon technologies or home designs. According to Shove et al. (2012) and Schatzki (2001a), practices are emergent and depend on how actors reconfigure existing skills and social meanings with new technologies. This suggests that carbon emission reductions, rather than being dependent on technical design and rational deployment of technologies, will depend on the unpredictable manner in which actors appropriate their newly retrofitted homes (Lomas, 2010). Social understanding of thermal and lighting comfort, in addition to notions of air tightness, are also highly personal and contingent, and when overlaid by low-carbon retrofits can produce social inequities (Crilly et al., 2012). In addition, social commitments to work, family and community limit the ability of actors to participate in climate and energy policy development, and to become familiar with retrofit options, impairing the development of new meanings and increasing the likelihood that actors will turn to tried and true doings and sayings (Rouse, 2007) and easy solutions which are often not the most efficient or economical (RAP, 2011).

2.4.2 More than shelter

Brand (1995) charges that despite the concerted efforts of many architects, all buildings, including dwellings, were made to change. Further, that buildings flow – constantly learning, adapting and changing – and if designed and managed wisely can provide meaningful space for their users through time.

[H]omes are the steadiest changers, responding directly to the family's ideas and annoyances, growth and prospects. House and occupants mold to each other 24/7 and the building accumulates and reflects this intimacy (Brand, 1995, p. 7).

Over the last century homes have changed from places of production to places of consumption (Thorns, 2002). In recent years the arrival of home offices and resource capturing and conversion technologies are reconfiguring the home again into a site of production (Maller et al., 2012), and Brand (1995) suggests that looking forward, rising energy costs and climate change will likely trigger further reconceptualizations of the dwelling. The idea of the ever-changing, flowing building lies in contrast to those earlier architects and engineers who Abramsson (2008) and Brand (1995) argue were more positivistic about their designs and understood buildings to be static objects, fixed in time and space, and taking on forms that speak specifically to function.

The home embodies individual intentions, understandings of self and everyday life, thus improving the energy performance of a home means intervening in the spaces and meanings that constitute the stage upon which much of the drama of peoples' lives are played out. Tucker contends that our relationship with the *spaces* and *stuff* within our homes (taken by Havel to include everything from the level of the house to the level of the universe), are inalienable from who we believe ourselves to be (Havel, 1992; cited by Tucker, 1994). The drive for self-actualization and identity is therefore interwoven with where we live, hence the home helps create a sense of self-identity, rather than just a place to shelter against the elements (Goldstein, 1998). Regardless of the location, size and shape of their dwellings, most humans engage in home-making; the creation of identifiable spaces that reinforce personal identities, and embody human values and dreams (Lefebvre, 1991; Thorns, 2002). Indeed, for Lefebvre (1991), space is a social product that is not simply produced for consumption, rather it is perceived in a material sense, conceived as a normative representation of space, and lived via emotional relationships developed through manipulation, appropriation and adaption of spaces. Retrofitting an existing home therefore necessitates the navigation of more than simply a non-human object; it entails reconfiguring spaces and views and reconfiguring existing relationships (practical and emotional) between occupants and their dwellings. All this suggests that as we reconfigure our dwellings, so do we reconfigure ourselves.

Brand's earlier notion of a form of intimacy and feedback between actor and physical environment nicely captures the idea of mutualism between occupants and the meanings that their living spaces and technologies imbue. Shove and Walker (2010) elaborate on this relationship in their study of the evolution of the meaning associated with showers and bathrooms for residents. Specifically, from sites of "*morality and propriety*" to places of "*freshness, invigoration and relaxation*" (Shove and Walker, 2010, p. 473). Latour (1988) also emphasizes this dynamic in his very insightful description of the relationship between building occupants and delegated non-humans like door closers. These writers reinforce the idea that our social relations and our perceptions of the world around us are prescribed to us by the numerous physical, inanimate objects and spaces that surround us. It is through the navigation among these objects and spaces that actors are able to build self-identity, knowledge, morality, craft, force, and sociability (Latour, 1988).

Historical conceptualizations of the home have emphasized the technical and inanimate nature of the physical building, resulting in technical upgrades with little attention to what homes mean to their occupants (Brand, 1995). Home energy retrofits are but one of several common mechanisms that facilitate changes to buildings during their lifetimes, and although much is known about the technical aspects of historical retrofits undertaken, the returns on investments made, and the motivations for doing so, some important insights are still missing. What is lacking from historical experience is an understanding of how actors' perceptions of home, and overarching structural dynamics, influence the nature of dwelling upgrades, and how these ideas can be employed to foster the kind of systemic change that Hodson and Marvin (2010) flag as vital to the new, climate change and energy driven retrofit era we have entered.

2.4.3 Material gaps

Three themes emerge from the literature on home energy retrofits, and each marks a separate point of contestation. The first relates to how retrofits are differentiated from other home alteration activities, while the second focuses on the battle between a 'rational' engineering and a social theory perspective on retrofits. The

final theme centres on the skills and capacity of a relatively invisible, and assumed homogeneous, workforce that is essential to home energy retrofit goals, yet rarely garners more than a footnote or a bullet point in a list of retrofit-related factors.

As already discussed, the term 'retrofit' is generally associated with the installation of an energy saving technology, but despite this generalization, there remain strong overlaps, and hence confusion, between energy retrofits and several other discernible categories of home altering activities including: refurbishment; repair, maintenance, improvement (RMI); and home-based micro-generation of energy. A scheme like that in Figure 2-6, adapted (with dashed lines) from Killip (2012), is a step toward Hodson and Marvin's (2010) conceptualization of retrofit as a systemic phenomenon. Killip (2012) sees energy efficiency, (changed to 'retrofit' in Figure 2-6) as distinct from two other sub-markets, repair, maintenance and improvements (RMI) and Micro-generation which involves generating energy via on-site technologies like photovoltaic (PV) solar cells and wind turbines. The scheme begins to delineate a unique space for the fluid activities constituting energy retrofits, yet as Bouzarovski (2015) laments , it still fails to situate retrofits with respect to broader socio-technical system conditions and scalar interactions.

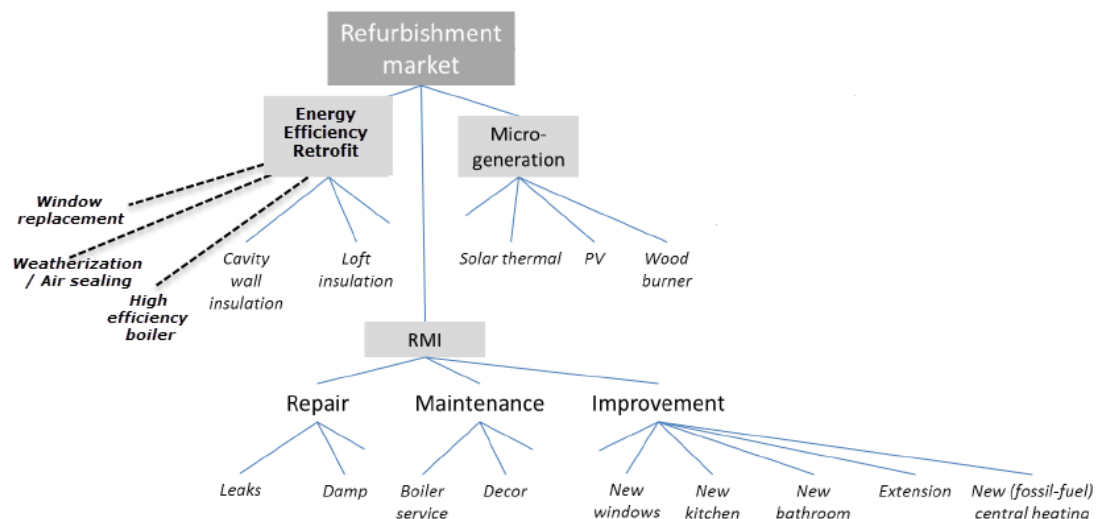


Figure 2-6 Retrofit sub-market in relation to related construction domains
Source: Adapted from (Killip, 2012, p. 5) (author's additions in bold)

2.4.3.1 Rationality vs subjectivity: the retrofit binary

The other fundamental tension in the retrofit literature reflects the binary manifest by disparate views on energy efficiency and retrofits. The first sees retrofits as engineering problems requiring engineering solutions, while the second takes retrofits to be inherently complex social phenomena, requiring flexible interpretations and acceptance of multiple, and equally valid, problem framings. Lutzenhiser (2014) proposes that traditional thinking on energy efficiency in homes is based on a physical-technical-economic-model (PTEM) which focuses almost exclusively on devices, costs, weather, and prices, rather than "*the realm of the random, noisy, messy, disorganized parts of the world*" (Lutzenhiser, 2014, p. 143). He adds that energy efficiency is not a concept that comes naturally to social scientists; it is too infused with normativeness and technological qualities that "*at least [imply] the engineering of something (or someone), quite possibly in ways that may not be agreeable, or even just and useful*" (ibid., p. 142). Lutzenhiser's research highlights how invisible energy use and energy conservation are to humans, and how uncomfortable it is when energy governance, which is so dominated by rationality and straight-line technical thinking, fails to perform according to reason (ibid.). In addition, Lutzenhiser suggests that how we evaluate energy efficiency should reflect "*contexts, conditions and culture*" (ibid. p. 142). Underlying decisions regarding which project approach to take (i.e. shallow, bundled, deep), what level of financial investment to commit, and ultimately which energy efficiency interventions to undertake, there is a generalized hierarchical model for undertaking retrofits that Harvey suggests (2013) focuses progressively on:

1. **Fabric:** ensuring that the building envelope (fabric) is highly insulative (i.e. reduced thermal bridging, minimum insulation levels) and breathable to prevent moisture from becoming trapped in the wall void;
2. **Design:** maximizing passive heating, ventilation, cooling and day lighting opportunities (i.e. natural stack effect and shallow floor plates for maximum light penetration);

3. **Efficiency:** installing efficient space conditioning and lighting systems to satisfy remaining loads (e.g. condensing boilers with a coefficient of performance of 93 percent, heat recovery ventilators);
4. **Load matching:** matching individual energy-using technologies with the loads they must satisfy;
5. **Commissioning:** ensuring the building envelope, systems and technologies are properly commissioned.

Ma and his colleagues characterize this model as principally a question of optimization:

The building retrofit optimisation problem is to determine, implement and apply the most cost effective retrofit technologies to achieve enhanced energy performance while maintaining satisfactory service levels and acceptable indoor thermal comfort, under a given set of operating constraints (Ma et al., 2012, p.890).

Such a positivistic view of energy retrofits has enjoyed popular support for over the past forty to fifty years, however, there are those who are keen to emphasize the importance of non-technical issues in determining '*the set of operating constraints*' referred to by Ma and colleagues (Ingle et al., 2014; Seyfang, 2010; Swan et al., 2012; Vergragt and Brown, 2012b). Sutherland (1991) takes up this challenge by examining the finance-related barriers to retrofit. He argues, counter to many, that market failure is not the reason for low rates of investment in cost effective energy efficiency technologies. He suggests that homeowners "*require higher rates of return when the investments are illiquid and they are unable to diversify away the risk*" (ibid., p. 15). The retrofit literature however flags high up-front costs as one of the most important barriers to wide scale retrofits, thus most programmes dedicate significant resources to mitigate financial burdens associated with retrofit investments (Globe Advisors, 2013c; RAP, 2011; Smith and Swan, 2012; WBCSD, 2009; Wilson et al., 2015; Ya He, 2012). These contestations contribute to fuzzy understandings and values where retrofits are concerned.

Like Gamtessa (2013) who views retrofits as an engineering challenge, Ma et al. frame a retrofit as a linear process including five discrete phases: project set-up and

survey; energy audit and performance assessment; identification of retrofit options; implementation and commissioning; validation and verification. The literature suggests there is a misalignment between how Ma and his colleagues (2012) see retrofits unfolding and what happens in practice, especially at the residential dwelling level. Several researchers (Better Buildings Partnership, 2010; Crilly et al., 2012; Vergragt and Brown, 2012) share the view that home energy retrofit projects undertaken by homeowners rarely follow this neat and linear process, tending instead to focus on the third and fourth phases only, and tending also to reflect wildly divergent sensibilities concerning value, risk, and motivation (Haines and Mitchell, 2014). This may reflect, at least in part, what Globe Advisors (Globe Advisors, 2013c) observe as a general lack of knowledge among homeowners about the *house-as-a-system* concept, and concerns over uncertain outcomes, lifestyle disruptions, and up-front costs. But lack of knowledge is not only an issue for the lay public. Many urge greater consideration of knowledge and capacity gaps among those working in the retrofit arena as well (Community Energy Association, 2014; Globe Advisors, 2013a; Haavik et al., 2012; RAP, 2011). The latter include building inspectors who are responsible for enforcing energy efficiency requirements in building codes, codes that are constantly being updated, vary between jurisdictions, and that regulate dwelling components that are often invisible to both lay and professional eyes. Using codes to 'certify' energy efficiency levels is not as straightforward as confirming a building is structurally sound for protected against fire risk. Many initiatives push for improved energy performance of homes, using measurements based on an 'X percent better than code' metric. With so many codes in circulation, there will always be confusion about what this might mean. In other words, when we say a building is 30 percent better than code, better than what code? The Rocky Mountain Institute (2012) recommends the construction community communicate energy efficiency in a new way. For example, from an established level of zero units of energy per square meter, per year, upward. Approaches like this highlight the kinds (and sources) of confusion that circulate in the retrofit world which impede its development. The dominant Cartesian discourse on energy efficiency seeks comfort in 'averages' (e.g. household sizes, dwelling areas, comfortable indoor temperatures, etc.) when setting design and regulatory

standards. Yet, Lutzenhiser (2014) argues that these averages deny natural variability in the spectrum of human experience and performance.

[D]omestic energy consumption patterns and conservation actions are highly variable, are not easily segmented and clearly involve a wide variety of non-hardware and “behavioral” dynamics (Lutzenhiser, 2014, p. 146)

Energy labelling too contributes to confusion according to Killip (2012). The potential energy efficiency improvements stated in energy performance certificates (EPC) are calculated according to only a selection of ECMs, rather than in accordance with that which is being realized by pioneers of more advanced retrofit techniques and technologies (ibid.). In the absence of changes to the EPC framework to reflect a commitment to climate policy goals, this high profile, awareness raising tool may contribute to increased public confusion about what constitutes meaningful home energy efficiency improvements.

The engineering-centric view of energy efficiency is further critiqued by Jaffe and Stavins (1994b) who conclude that theoretical predictions of energy performance - implied in building codes, standards and energy retrofit incentive programmes - rarely reflect the real-life performance of post-retrofit buildings. The discrepancy between the two measures can vary significantly, as revealed by Stafford (2011) (Figure 2-7).

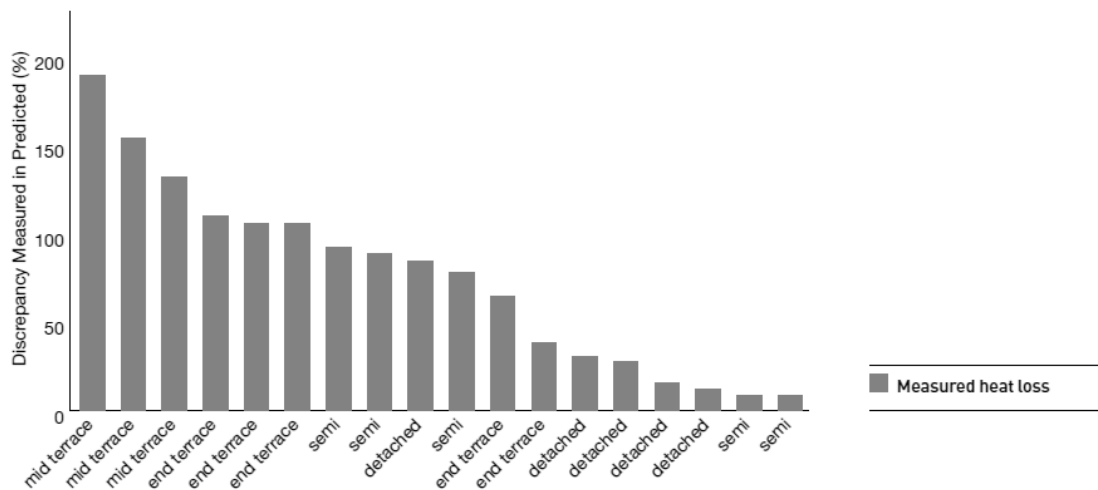


Figure 2-7 Discrepancy between measured and predicted mean U-value for UK housing sample (n=18)
Source: (Stafford, 2011, p. 15)

The literature offers wide scale support for deep rather than shallow retrofits, despite the cost, inconvenience and temporal implications of the former (Community Energy Association, 2014; Globe Advisors, 2013c; Harvey, 2013; RAP, 2011). Questions regarding the relative merits of deep versus shallow retrofits, or the strategic advantages of doing a project 'all at once' or over time in stages, are important but this thesis argues that they likely mask other equally confounding questions regarding socio-technical system conditions, normative practice, and perhaps most importantly, other actor groups operating in the background.

2.4.3.2 Invisible no more: intermediaries in a retrofit system

The present research notes that the literature on retrofits consistently fails to engage meaningfully with the intermediary actors that sit between homeowners and policy circles. That is, the people who neither make the laws, nor pay for the energy conservation measures, but who do the advising, designing, installing, constructing, and consulting associated with home energy retrofits. This group appears (ironically) invisible to both energy retrofit discourse and policy actors. Kelly (2009) highlights the broad structural impediments that hobble this group of actors, arguing that,

internationally, the supply chain for renovating existing buildings is entirely balkanized – there are many independent suppliers of materials, and a huge number of small companies and independent operators providing the service and installation of renovation measures (Kelly, 2009, p. 197).

Globe Advisors (Globe Advisors, 2013b) point out that despite their seeming disarray, these trades and professions are very visible to homeowners, as the former frequently interact with the latter during repair, maintenance and improvement projects. However, these encounters infrequently transpire within an energy efficiency context.

References to these industry actors often appear in discussions of barriers to retrofits. An example is reflected in one of the BC Government's (2015) conclusions related to their review of whole home energy retrofit programmes in British Columbia:

There are challenges including the limited number of whole home contractors available, lack of consumer trust in contractors, lack of established quality assurance frameworks to verify quality of installations and lack of a single point of contact for homeowners wanting to undertake different types of energy efficiency upgrades, such as space heating and insulation (BC Government, 2015, p. 7).

Globe Advisors (2013b) find low levels of energy efficiency retrofit training among those working in the construction sector which further impedes formation of an industry consensus where energy efficiency is concerned. In addition, the intermediaries providing retrofit products and services are sometimes 'hard to access', and relatively obscured when compared to those considered by policy makers as the 'usual suspects' (e.g. homeowners and utilities).

The next section examines who or what these actors include, where and how they are situated, what the nature of their interrelations is, and what they do in the context of altering the physical state of buildings. The reader will be introduced to the intermediaries circulating in the retrofit socio-technical system, and shown how this group of actors contributes to the persistence of a dominant building practice through repeated performances of normal daily work routines.

2.5 Intermediaries

Relatively low levels of observed retrofit activity across OECD countries present a case for re-thinking current policy approaches so that building practices, and the people that perform them, are at the centre of the picture. There is an urgent need to dismantle the hegemonic view that "*people only live in houses rather than making their livings in them*" (Janda and Killip, 2013, p. 40). To effect a transition such that energy retrofits become common and normative, requires what Watson (2012, p. 488) refers to as getting "*enough people to do enough things differently, enough*". It means making changes to existing building practices and wide scale adoption of an energy efficiency ethos by the middle actors that make retrofits happen, not just homeowners. This thesis reflects on what 'enough people' means in the context of retrofits. To now, it has meant getting enough households to change their behaviours and choices enough. Adapting Watson's research, the challenge is to effect change in all the working parts of the retrofit socio-technical system, rather than focusing solely on the end-user. While the middle actors considered here do not in themselves represent all the working parts, they do play a vital role in determining many of the relations between them.

The retrofit literature does not ascribe to these middle actors any attribute other than building-related expertise, but this thesis posits that the position and functions of these actors within the retrofit chain of action infuse them with intermediary qualities, in addition to their expert capabilities, and hence powers to influence. As intermediaries, these actors negotiate between opposing interests to create shared visions and optimal solutions that would not otherwise be achievable in their absence. To support this contention, this section explores the essential nature of intermediaries to better understand how these middle actors contribute to the maintenance or alteration of building practices which impact on the energy performance of residential dwellings.

2.5.1 From honest broker to adaptive actor

Taking inspiration from Watson, I am encouraged to look at building practices and the intermediaries that influence them. With respect to retrofits, intermediaries that actually 'do' retrofits, or who are materially implicated in how retrofits are

'done', are of principal interest, and getting enough of them to make energy efficiency the default involves looking at what they currently do and how they do it.

2.5.1.1 Leading from the middle: the work of early intermediaries

Intermediaries, although not always referred to as such, have been around for a long time. British wool and textile markets provide evidence of 'middlemen' [sic] disseminating technical information to buyers and sellers as early as the sixteenth century (Smith, 2002). Intermediary organizations, acting as liaisons between science and policy, began to emerge in the latter part of the twentieth century in response to market liberalization in capitalist economies, and the fact that government departments were not designed to materially supercharge private markets, which was the ultimate goal (Howells, 2006; Piore, 2001; Seaton and Cordey-Hayes, 1993; van Lente et al., 2011). Prior to government decentralization and market liberalization (Marvin and Medd, 2004), and hence the era of command-and-control economics and more static socio-technical systems, the need for intermediary organizations remained largely restricted to market expansion efforts (Piore, 2001).

The early schools of thought, from which the principal notion of the intermediary comes, include innovation (Edquist and Johnson, 1997; Rogers, 1983) and science and technology studies (STS) (Procter and Williams, 1996). It is from these schools that financial (Allen and Santomero, 1997), market (Kazis, 1998), and commercial (Brousseau, 2002) intermediaries first appear. Toward the end of the twentieth century, STS and innovation scholars are joined by authors from other disciplines applying different adjectival prefixes to conceptualize intermediaries in myriad different ways. For example, these later intermediaries are framed as social (Piore, 2001), welfare (Allen, 2003), cultural (Hennion, 1989), and information (Ehrlich and Cash, 1999) intermediaries.

In early studies of intermediaries, scholars credit intermediaries with bounded rationality and agency operating under clear mandates and rules of engagement to reconcile contested visions and foster new imaginaries. Despite their limited autonomy, these early intermediaries functioned as influential (yet largely

apolitical) actors, specially designed to build relations, communicate ideas, transfer knowledge, and broker agreements between opposing interests in the name of stimulating economies, facilitating market integration and hastening innovations (Allen and Santomero, 1997; Cronin, 2004; Freeman, 1991; Kazis, 1998). In these ways classical intermediaries translate between experts and lay-populations and function as pseudo-governmental institutions to keep markets functioning efficiently. Unsurprisingly, given this upbeat reputation as wheel-greasers and market builders, intermediaries are traditionally painted in a rather positive light (Allen and Santomero, 1997).

Several simple, but key concepts dominate the literature concerning the form and function of early intermediaries. First, they are formal organizations (rather than individuals or networks), designed by government or industry to function as market efficiency and innovation enhancers (Newell et al., 2012). In line with this characterization, Howells (2006, p. 2368) describes early intermediaries as "*brokers, middle-men, consultants, bridge builders, and technology brokers*". Second, intermediaries always situate themselves in-between interests, be these designers and user groups (i.e. innovations), or producers and consumers (i.e. markets).

To get at the essence of early intermediaries, two examples situated at the science and policy interface are examined. The first example involves the Dutch Council for Agricultural Research (NRLO). As intermediary, NRLO's primary function is to develop options and priorities for near and long-term research on issues related to agriculture. Rather than relying on bureaucrats to set research agendas, NRLO provides the government with ready access to a synthesis of deliberations and perspectives expressed by three key stakeholder groups, and provides an independent and comprehensive vision for the strategic direction, content, and coherence of agricultural research. In order to deliver this value, NRLO relies on the relations it maintains between itself, users and researchers, its multi-disciplinary nature, and its expert familiarity with strategic research issues. This organization was designed to make the research-policy space more efficient and well targeted, by acting as a skilled convener of parties and synthesizer, (rather than transformer), of information.

The second example hails from across the Channel and features Regional Technology Centres (RTC) (Seaton and Cordey-Hayes, 1993). These bodies were designed and promoted by the UK Department of Trade and Industry (DTI) in the 1990s to function as linkages between technology providers and potential buyers. The material nature of the RTCs was to act as technology information clearinghouses in order to improve producer-buyer access and facilitate acquisitions. This involved compiling a technology database, answering questions, scanning markets, and connecting parties.

These examples demonstrate the rather purposive and straightforward modus operandi of early intermediaries as market lubricators and efficiency enhancers. Yet, in response to continuous processes of neo-liberalism, deregulation (Hodson and Marvin, 2011; Moss, 2011) and multiple environmental crises including climate change, we are experiencing an environmental turn in public policy (Guy and Shove, 2000). This trend is particularly relevant to the study and management of socio-technical and socio-ecological systems, as fragmented control structures increase their internal complexity and contribute to the unsustainable lock-in of these systems (Chappells and Shove, 2004; Maneschi, 2013; Moss, 2011, 2004). The social, technical, policy and scalar questions resulting from these shifts, coupled with the contrasting visions and perspectives relating to the many wicked challenges we face today, warrant the rise of many more, and new types of intermediaries (Moss et al., 2011). These more adaptive intermediaries allow socio-technical and socio-ecological systems to continue functioning, but they can also wield significant power over public policy goals and discourse. Unlike the late twentieth century institutional intermediaries that served principally to facilitate market integration, expansion and innovation, these new intermediaries are sometimes stakeholders in the same debates they negotiate (Beveridge and Guy, 2011; Moss, 2011). In essence, these actors are emerging as default and material arbiters of public policy debate, interpretation and implementation (Moss, 2011). Unlike earlier intermediaries who were tangential to the topic at hand, these intermediaries are now relevant in their own right as they fill governance and knowledge gaps, and develop and maintain vital bridges among and between

institutions, businesses and citizens (Meyer and Kearnes, 2013; Moss, 2011). They sit in the interstitial areas between stakeholders and interest clusters where meanings and boundaries are often blurred, and through their work as translator and interpreter, they can alter existing processes and relations to steer new outcomes (Howells, 2006). Today's intermediaries also appear in a sense to justify neoliberal policies of deregulation and privatization by diverting attention from legitimate (and technically accountable) power holders toward a whole array of independent, spatially scattered, and disparate actors in a long, convoluted and relatively unaccountable chain of command. In a sense, intermediaries are depoliticizing public debate and the ways in which we understand socio-technical and socio-ecological systems. These new intermediaries are not always purpose-built or fully conscious of their intermediary roles, thus, these 'accidental' intermediaries are not accounted for in current conceptualizations (Moss et al., 2011). Moreover, today's intermediaries are not always readily identifiable as such, and can come in a variety of forms, ranging from objective-driven and purposeful individuals or organizations, to self-interested entities or inert technologies unaware of their intermediating potential (Moss, 2011). In this research, what is taken to be an intermediary today differs from that which was considered an intermediary 30 years ago. First, there are many more actors that can usefully be considered an intermediary, given their position and impact within a system, and the nature of the very systems they help others navigate. They can range from a pre-configuring physical artefact with no clear intent, to a highly visible and formal organization intentionally created to broker and foster common visions. In between these extremes we can find large, small, formal and informal organizations, some of which are taking on intermediary functions unknowingly and without notice, and others who are doing so involuntarily. Their diversity, varying visibility, and power to influence contested arenas justify efforts to differentiate between them and early intermediaries that displayed clearer purpose and transparency.

2.5.1.2 Form and function

Despite frequent reference by authors over the past 40 years, and perhaps because of the broadness of the definitions found in the literature, the concepts of

intermediary and intermediation remain under-developed concepts, both empirically and theoretically (Beveridge and Guy, 2009; Howells, 2006; Moss, 2009; Randles and Mander, 2011). This is likely due in part to a low level of cross-referencing between research domains (Guy et al., 2011; Howells, 2006). Moss et al. (2011) echo this sentiment, pointing out that intermediaries and their activities would benefit from greater critical analysis.

Intermediaries can come in a variety of guises depending on the field they operate in. Turning to the question of what form intermediaries take, Guy et al., (2011) who are concerned with socio-technical changes at the city level, include "*individuals, organizations, networks, institutions, processes, or even technologies*" in their definition of intermediaries (Moss et al., 2011, p. 5), while Moss (2009), who writes about shifting processes of European water and energy services, suggests intermediaries can include business consultants, research organizations, non-profit agencies, information campaigns, and innovation networks. The definition of intermediary is further broadened out by Guy (2011) who argues that local, regional and national planning systems can also be considered intermediaries. In his exploration of the roles that intermediaries play in innovation processes, Howells (2006, p. 715) describes them as "*brokers, third parties and agencies that are involved in supporting the innovation process*". Expanding the definition of intermediary even further, Hennion (1989), in his examination of the commercial music industry, identifies artistic directors as key intermediaries who, through their work of forcing, tearing and knitting, represent the public to the singer and the music to the public. By doing so, he claims they "*define the relationships between art and the world*" and in effect create musical art (Hennion, 1989, p. 403). This last point is under-emphasized in the literature but it expresses an important idea; that is, intermediaries can actually create meaning and substance through structuring relationships within a system.

Linked to intermediary functionality is the long-standing and universal agreement that intermediaries are distinguished by their in-betweenness, their situatedness between two or more parties (Guy, 2011; Howells, 2006; Moss, 2011; Moss et al., 2011), or interests, wherein actors are re-interpreted and re-ordered through the

construction of new network relations (Callon, 1984). The unique thing about intermediaries is that although they are located among actor groups, they are not always constrained by the same relations that structure the system wherein they and the other actors operate. Instead, whether brokering, interpreting or facilitating knowledge transfer between actors, they interrupt traditional relational patterns and mediate across boundaries (Beveridge and Guy, 2009) to produce new system configurations and meanings (Maneschi, 2013).

Scholars are not in complete agreement about the nature of the entities between which intermediaries mediate, which leaves questions as to whether or not intermediation always takes place between human actors, or whether intermediaries can mediate between actors and artefacts (e.g. technologies) as Moss (2009) suggests. Intermediation can also take place "*in-between different sets of social interests, in-between different natural, institutional and economic geographies, and in-between technological and social contexts*" (Moss et al., 2011, p. 6). van Lente et al. (2011) expand the notion of in-betweenness, arguing that intermediaries sit not only between private, public and third sectors, but also between scales, institutions and interests. The idea of scales is usefully elaborated upon by van Lente et al. in their discussion of systemic intermediaries and the ways in which they operate across sectoral and spatial boundaries that traditional intermediaries cannot traverse. These unique intermediaries are particularly potent as they not only work between parties, but also deny scales of action while simultaneously enabling "*multiple relations*" (Moss, 2009, p. 19). The concept of systemic intermediaries aligns well with the fields of environmental and sustainability studies where working across organizations and sectors, reconfiguring relations, and negotiating between actors operating at different scales is of central importance.

Such a broad range of descriptions of what intermediaries are and where they situate themselves highlights what other scholars (Ehrlich and Cash, 1999; Guy et al., 2011; Howells, 2006) reviewing the literature conclude: defining the ideal intermediary form is of less value than defining what an intermediary does, or as

Moss et al. (Moss et al., 2011, p. 5) argue, “*it is what they do, rather than their appearance, that distinguishes them as intermediary*”.

Table 2-3 provides a summary of several key authors’ understandings of what intermediaries do. As Maneschi (2013), (upon whose work this table is based) notes, the descriptors say what intermediaries do rather than who they are, which confirms that scholars struggle to narrowly define these actors according to their identities.

Table 2-3 Intermediaries according to their functions

Bessant and Rush, 1995	Articulation of needs, selection of options Identification of needs, selection training Creation of business cases Communications, development Education, links to external info Project management, managing external resources
Kaghan and Bowker, 2001	Stand[s] at a place in a network between two other actors Translate between the actors Intermediate between different scales, between technologies and different social contexts, between different meanings and between different sets of interests Help the different parties involved in a situation to “improvise” a response that is both sensible and acceptable under the circumstances
Howells, 2006	Foresight and diagnostics Scanning and information processing Knowledge processing and (re)combination Gatekeeping and brokering Testing and validation Accreditation Validation and regulation resources, organisational development Protecting the results Commercialisation Evaluation of outcomes
Smedlund, 2006	Function[s] in the midst of the users and producers of knowledge
Stewart and Hyysalo, 2008	Facilitate Configure Broker
Beveridge and Guy, 2009	Operate along the consumption and production nexus Act as conduits between actors Play[ing] integral roles in altering practices in the water sector (<i>sic</i>)
Heiskanen <i>et al.</i> , 2009	Mediate between production and consumption rather than focusing solely on production or consumption issues Mediate the different priorities [...] across different levels Mediate [...] between the embodiment of these priorities in plans or policies and their ‘application’
Janda and Parag, 2013	Enable Mediate Aggregate

Adapted from Maneschi (2013, p. 2370)

Clearly, intermediaries perform many functions, partly as a result of sectoral peculiarities, and partly because facilitating agreement between parties can involve an endless variety of actions. Based on a review of the literature, intermediaries

might best be described as another form of governance, or perhaps vision builders or sense makers; all relevant qualities for socio-technical and socio-ecological systems stalled due to uncertainty and conflicted views. Intermediaries create visions and contribute to sense-making (Ehrlich and Cash, 1999) by:

- supporting and coordinating the flow of new ideas, knowledge and information between actors;
- building bridges and relations between opposing interests;
- identifying and filling information or knowledge gaps;
- interpreting and translating ideas and information between interests; and,
- working across scales of action and multiple relations (i.e. systemic intermediaries) (van Lente et al., 2011).

The tendency to focus on how intermediaries act and what they do, rather than their internal structure and logic, means that intermediaries are many different things to many different disciplines. This is exemplified by the work of a raft of authors such as: Piore (2001) (social intermediaries); Kazis (1998) (market intermediaries); Allen (2003) (welfare intermediaries); Hodson and Marvin (2011), Cronin (2004) and Hennion (1989) (cultural intermediaries); Coggan et al. (2013) (planning intermediaries); Allen and Santomero (1997) (financial intermediaries); Ehrlich and Cash (1999) (information intermediaries); Heiskanen and Lovio (2010), Ricci et al. (2010), and Palm (2010) (knowledge intermediaries); Looney and King (2005) (labour intermediaries); Cronin (2004), Brousseau (2002a) (commercial intermediaries); and van Lente et al. (systemic intermediaries).

The use of the term intermediary by researchers in numerous fields of study, while somewhat disorienting, does nevertheless underscore their relevance. It also reinforces the notion that intermediaries, although not always visible and front and centre in daily life (Ehrlich and Cash, 1999; Meyer and Kearnes, 2013; Moss, 2009), warrant recognition for their substantial contributions to the way in which social, economic and institutional interests coalesce. The present research takes intermediaries to include all those actors that, through their routine activities,

contribute to the creation of collective norms and visions within any contested socio-technical system. This conceptualization differs from traditional literatures by implicating actor groups that are not readily identifiable as either capable or designed to perform intermediation functions, but that nonetheless do so. It also offers up for discussion the idea of positionality with respect to the results of intermediation, and whether these activities move toward or away from some objective political goal.

2.5.2 Changing Contexts

Having explored the form and function of today's intermediaries, the discussion now turns to an examination of the contexts within which post-turn intermediaries emerge. Reference to 'post-turn' relates to the environmental turn (Guy and Shove, 2000) in public policy which started in earnest in the 1990s is still underway, and although environmental issues are important in their own right, it is important to add that where policy making is concerned, they represent several challenges (Moss and Wissen, 2005). First, environmental issues, including climate change, tend to be framed as moral debates (Fischer and Guy, 2011; Rogers, 1983), and hence are seen as an exemplar of the tragedy of the commons. Second, popular ideological debate further frustrates environmental challenges, as to argue in favour of the environment is to argue against growth and open and free markets. Third, given their inherent complexity, ecosystems do not enjoy the same scientific objectivity that human-designed economic systems do. In sum, these factors contribute to a high degree of uncertainty. And this uncertainty is increased further when environmental crises are intertwined with a host of other ongoing global socio-technical shifts related to the economy and society (Piore, 2001). Each issue is complex and comes loaded with ambiguities, ideological debate, rapidly evolving discourse, diverse perspectives, and multiple competing visions. In a broad sense, these are sustainability challenges which are systemic by nature; they involve multiple and simultaneous imperatives, multiple actors operating at local, national and international levels, in multiple disciplines or fields (Hodson and Marvin, 2011). As a result, they require new response strategies that involve system-wide

innovations, instead of relatively impotent individual and uni-scale actions (Chappells and Shove, 2004).

Intermediaries take on heightened relevance, not because bureaucracies lack the expertise or capacity to manage, but rather, because they lack "*the legitimacy to act*" (Newell et al., 2012, p. 366). It is in those contexts where rules, system goals and priorities are most likely to be open to interpretation, translation and negotiation by intermediating actors, that new forms of intermediaries are likely to emerge.

Marvin and Medd (2004, p. 82) refer to these newly opened spaces as "*intermediary spaces*". Unlike pre-turn intermediation contexts precipitated by innovation and market efficiency goals, these intermediary spaces are emerging in non-traditional contexts where social, ecological, and market institutions, despite being co-evolved and interdependent, pursue competing visions. Contested domains are no longer being governed strictly by government policy and their institutional levers (Moss and Wissen, 2005). Instead, they are often relying on intermediaries to step in as proxy actors to compensate for public institutions operating with limited power and influence (Marvin and Medd, 2004). Climate change offers a good example of this sort of space; it is a new socio-economic-ecological debate arena, presenting significant management problems for governments, and generating a need for new intermediaries to jump in to create and maintain new network relations, new partnerships, and contribute new forms of governance, all of which are needed to address the challenge. Perhaps due to low levels of cross-referencing, the literature largely fails to recognize the links between the creation of increasing numbers and new types of intermediaries, and the meaning and understanding voids left specifically by hyper-complex and mutually reinforcing socio-technical and ecological crises, and weakening or retreating governments (Moss and Wissen, 2005).

So how does the literature understand these new contexts, and if any generalizations can be drawn from this understanding, what might these signal for future studies of intermediaries? The arrival of intermediary actors in newly opened

up spaces like those described by Moss (2011) in his study of urban infrastructure transitions, alters our understanding of network actor relations, systems of governance, and power relations in the producer, user, regulator triad, common to urban energy and water systems. Moss (2009, p. 1481) argues that intermediaries “act as a window on [the] transformation process”, and their ascendance is “indicative of a broadening and diversification of the social organization of [urban] systems”. In the case of urban energy and water infrastructures, Moss (2011) finds that new understandings of resource conservation among users, new regulatory agencies, and the involvement of transnational utility enterprises lying beyond traditional regulatory and cultural controls, are conspiring to reconfigure traditional operating conditions and user sensibilities. In the process, they are creating a new socio-technical context. This context is characterized by myriad, spatially dispersed interests, multiple levels of action, changing power relations, technical complexity, cultural biases, and ecological feedbacks. Scholars highlight the role that deregulation and shifting governance play in setting the context and catalyzing the arrival of novel intermediaries (Bakker, 2003; Hodson and Marvin, 2011; Marvin and Medd, 2004; Moss, 2009; Moss et al., 2011). They also note the influence the latter have on socio-technical system functioning.

Places are also being reconfigured to create new contexts for intermediaries to operate. This is demonstrated by Hodson and Marvin’s (2011) examination of cities governing infrastructural technologies related to waste, water, transport, energy and communications. They conclude that urban contexts can change substantially when extra-urban forces (e.g. devolution of state responsibilities to the local level, or reconfiguration of national/international financial and political institutions) are interpreted by the networks of organizations and individuals that make up the city. This process of interpretation reflects the collective history and adaptability of local network actors, and results in a realignment of relationships between cities, their infrastructures, users and private sector actors. As Hodson and Marvin (2011, p. 520), suggest, these network processes result in a “re-envisioning of places” and the subsequent emergence of new intermediaries.

The last example is provided by Maneschi (2013) who explores the intermediating role of banks as novel intermediaries working to promote energy efficiency investments in Denmark. Here, relations between energy, and non-energy sector actors are shifted in response to national climate mitigation objectives requiring private utilities to reduce the amount of energy delivered to clients. The resulting energy savings obligations for energy providers help to create a new context wherein banks are cast, not simply as lending institutions, but as impartial and trusted intermediaries operating at a critical juncture between a host of usual energy suspects including: energy utilities, national climate policy, engineers and homeowners.

These examples highlight how changing socio-technical and ecological contexts are giving rise to the emergence of new or transformed actors who are performing important functions related to defining system relations, visions and principles. The emergent nature of some of these actors means that they are not always readily identifiable to policy makers, despite their relevance to policy outcomes.

2.5.3 When position means power

Early theorizing about intermediaries presented them as rather benign market enhancers. The co-evolution of public institutions and industry ensured that the power of these intermediaries, established via formal processes undertaken by governments in consultation with industry, was assumed to align with the goals of the local political economy. As a result of this master-slave relationship, many earlier conceptualizations of intermediaries and their functions paint a '*rosy*' and optimistic picture of intermediaries and their work according to Randles and Mander (2011, p. 126). These earlier innovations and science and technology studies fail to recognize that intermediaries are not always benign, and consequently display a blind spot with respect to explaining the influence of intermediary power in spaces of contestation and uncertainty (Medd and Marvin, 2008; Moss, 2009).

A review of the literature suggests that pre-turn intermediary research neglects to recognize what Beveridge and Guy (Beveridge and Guy, 2009) and Ferlie et al.

(2005) conclude in their respective studies on wastewater practices in the north of England, and UK health care innovations. That is, intermediation is not an inherently benign act, and intermediaries can both enable policy and innovation or derail it (Beveridge and Guy, 2009; Jessop, 2003; Moss et al., 2011). The ability for intermediaries to do good, socially and politically aligned work is contingent on the priorities and interests they pursue. The normative assumption that intermediaries help produce outcomes not possible, or as optimal, without their involvement, ignores intermediary self-interest, bias and power in relation to optimal policy outcomes. Intermediaries can gain and hold power in several ways including:

- situating themselves in between interests (Bakici et al., 2013);
- controlling information and knowledge flows (Howells, 2006);
- translating and structuring meanings and understandings (Callon, 1984; Bulkeley and Castán Broto, 2013);
- maintaining interdependencies between stakeholders (Allen and Santomero, 1997);
- "showing a responsive face to either audience" (Guston, 2001, p. 405) and appearing irreplaceable;
- controlling limited resources (e.g. information, know-how, training, etc);
- acting as gatekeepers to control the flow or interpretation of "something [going] from somewhere to somewhere" (Randles and Mander, 2011, p. 126);
- acting as information hubs that gather and disseminate information selectively via the web of linkages they maintain in their networks (Hiteva, 2013);
- structuring relations between actors (Callon, 1984):
- structuring and maintaining networks of relations; and (Callon, 1984),
- creating visions (Bulkeley and Castán Broto, 2013).

Guston (2001) describes all of these strategies as means to secure power within the system and reduce the threat that either interest will find the intermediary inimical.

The potential for intermediaries to do political work and acting as hybrid governance entities, is considerable and hinges on their own self-interests, especially in highly contested contexts where social, ecological and economic imperatives are at odds (Janda and Parag, 2013; Moss, 2009; Rohracher, 2011). If intermediary interests are aligned with the social policy goals or system objectives then the impact on outcomes of intermediation activities can be considerable, and positive. However, the very presence of intermediaries presupposes the existence of fluid and fuzzy visions, which by definition are susceptible to redefining via processes of translation and interpretation. Thus, even well defined policies and regulations can be profoundly re-interpreted and re-framed having passed through a handful of translation events by intermediaries with alternate agendas (Beveridge and Guy, 2009). Rather than facilitating optimal decision-making under contested conditions, re-configuring network relations through poor translation can serve to stall a process and contribute to system obduracy or maintenance of path dependency or technological lock-in (Moss et al., 2011). In terms of the shortcomings of market intermediaries, Randles and Mander (2009, p. 35) do not mince their words, saying that this type of intermediary "*represents the 'dark side' of intermediation*".

In addition to altering policy directions, Hiteva (2013, p. 212) finds evidence in her examination of the UK energy market that intermediaries can actually reconfigure the nature of what they intermediate, which can further degrade a policy's efficacy and impact. This dynamic is reflected by Doganova's (2013) thinking on knowledge transfer within systems. Intermediaries can affect such transfers within a system, and these transfers can follow either 'transfer' or 'exploration' models. Concepts and ideas transferred are deemed stable, well codified in statements, and integrated in actors, in the former model. While in Doganova's exploration model, intermediaries engaged in the movement of information and knowledge can, through their own interpretations, "*transform not only the knowledge that they put in motion, but also the spaces between which such movements take place, and the entities that are poised to emit or receive*" (Doganova, 2013, p. 444).

The implications of these power shifts are important, as the institutional networks and systems of governance that give rise to the need for intermediaries in system functioning are themselves reconfigured by these same actors (Moss, 2009). When, and at what point intermediaries go from being neutral wheel-greasers to determinants of political agendas and collective imaginaries are questions that, despite the work of some scholars, remain unanswered. And hence, is there a case to be made to govern, or at least strategically manage intermediaries as Braun (1993) suggests?

2.5.4 Importance of intent among post-turn intermediaries

The next critical issue that the literature touches on only superficially, is the idea that among intermediaries, intent and agency can vary. Marvin and Medd's (2004) strategic intermediaries lie at one end of the intention spectrum, just below systemic intermediaries in terms of agency and interconnectedness. Strategic intermediaries are deliberately designed and created to optimize outcomes by working in the middle and bringing interests together to effectively reconfigure meanings and network relations. Some intermediaries emerge more organically, as a result of the reconfiguration of an existing organization to fill a gap or respond to a system crisis (Moss, 2009). Along similar lines, some organizations reluctantly, and hence gradually, take on intermediary roles following contextual changes in their sector, while others perform roles never envisaged by their progenitors.

It should be pointed out that intermediaries themselves operate according to their own normative cultural rules and motivations (Moss, 2009). Hence, one set of values and norms are used to reconfigure two opposing sets of still different interests. What role do these processes of interpretation and translation play in structuring practices and altering system rules and norms? Intermediaries act at, and as a nexus where ideas, understandings and even materials are questioned and reconfigured to create new networks, new visions, and potentially new practices (Beveridge and Guy, 2009). However, understanding and normativeness are key to the stability of socio-technical and socio-ecological systems, therefore, if intermediation can alter norms and meanings, then they can potentially materially alter system trajectories.

This means that we cannot assume that all intermediaries are intentional, are always aligned with the objectives of other intermediaries, or even aware of their status as intermediary (Moss, 2009). As Wenger (2009, p. 2) argues, "*practitioners can be deluded or myopic. Subconscious forces can undermine the best intentions*". It may seem obvious that this situation applies to objects and technologies, however, even inanimate objects are imbued with interests and biases which may well influence negotiated outcomes. This raises the possibility that intermediaries may be "*unaware that they are acting as intermediaries*" (Moss et al., 2011, p. 1485), and may or may not be sympathetic to system goals. From a public policy perspective, it is important to understand what actors are, or are not performing as intermediaries, how their functions differ from what was originally expected of them, the degree to which they are committed to the interests of the system, or the degree with which their interests align with other intermediaries operating in the same space.

The final question is: how has intermediation evolved between the pre-turn and post-turn eras? Pre-turn, intermediation was more structured and system objectives (i.e. efficient markets and hastened innovations) were largely unambiguous (Rogers, 1983; Stewart and Hyysalo, 2008a). In the current post-turn world however, system objectives are rarely straightforward, and public institutions appear to be abandoning, rather than entering the growing debates (Newell et al., 2012). Thus, as intermediaries change meanings, they can reconfigure norms, values and principles that circulate among system stakeholders, and ultimately, they can change modes of governance (Cronin, 2004; Moss, 2011). This situation raises questions about the legitimacy of self-appointed or accidental intermediaries to act, especially in those cases where intermediaries operate invisibly, beyond the public's gaze (Jasanoff, 1994). Today, we see evidence of this type of scenario in governance voids and spaces of conflict and uncertainty (e.g. water infrastructure privatization), where the desired outcomes are far from certain (Hodson and Marvin, 2011; Miller, 2001).

2.6 Theories of social practice

The present research is premised on the idea that home energy retrofit is a practice, and it is a fundamentally social phenomena undertaken by intermediary actors who help configure organizational relations within a retrofit socio-technical system of provision. Normalizing retrofits requires a fuller understanding of the daily activities of retrofit intermediaries.

Theories of practice are, as Shove et al. (Shove, 2010b) suggest, "*positively fizzing with potential*". From their origins in the works of Wittgenstein, Heidegger, Bourdieu and Giddens, theories of practice today sit among a suite of other cultural theories, all of which understand and explain action "*by having recourse to symbolic structures of meaning*" (Reckwitz, 2002, p. 244). This group of theories is sympathetic with of a broader and more generalized rejection of positivist-functionalism. The interpretive paradigm is shared by hermeneutics, ethnomethodology, symbolic interactionism, and poststructuralism (Giddens and Dallmayr, 1982; Mottier, 2005; Rouse, 2007). In contrast with "*accounts that privilege individuals, (inter)actions, language, signifying systems, the life world, institutions/roles, structures, or systems in defining the social*", the social, according to a practice approach, "*is a field of embodied, materially interwoven practices centrally organized around shared practical understandings*" (Schatzki, 2001a). For praxeologists, social phenomena like language, the individual, and signifying systems can only be accessed through practices.

Broadly speaking, theories of practice attempt to articulate the ways in which identity and individual agency rely on and produce cultural forms. For the purpose of clarity and to bound the discussion to follow, I adhere to the view that theories of practice are those which are concerned with what Ortner refers to as those

mundane, daily performances that engage humans, but which [study] can reveal important insights about social behaviour, and the genesis, reproduction, and change of form and meaning of a given social/cultural whole (Ortner, 1984, p. 149).

Practice theory is understood in a similar, yet more abstract way by Bourdieu (1977, p. 72) who defines it as "*the theory of the mode of generation of practices, [...] [the]*

internalization of externality and the externalization of internality, or, more simply, of incorporation and objectification". Schatzki (2012), relies on three concepts to define practice theory: the idea of practices as organised activities; that social phenomena and key mental aspects of human life are embodied in practices; and, the concept that nonpropositional bodily abilities constitute the basis of human activity. Practices are organized in that they are constituted by a set of activities and elements that hang together in the same way, regardless of the multiple people that perform them (Ibid). Crucially, the second concept argues that what defines the social is not human activity, but practices (Ibid). What Schatzki means by non-propositional is similar to what Bourdieu understood as habitus, Giddens took to be practical consciousness, and Dreyfus conceived as skills. In simple terms it highlights the fact that skillful human actions are often not decipherable by the human who performs them; they are simply what they do.

Practice theories today have been adopted by many researchers, yet they are arguably still a work in progress. They are nonetheless coalescing into an robust ontology, thanks especially to an expanding group of contemporary praxeological thinkers including Schatzki (2001a), Shove (2010a), Reckwitz (2002), Røpke (2009), Warde (2005), Southerton (2000), Watson (2012), Strengers and Maller (2012), Hargreaves et al. (2011), and Pantzar and Shove (2010). These scholars are contributing to the practice discipline through interpretation and application of some of the rather abstract philosophical accounts presented here. To the question, what do practice theories explain or account for? Shove and Pantzar (2012) posit that practice theories simply help explain social change, or that it facilitates an understanding of the:

social science significance of human activity; the nature of subjectivity, embodiment, rationality, meaning and normativity; [...] and the organization, reproduction, and transformation of social life (Schatzki, 2001a).

Practice theories tell us that humans live in a social world composed of practices (e.g. cooking, child rearing, politics, farming, negotiation, banking, recreation, etc.), and that from the moment they become self-aware, humans take on board an array of competences and practical understandings that are constituted by and within

practices (Schatzki, 2001a). Rather than relying purely on human cognitions based on rational choice and objectivity, daily social interactions and activities routinely involve the coordination of three foundational elements: competences (i.e. explicit and tacit know-how, and shared understanding), symbols (i.e. imagery and representational meanings), and materials (i.e. objects, equipment, technologies and tangible, physical entities) (Giddens, 1984; Shove et al., 2012). These elements are what Shove and Pantzar (2005) refer to as stuff, images, and skills. Shove et al. (2012) also draw our attention to practice bundles (i.e. practices linked loosely through co-location), and practice complexes (i.e. 'stickier' matrices wherein practices are more strongly interdependent by virtue of their temporal sequencing or synchronization, spatial proximity, or "*necessary co-existence*" (Shove et al., 2012, p. 87).

2.6.1 Key definitions

The definitions of practices abound. According to Schatzki (2012, p. 14), they are "*open-ended, spatially-temporally dispersed nexus of doings and sayings*", and importantly, not simply habits (Thévenot, 2001). Barnes provides a more commonsense definition of practices, specifically:

[S]ocially recognized forms of activity, done on the basis of what members learn from others, and capable of being done well or badly, correctly or incorrectly (Barnes, 2001, p. 27)

In non-praxeological terms, a practice is a repeated or customary action. Within theories of practice, it is a grouping of actions or a pattern or block which is filled out through the performance of its constituting actions (Reckwitz, 2002). Home energy retrofit practices for example, comprise various actions like installing vapour barriers, modelling a home's energy performance, installing high-performance windows, buying materials, or explaining the house-as-system principle. The performances that make up a practice are teleological, existing as either simple bodily doings and sayings or more complex activities that these doings and sayings constitute (Schatzki et al., 2001). The teleological nature of practices signals the presence of a hierarchy; that basic actions (e.g. done without having to do something else) constitute more complex activities, which themselves contribute to

even higher level activities (ibid). Reckwitz (2002) offers a comprehensive and contemporary definition that paints a deeper picture of practices and nicely compliments Schatzki's (2001) conceptualization. He suggests a practice consists of interdependencies between different elements including:

forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge (Reckwitz, 2002, p. 249).

In the present context, examples of things and their use include hammering, caulking, inspecting, uttering words, and writing, while examples of the actions these might constitute include house building, buying building supplies, examining a wall's construction, rushing home, directing a colleague, and writing a job estimate (Schatzki, 2001b).

Schatzki (2001a) distinguishes between a practice-as-entity and a practice-as-performance. The former is the nexus of linked sayings and doings, and the latter is the actual do-ing of actions by humans (i.e. through integration of meaning, competence, and materials). Practices-as-entities are "temporally unfolding and spatially dispersed nexus of doings and sayings" (Schatzki, 1996, p. 89). The central notion of nexus is characterized by what he describes as three types of linkages exhibited between doings and sayings: 1) via understandings; 2) via explicit rules, principles or instructions; and 3) via what Schatzki calls teleoaffective structures constituted by emotions, purposes, beliefs, tasks, projects and end goals. Practice-as-performance focus on "*the ceaseless performing and carrying out of action*" (Schatzki, 1996, 90).

The power and influence of practices is considerable; most theorists argue that individuals are defined more by those bodily activities they perform, than through what they think mentally (Schatzki, 2012, 2001b; Swidler, 2001). Norms, language and meaning too are engendered in practices, rather than emanating from the individual (Schatzki, 2001a). And it is further argued that activities themselves get their meaning through the practices their performance help reinforce (Schatzki, 2001b). Even language, often seen as a structural system, is considered as a

discursive activity and thus, a practice phenomenon (Schatzki, 2001a). Simply put, practices rule.

2.6.2 Material and spatial relations

We need materials to perform many practices, assuming we know what to do with the materials and understand what it all means together. But also, materials may transform or fix practices in time and space (Strengers and Maller, 2012). Schatzki confirms this intellection, claiming,

Most practices, [...] would not exist without materialities of the sorts dealt with in them, just as most material arrangements today dealt with in practices would not exist in the absence of these practices (Schatzki, 2015, p. 2).

The role of material objects in co-constituting our world is well known (Latour, 2000). The social practice ontology embraces this idea and goes further in ascribing to human bodies the status of mediator or constitutor of the relationship between practices and carriers. For Schatzki (2012), materials are central to practices as he argues they perform multiple enabling functions like channelling, prefiguring, and facilitating. Importantly, the reciprocal is also true for Schatzki (2012); most material arrangements would not exist (i.e. have no intelligibility or meaning) were it not for practices that use physical things as part of practices-as-performances and effect them in infinite ways as a result. This is an extremely important assertion as he posits the pivotal role that material objects play in day-to-day human interactions, and suggests that the meaning of practices, and the identity of agents who reproduce them, are intimately connected and dependent on material arrangements. Obviously, this has profound ramifications for the study of practices, but also for consumption and innovation studies.

Schatzki (2012) conceptualizes interrelated and mutually dependent practice and material arrangement bundles, and argues that bundles of material arrangements and practices relate to each other dynamically in five different ways (i.e. via causality, prefiguration, constitution, intentionality, and intelligibility) to facilitate meaning and intelligible social interactions (Schatzki, 2012). Causality refers to situations in which either humans alter objects through their practices (e.g. converting lumber into house framing), or the physical world induces practices

through events (e.g. lowering temperatures induce weather stripping) (ibid). Prefiguration occurs when physical arrangements predispose practices to unfold in a particular way (e.g. suburban development gives rise to car commuting) (ibid). The relationship between practices and materials is constitutive when materials and practices are essential to each other's existence (e.g. poorly assembled building envelopes constitute caulking and sealing, and energy performance modeling necessitates blower-door ventilation fans) (ibid). Practices and material arrangements are also related intentionally as when an individual's performance is determined – in part or in whole – by prior expectations or preconceptions of a material object. Lastly, material arrangements are related to practices through a relationship of intelligibility (ibid). In this case practitioners ascribe to material objects meaning, and this meaning then exerts determining effects on the way in which the practitioner carries out a practice (Schatzki, 2012).

Schatzki (2015) emphasizes the fundamental entanglement of practices and physical entities in his conceptualization of practices as practice-arrangement bundles, rather than singular practices. The spatiality of practice bundles is manifest in two ways: via their spatial configurations, and their constitution as temporal-spatial phenomena. The main point behind the first of these mechanisms is that practice performances occur in objective spatial configurations. For example, the performance act of weather stripping takes place in a particular space between the doorway or window frame and the builder, where weatherization occurs. The practice of retrofit (as-entity) on the other hand, takes place in the aggregate of locales where the associated sayings and doings that constitute energy retrofit take place. These locales include supply stores, design offices, private dwellings, training rooms, etc. Schatzki (ibid., p. 2) is careful to clarify that the term 'objective' denotes something "*independent of human activity, experience, and understanding, even if it is or was effected through human activity*". Shove and colleagues see space as performing three functions (i.e. as resource, geographical location, or outcome of practice), one of which equates to Schatzki's notion of spatial configuration. That is, as "*a representation of geographical location*" (Shove et al., 2012, p. 130).

The second way in which Schatzki's practice bundles relate to space is through 'activity timespace' (Schatzki, 2010a). The temporal aspect of timespace reflects the motivations, emotions and teleologies that organize activity. Unlike more concrete concepts of space like Shove et al.'s (2012) space as a resource model, and Schatzki's spatial configurations, timespace is not geographically definable. For Schatzki, it is constitutive of human activity, or practice bundles. In this way, we can say that space and practices are linked reciprocally; practices elaborate space and vice versa. For example, carpentry can transform part of a building into a worksite, and the worksite, and the paths that lead to and through it, in turn shape the carpenter's re-enactments of sawing, nailing and measuring. Shove et al. (2012, p. 130) refer to this relationship as space becoming so as an "*outcome of practice*". Shove and her colleagues introduce another important distinction regarding the spatiality of practices, namely, the varying spatial requirements of different practices. An example might be daydreaming and building construction, wherein the former requires far less available area than the latter (ibid., p. 130). Practice-as-entities have a particularly strong and diffused spatial element. As entity assemblages are defined, more by their meanings and their internal organization, they are far less locale-dependent and likely to occur in multiple, and possibly widely dispersed sites.

2.6.3 Practices in practice

To break through the abstractions of the social practice ontology and generate a concrete understanding of what it explains in reality, it is useful to consider some basic mechanistic questions about practices. Practices, as Reckwitz (2002) points out, are constituted by blocks or clusters of elements that are linked and integrated via an actor's performances, where elements include materials, competences, and meanings. It is the links between these elements, and their repeated realization, which are critical to the life of a practice (Schatzki, 2012, 2001a). Thus, when humans – via their bodily and mental dispositions – successfully assemble, grasp, and knowledgeably deploy these elements in their day-to-day activities, practices are constituted. Without humans – together with either their intentional or unwilling bodies – as central brokers, the constitutive elements of practices remain

discrete, unconnected and devoid of meaning. A blower-door ventilation fan is simply a meaningless object without a human to first grasp its representational meaning (i.e. resource efficiency, modern, current) and potential for realizing personal ends (i.e. saving energy, reducing bills, improving comfort) and then deploying it skilfully and intelligibly (i.e. installing unit in open doorway, manipulating buttons proficiently, exploiting majority of technological features) to realize those ends. The practice of energy modelling a home via the blower-door test persists as a consequence of humans performing these three processes repeatedly and in a connected manner that makes sense to them and others. Yet, if humans en masse, for whatever reason, alter their understanding or commitment to any of these elements and fail to support the meaning carried by the practice, the interrelationships and links between the elements will falter and result in either a modified practice, or perhaps, the disintegration of the practice altogether. Stated another way, practices evolve as their constituent elements change. Without coordinated and interdependent links between elements of a practice, the latter cannot exist (Røpke, 2009). This need for coordinated and interdependent links is especially relevant to the emergence and stabilization of new practices (e.g. energy retrofit).

Practices require groups of committed carriers to consistently and persistently reproduce the practice (Shove et al., 2012). However, practices must effectively recruit practitioners to be adopted, and actors need to adopt practices to be constituted. Shove et al. (2012) argue that recruitment into a practice can be either an involuntary or voluntary act for the practitioner, but always involves learning, sharing and carrying among practitioners. However, for discretionary practices or those that have more flimsy elements, recruitment and retention depends upon a complex interplay between the practice itself, the relative influence of practitioners with the practice, the competences of carriers, and their commitment levels (ibid.). We find among practitioners of a given practice varying levels of commitment and skill. This reflects the different career stages of the practitioners of the practice. As (Shove et al., 2012, p. 71) say, “[a]t any one moment, ‘a practice’ consists of a

composite patchwork of variously skilled, variously committed performances enacted and reproduced by beginners and by old-hands alike.”

In summary, the trajectory and nature of a practice hinges on several key parameters including the types and commitment levels of participants (e.g. newcomers or skilled hands), the relative influence of these different practitioners on the interpretation of the practice, the degree to which actors respond to the symbolic meaning carried by the practice (i.e. internal reward), and the manner in which actors are influenced by participating in the practice (Shove et al., 2012). Practices, in general will persist longer if they enjoy connectedness with other practices, and hence greater symbolic meaning and relevance. On the other hand, practices will normally expire if they engender little or no internal reward for the practitioner, are stand-alone (i.e. not connected with any other practice), or there is a mass defection of practitioners, or a fundamental change in one or more of its constituent elements (Schatzki, 2010b). In reality, practitioners tend to come and go with respect to their careers as carriers of a particular practice. Far from destabilizing, this ever changing group of carriers serves two productive functions: a constant renewal, reinterpretation and relevance-checking for the practice; and, self-actualization and identification for the carriers who are defined by those practices they participate in (Shove et al., 2012). For the practice of energy retrofit to stabilize and persist, its symbolic meaning and logic must resonate with participants and provide these carriers with internal reward and satisfaction. However, the meaning and reward that membership in the retrofit practice confer are not static and can morph as new carriers, with new levels of retrofit skill and experience, adopt the practice.

Changes in practices are also contingent on the making, breaking or redefining of linkages between elements (Schatzki, 2012; Shove et al., 2012). New conceptualizations of interconnectedness between elements foster variants of existing practices (i.e. possible innovation), while a wide-scale, total breakdown of coordination between elements signals the end of a practice. Shove et al.'s (2012) example of driving in the USA around the turn of the last century provides a useful case study demonstrating how practices evolve. Shove and her colleagues conclude

that the specific configuration of materiality and competence, characteristic of the practice of driving at the time, objectively impeded the market penetration rate and fostered a risky view of automobiles. There was a scarcity of necessary competence (e.g. good driver/mechanics). In addition, the ascendance of automobile transport resulted in people's altered understanding of the symbolic meaning of the village blacksmith. As the blacksmith's shop either morphed into, or was replaced by garages and gas stations, symbols of the new transport paradigm emerged (Shove et al., 2012). Looking at automobile transport today presents a rather different picture. Inertia-rich and nation-scale materials like roads, bridges and parking lots make the practice of driving close to normative – something one just has to do – because to do otherwise is to materially impair one's daily life. Hence, the practice of driving enjoys a robust and populous membership and can be considered as one of society's dominant projects (Pred, 1981). In much the same way, the practice of retrofit is impeded by poorly configured meaning, materiality and skills. Debate around the value and logic of home energy efficiency in terms of cost savings and dangerous climate change blurs symbolic meaning, and impedes the creation of new (necessary) linkages with existing construction skills and materials.

What happens then to elements of a practice when the practice loses grip of its carriers? Shove and Pantzar (2005) provide the term fossilization to describe the process whereby remnant elements of old practices, unable to recruit carriers, linger as fossil or artefact elements to which no meaning exists (Shove and Pantzar, 2005). This suggests that orphaned elements continue to persist through time, waiting to be re-constituted within a practice to yield a new entity, not unlike pseudo genes that can give rise to organisms after lying dormant. Given the commonly held view that practices account for the processes of social change, we might reasonably deduce that social change and stability can be described and analyzed through the analysis of the dynamics (i.e. making and breaking of links) between elements. This has critical implications for policy work and empirical analyses using the social practice approach. In the context of energy retrofit, and the social change it implies, there is evidence of fossil elements (e.g. designing for

passive energy) being re-constituted and linked up to new materials and wall assembly techniques to reduce the space heating loads.

As mentioned before, practices require practitioners for their persistence, but how do practices capture carriers? First, uptake of practices among actors requires the availability of relatively stable and persistent constituting elements (Shove et al., 2012). Schatzki (2012) notes that while practices tend to be in a constant state of flux – emerging, morphing or imploding – elements display a greater degree of stability through time and space. Elements might thus be viewed like food ingredients that tend to be quite universal across the globe, while practices more closely resemble recipes which have the capacity to create totally different dishes from the same ingredients. Elements, as the building blocks of practices are more mobile, but they are also more substitutable and hence, transient.

Shove et al (2012) emphasize the essential role of elements in constituting practices. They argue that locating similar practices across space necessitates identifying the occurrence of the competences, materials and meanings that together enable the practice (Shove et al., 2012). That practices are distributed across space reflects the fact that elements are often, but not always, mobile; building materials can be shipped, construction methods can be abstracted and training can be transferred, and meanings can similarly pass between cultures, courtesy of human carriers. Competence also travels, not as materials do, but rather by mental processes among actors who exchange (often through abstraction) theoretical ideas about skills and techniques with other actors who have the capacity to decode, adopt or reconfigure the skill (Shove et al., 2012). This all takes on particular relevance when contemplating the adoption of new ways of configuring a home in aid of reduced energy consumption. These might include conceptualizing the house as an interconnected system of materials, functions and technologies, novel ideas about framing exterior walls to minimize thermal bridging, or designing roofs to reflect, rather than absorb sunlight that might overheat a home's interior space. Thermal bridging for example, occurs when heat moves into or out of conditioned space via pathways formed by solid and contiguous materials with relatively higher thermal conductivity (Globe Advisors,

2013c). To make this process visible and relevant to those actors that regularly interact with wall assemblies requires the transfer of new skills (e.g. framing with new materials assembled in different ways), new ways of thinking about heat (e.g. something that actively moves through 'solid' wall barriers), and new understandings concerning the importance of what is widely considered an invisible wall cavity space.

As a result of decoding and reconfiguration by recipients during transfer, competences can easily morph during this intrinsically random process yielding new forms of the original practice. Meanings travel but often in ways that build on, merge with, or supplant existing object-meaning structures. The travel of practices through space is therefore heavily linked to the proximity, mobility and accessibility of its component elements, but also to localized, existing competences, and meanings (Shove et al., 2012). The implication therefore is that when considering a practice's trajectory and evolution, it is important to consider the structure of the networks that a practice is likely to circulate within, and the positionality of the actors that operate within these.

Practice theories, as conceptualized above, provide an alternate view of the world. With respect to the policy development domain, the framework, when translated from its abstract form, reveals a previously unseen dimension of our social world – practices and their constitutive material objects, meanings, and competences – and compels a re-problematizing of all social challenges. Practice dynamic concepts are employed in the present research in an attempt to reveal the motive forces behind existing building practice trajectories, and hence possible avenues for nudging these in a more sustainable direction. This means investigating how energy efficiency principles and meanings are framed and travel among actors in the retrofit socio-technical system, and how these understandings and information conduits influence the configuration of retrofit practice element linkages and the overall nature of this practice. To explore these dynamics, a series of empirical methods, discussed in the next chapter, are deployed.

2.7 Reconciling the ontological toolkit

To explore the ways in which practices gain carriers and contribute to reconfigured social phenomena and change, the present research turns not only to theories of practice, but also to theory concerning social transitions. Geels' (2010) framing of the multi-level perspective (MLP) is an example of a transitions framework. The MLP explains changes in socio-technical system trajectory by considering interactions between activities occurring at three structural scales: niche, regime and landscape. Both of these intellections (i.e. practices and systems approaches) strive to explain societal change, yet practice theories' ontological 'flatness' is generally considered incompatible with the hierarchical character of the MLP. This ontological tension warrants further discussion.

By deploying concepts from theories of social practice, socio-technical systems thinking, and common understandings regarding energy retrofits and intermediaries to achieve the research aim, I am addressing a central proposition of the research. That is, the practice of retrofit implicates several, recursive social phenomena that can involve actions of varying complexity, multiple and diverse actors, and observable and un-observable structural effects. I also suggest that to understand the barriers preventing the practice of retrofit from becoming normative requires engaging with all of these phenomena at the same time. To this end, I rely on theories of practice to situate routine performances and activities of human actors in more complex, multi-scalar, multi-temporal socio-technical system dynamics that can enable new construction and building upgrade techniques to emerge, stabilize, and travel.

To account for the system dynamics of the retrofit space and the diverse actor groups working within (and beyond) it, a socio-technical systems frame is used. This frame reinforces the idea that home energy retrofits, while always bespoke in the way they unfold at the building level, are constantly being buffeted by multi-directional interactions between retrofit socio-technical system actors, other socio-technical systems (e.g. construction system, transportation, energy), and ongoing multi-scalar and non-hierarchical interactions between actor groups operating in sometimes distant socio-technical systems. As mentioned earlier, the flat

ontological stance of practice theories would seem to conflict with the more hierarchical characteristics of socio-technical system conceptualizations, however, I argue against this intellection. I do so because at the heart of the processes of structuration that define socio-technical systems, lies human subjectivity and activities interpreted by tacitly knowledgeable agents according to what they understand to be the rules of the game. All of these elements can usefully be navigated using the practice ontology in conjunction with a systems perspective. What I am urging is a recognition that what people do is at least partially shaped by the socio-technical system landscape they find themselves in. And in a reciprocal manner, the I argue that the same socio-technical system is partially constituted by what people do and say. Watson (2012, p. 492) bridges the theoretical chasm described above by proposing a 'systems of practice' approach to socio-technical system transitions. He conceptualizes transitions as occurring "*through the flow of practices - of action and doing - which comprise them*". The systems of practice model also addresses a key criticism of practice theories, namely that they fail to explain broader societal change. Watson (2012) presents a useful conceptual tool for investigating the links between practices, system actors, and the relations between them, many of which extend beyond common-sense.

My overall argument is sympathetic with Watson (ibid., p. 489) who urges us to see that, "*changes in socio-technical systems only happen if the practices which embed those systems in the routines and rhythms of life change; and if those practices change, then so will the socio-technical system.*" Shove and Walker (2010, p. 471) support Watson's argument by linking the constitutive elements of practices to socio-technical system dynamics:

Where the socio- of socio-technical does refer to forms of practical know-how and to routines and expectations that sustain and are part of incumbent regimes, the driving interest is in how these arrangements configure the conditions of future innovation: not in how they evolve themselves.

Spaargaren (2003) too has pushed for conceptualizing practices as the sites at which the behaviours of consumers and producers interface with socio-technical systems of provision. Shove and Walker (2010, p. 471) take Spaargaren's line of reasoning even further suggesting that, "*practices are not merely 'sites' of*

interaction [between agents and socio-technical systems], but are, instead, ordering and orchestrating entities in their own right". In doing so, Shove and Walker (2010) link practices and socio-technical systems in a tight recursive relationship so fundamental to societal change.

Linked to 'systems of practice' is the concept of 'communities of practice'. These focus on higher level learning among members of a social system, and how such "*learning becomes an informal and dynamic social structure among [system] participants*" (Wenger, 2009, p. 2). It is argued by Wenger (2009) that communities of practice help create a shared identity for community members via their participation in a collective activity, in the same way that practices help constitute the identity of their carriers. The literature on communities of practice reinforces the idea that collective understanding and knowledge is fostered through active intra-group communication and exchange of ideas and experiences. These types of exchanges within communities of practice resonate with the present research's interest in how intermediaries within a retrofit system (or community) foster collective understandings through regular contact and information sharing. The ideas embodied within communities of practice however are inadequate to account for practices that materially implicate members of diverse communities pursuing often times unrelated mandates. Such is the case with the practice of retrofit where communities do not share common mandates or causes.

2.8 Conclusion

This chapter began by opening up the literature on retrofits in section 2.2 to understand how the meaning and materialities underpinning these home alteration events have shifted over time. These shifts reflect fluid homeowner motives linked to notions of utility, comfort, and status, in addition to the availability of novel technologies. What the discussion has shown is that energy efficiency, as a driver of home retrofits, only emerged with sincerity following the 1970s oil crises. Yet, even then the energy conservation ethic in the post-OPEC oil crisis era, largely reflected concerns related to economic slowdown rather than social or environmental concerns.

In section 2.3 the chapter explored present day policy responses to the climate threat posed by the housing stock, arguing that contestations abound. Be these among homeowners trying to decipher technical, economic and moral questions related to climate change efficiency options, who pays and who benefits, or policy makers navigating among a suite of retrofit strategies and tools, each with its own set of constraints.

In the following section (2.4), retrofit policy and practice were examined through a critical lens, revealing several limitations. Social and spatial justice (Bouzarovski and Simcock, 2017) is threatened by retrofit programmes that fail to recognize the risks of putting energy efficiency improvements above broader community development goals, or the complex meanings and emotions embodied in the home. The section ended by drawing attention to the pitfalls of an engineering-centric and overly positivistic perspective on energy efficiency at all costs, and the lack of attention paid to intermediary actors operating between policy and homeowners. The fifth section built on this last issue by exploring the world of intermediaries, from their beginnings as 'wheel greasers' and optimizers, to their post-turn reincarnation as everything from power brokers and political operatives, to involuntary agents of change. The results of this change in intermediary character include new forms of governance brought about by new relations in the producer-regulator-consumer triad, and greater uncertainty with respect to how system conflicts are resolved. The sixth section explored theories of practice by first unpacking key concepts, principles and definitions, then elaborating on the ways and means by which practices attract carriers and evolve through time and space. By unpacking the key tenets of theories of social practice, I have demonstrated the utility of deploying these to better understand the nature of societal change. That is, the ways in which practices mediate between agents and structures across space and time. Section seven argued in favour of deploying the flat practices ontology alongside the more hierarchical systems frame in order to more fully engage with the critical factors that determine the nature of social phenomena such as home energy retrofit.

This chapter has shown that policies founded on rational behaviour and techno-centric interpretations of home energy upgrades and energy efficiency are no

longer fit for purpose. Tightly interwoven, yet rapidly changing economic, social and environmental imperatives related to retrofits, require that policy assume a much more contingent and interpretive stance. Tensions and contestations imbued in climate debates are blurring retrofit motives, meanings and values further, leaving a governance void in the spaces between homeowners and policy makers implicated in home energy retrofits. These observations suggest there is utility in paying greater attention to the diverse and fluid framings of energy conservation, the 'home' as situated place, and the largely 'invisible' middle actors circulating in a retrofit socio-technical system of provision. Their position between policy circles and homeowners, and the uncertainties that lie therein, are giving rise to new forms of hybrid intermediaries. We should be particularly interested in these hybrids operating in fluid and uncertain environmental debates, given the power that they can potentially exert over the process of transforming complex socio-technical and ecological systems to more sustainable configurations. In the absence of clear governmental leadership or domain over environmental policy, the power that intermediaries and intermediation practices wield in co-creating consensus, making sense of environmental problems, shaping practices, and ultimately impacting environmental policy, is substantial.

Chapter 3 Methods

This chapter is critical in the overall scheme of the thesis as it details the methodological framework upon which the research relies, and acts as a bridge between theory and practice. It is here that I pivot from curious reader to engaged researcher, and where the threads that link the literature and theory to my empirical methods and findings are defined. The first section lays out and explains the main problematique the research aims to address, in addition to the conceptual pillars that underpin the research, and details and justifies the methods used to answer the research questions. The second section presents the methodological toolkit assembled to put theoretical concerns into practice. Details regarding research design and method choices are discussed in the third section. Owing to the centrality of the case method, the fourth section of the chapter contextualizes the selected case by exploring the geo-cultural character of Vancouver. After reading the chapter, the reader will see more clearly how climate action and the nature of intermediary practices in the home energy retrofit socio-technical system in Vancouver, Canada, lend themselves to a methodological approach framed by theories of social practice and intermediary dynamics, and an empirical strategy comprised of mixed methods.

3.1 Research problematique and ontological frame

The overarching concern that this research endeavours to address is environmental policy failure related to human-induced climate change and the built environment. The literature is replete with scientific evidence that energy inefficient buildings, including private dwellings, contribute significantly to this environmental problem, yet to date, public policy has largely failed to achieve the levels of home energy retrofit activity required to meet globally agreed targets.

Despite the fact that people often renovate and alter their homes, they rarely do so in order to improve the energy performance of their dwellings. This absence of a desirable activity is the observable phenomena upon which this thesis focuses. To address this activity gap, the present research does not concern itself with homeowner motivations to undertake energy retrofits, although the author acknowledges their role with respect to retrofit policy success, and the considerable

scholarship already undertaken in this domain. Instead, the research sidesteps the homeowner and asks questions about the regular practices and perceived realities of those actors that actually do retrofits on a daily basis. I propose that homeowners might be more usefully represented as rather passive observers of the practices constituting a complex home energy retrofit system of provision, a system comprising numerous intermediary actors and materials. As consumers, I posit that homeowners' views on energy efficiency in their homes are at least partially influenced by the sayings, doings and collective understandings of the expert actors in this system of provision. This proposition is supported by previous research on barriers to energy efficiency retrofits (Globe Advisors, 2013c). The research thus seeks to understand the intermediaries operating in this system of provision, from their unique points of view, as it is this system of actors that helps determine the energy efficiency aspects of house renovations and alteration events. Also, it is in this system of actors, materials and relations where a new retrofit practice is likely to take full form. Thus, the research explores the world of intermediaries to understand what they do, why and how they do what they do, and what impact, if any, their sayings and doings have on the emergence of a new retrofit practice.

The ontological stance deployed in this research is influenced by the humanist premise that there is no one objective reality, and that the social world is constructed by humans. This stance is further shaped by the praxeological contention that although the social world is indeed constructed by humans, it is so thanks to the practices humans perform rather than purely via their own cognitions. The problematique and the subjects of interest in this project invite an interpretivist approach, like that deployed in previous research involving similar phenomena (Ellsworth-Krebs et al., 2015; Rauschmayer et al., 2015; Rice et al., 2015; Shove, 2003). Such an approach assumes that knowledge is socially and spatially situated, and created by those situated in the context within which the research unfolds. This requires employing methods to discover the constructed views of those 'on the inside' (Blaikie, 2000). So, although socially constructed, the values, opinions and knowledge of the intermediary subjects at the centre of this

project, while uniquely linked to their experiences of the world, are still valid and can be known, if only in situated terms.

Much of the research preceding the present project follows a deductive logic, where universal generalizations about homeowner attitudes toward the environment, returns on investment, and rates of technological uptake are employed to explain the nature of reality. Such a positivist approach is founded on ontological assumptions that this thesis rejects. Specifically, that an ordered universe comprising discrete and discernible events exists, and that researchers can develop generalized theories to represent the universal connections between events. The focus of the present research does not lend itself to either an inductive or deductive research strategy as these assume the presence of objective facts and essential uniformities in the social world. The research relies heavily on an abductive approach, which facilitates exploration, description and understanding. Also, by definition, abductivism rejects positivism and sees social reality as the result of the social construction of actors, and permits the discovery of "*why people do what they do by uncovering the largely tacit, mutual knowledge, symbolic meanings and rules which provide the orientation for their actions*" (Blaikie, 2000, p. 114). By employing an abductive strategy the research aims to develop an explanation of why retrofit policy is failing based on the understandings and "*everyday activities, materialities, and meanings of the social actors under investigation*" (Blaikie, 2000, p. 117). The abductive research approach employed takes much of what transpires during social activities to be taken-for-granted and rarely reflected upon. Therefore, actors may need to be prompted to "*consciously search for or construct meanings and interpretations*" (Blaikie, 2000, p. 116). The author's unique positionality, discussed next, and understanding of historical sensibilities and debates makes the likelihood of successful prompting far higher than it would be if the case study city, or research domain was unfamiliar.

3.2 Researcher positionality

My positionality within the research domain warrants clarification as it had a material bearing on research aims, objectives and methods. While I cannot claim to be intimately familiar with the unique work lives of all the various types of

intermediaries interviewed for this research, I do have considerable experience working in the general field of home renovation, green buildings, and energy efficiency in Vancouver. This prior knowledge and experience allowed me to assume a degree of nativeness where the retrofit socio-technical system of provision is concerned, and engage with subjects on mutually recognizable terms.

I have worked in the urban sustainability space in Vancouver for almost two decades, and as discussed in the Introduction, have been paying particular attention to the green building agenda for almost half of that time. I have worked with local government in the Vancouver region on green building and climate policy, worked with an NGO to advocate for improved building energy efficiency buildings, and have pioneered the marketing of eco-friendly building materials across Canada. My policy experience provides me with first-hand knowledge of how the retrofit challenge is approached by governments. My broad experiences in and around the home energy retrofit space have resulted in me holding a privileged position within the social world this research seeks to understand. I have also renovated a number of residential dwellings during my life and have a good understanding of many of the home energy retrofit challenges. As a former member of two of the intermediary actor groups (i.e. material supplier and renovator), I feel a high degree of familiarity with both my interview subjects and the overall field of study. While my proximity to the retrofit system and the case study through which it was examined may pose questions of bias, it has also enabled me to empathize more fully with the daily lived experiences of research subjects, and enhanced the value of the analysis and conclusions. I was able to assume what Lofland and Lofland (Lofland and Lofland, 1995) refer to as a "*starting where you are*" stance, which enhanced my access to, and understanding of, interviewees realities. Something that Blaikie (2000) flags as advantageous whenever possible. As Blaikie (2000, p. 120) states, "*if the researcher can learn to inhabit [the actors] social reality as a native, then they will be as close as any person can be to that social reality*".

3.3 Methodological approach

Taking a practice-based approach to the study of home energy retrofits by definition, moves the focus away from individual homeowners who do not routinely do energy retrofits, and who have generally not responded to policy interventions to date, toward the more routine performances and relations among intermediary actor groups that are implicated in and partly defined by the practice of retrofit. By centering the practice of retrofit, rather than homeowner behaviour, the research achieves one of its key aims which is to develop a novel way with which to interrogate the overall retrofit policy challenge.

This research endeavour attempts to pry open a part of the retrofit world that has heretofore been treated largely as an unopened black-box. Inside this box is a relatively un-studied space containing intermediaries, their practices, and their networks. While some of the actors in the box are familiar to policy makers and thinkers alike, some are not. Examples of the former include contractors and utilities (City of Vancouver, 2014), while examples of the latter include plumbers, electricians, insulators, energy advisors, consultants, suppliers, green building NGOs, interior designers, and trades associations (Globe Advisors, 2013a).

Exploring the retrofit system via an intermediary lens contributes to another of the project's aims by re-interpreting the home energy retrofit policy context from the intermediary's perspective, and re-presenting the retrofit socio-technical system as a series of relations between intermediaries of varying position and function. Deploying concepts concerning practice dynamics and intermediation together, challenges traditional retrofit policy framings. It does so by providing a useful way of understanding how intermediary relations and routine acts of translation and interpretation (linked to collective norms, values and meanings concerning climate change and energy efficiency) can contribute to the evolution and persistence of the practice of retrofit.

In line with Warde's (2005) view, research inspired by theories of practice require "*breadth in method and techniques of interpretation*" (Warde, 2005, p.3). The present project therefore employs a mixed method empirical case study approach,

consistent with the ontological and epistemological assumptions discussed earlier in the section, *Research problematique, and ontological frame*. The methods discussed below facilitate an articulation of the mundane and taken-for-granted, everyday values and activities of intermediaries in order to provide an understanding of the practices these actors carry and how they engage with their worlds. Both quantitative and qualitative methods are used to collect and analyze data. These include: the case method, semi-structured interviews, a questionnaire, document analyses, transcription, coding, relational mapping, and praxeological analyses, details of which are described below. Behind my data collection efforts is a concern for the biases inherent in my chosen theoretical framework, and how these might be manifest in the research. As Blaikie notes:

social scientists can only collect data from some point of view, by making 'observations' through spectacles with lenses that are shaped and coloured by the researcher's language, culture, discipline-based knowledge, past experiences (professional and lay), and the expectations that follow from these. It is possible to introduce some controls, but ultimately, all observation is interpretation - all observation is theory dependent (2000, p. 120).

3.3.1 The critical case

The case method involves a detailed investigation of a single example of an observed phenomenon, and is "[t]he method of choice when the phenomenon under study is not readily distinguishable from its context" according to Yin (1994, p.3). It is ideal for the project at hand as it facilitates exploration and theory building (something that the research acknowledges is lacking in the case of social practice theory) (Higginson et al., 2015; Shove, 2012), it can be used to illustrate an effect or set of processes in their natural setting (i.e. emergence of a new retrofit practice), it allows for a deeper level of understanding of the tacit knowledge and routines of subjects within a particular local context (i.e. critical for understanding practice dynamics), and it ultimately allows for the development of context-dependent knowledge (i.e. key to the study of human affairs) (Flyvbjerg, 2006). In response to some criticisms leveled at the case method, Flyvbjerg (2006, p. 224) points out that,

predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is, therefore, more valuable than the vain search for predictive theories and universals.

Exploring social practices using the case method is common. Hand et al (2007) undertake a case study to discover the co-evolving nature of technologies and practices in York, England, and Barr et al. (2011d) apply a case study approach to examine consumer practices at home and away. Similarly, Baborska-Narozny et al. (2016) use the method to demonstrate the need for capacity building and training for residents and photovoltaic industry actors, and Stephens (2007) deploys it to reveal problems arising from misaligned understandings concerning identity practices in a small New Zealand town.

Some argue the case method is best suited for the early stages of research where plausible hypotheses are being sought, and not for hypothesis testing and generalizing. Yet, as Flyvbjerg argues, "*formal generalization is overvalued [...] whereas "the force of example" is underestimated*" (Flyvbjerg, 2006, p. 228, *original author's quotes*). While I am convinced by Flyvbjerg's (2006) argument that the case method's capacity to test for falsification renders it effective for generalizing, I employ a case approach, not only because it permits this sort of test, but because it facilitates detailed investigations and exploration of new fields of study where little is previously known. Such is the case concerning energy efficiency retrofit systems of provision in Canada. Bergman et al. (2008) use cases to look at the transition to sustainable housing in the UK, Gram-Hanssen (2011) examines change and continuity in energy practices in the home via a case study, and Maneschi (2013) uses the case method effectively to explain how a financial intermediary uses an energy efficiency policy obligation to support a loan offer to its customers. However, no scholars to date have used the case method to examine the interdependencies between practice evolution and intermediaries operating in a socio-technical system context, such as that found in Vancouver's home energy performance retrofit arena. Vancouver's nationally recognized green building industry and policy landscape make it an interesting case to study where an energy retrofit practice is concerned.

3.3.2 Data generation

A combination of semi-structured interviews, a network questionnaire, and document searches were used to generate data in the field. Collected data include: transcribed interviews reflecting the lived experiences of diverse intermediaries working in the retrofit space, government reports, primary and secondary source documents, and various media (web sites and photos). These data were generated, both in the field and through desk-based research, between 2013 and 2016. Fieldwork took place between January and June of 2015. The use of diverse data types permits information triangulation, which is particularly important when exploring the highly context-dependent lives of intermediaries, and developing more textured images of the phenomena of interest. Details of how and where data were collected follows below.

3.3.2.1 Interviews

Thirty-eight subjects were interviewed in the field, in two phases, between January and June of 2015; all but two were face-to-face. The semi-structured interview, rather than ethnography, was used to study the intermediation and professional retrofit practices of intermediaries. Given the number and diversity of intermediary actor groups in the retrofit system of provision, and my desire to include as much of the system as possible in the research, semi-structured interviews were deemed an effective and practical means with which to access the routine sayings and doings of these actors, and the ways in which intermediaries co-construct (actively and passively) the practice of retrofit. While ethnography is well suited for understanding the context within which a particular intermediary operates, I was interested in learning about the understandings, imageries, principles and values that helped my interviewees make sense of their worlds, and I explored these via their representations of their own lived experiences. The daily routines and contexts within which intermediaries operate were explored via an adaptive interview technique and open-ended questions concerning how intermediaries understood both themselves in relation to other intermediary groups, and key debates and tensions circulating in the overall retrofit system of provision. Due to my familiarity with many of the retrofit intermediaries' daily routines and concerns,

and my ability to empathize and adjust vocabularies, I was able to uncover the motivations, beliefs and intentions of my subjects that got me closer to understanding 'why' instead of simply 'what' or even 'how' intermediaries do what they do.

Interviewees were selected to reflect both the structural and operational diversity of the retrofit system of provision. This required I interview a variety of actor types including: sole proprietors and employees of large organizations and public institutions, consultants, formal and informal entrepreneurs, private enterprises, and non-governmental organizations (NGOs). All interviews were in-depth, semi-structured and conversational, lasted between one and one and a half hours. Interviews were audio recorded and transcribed to maintain the integrity of the subject's understandings expressed during the interview event.

In all cases, interviews were preceded by emails (and sometimes telephone calls) which facilitated delivery of research background documents and research participation consent forms, and logistical arrangements regarding meeting times, places and agreed upon rules. With very few exceptions, every invitation to participate in the research was greeted enthusiastically and sincerely by subjects. Such enthusiastic responses might be emblematic of a group of actors that to now, have received little attention from researchers, and hence, may support a central argument of this research concerning the relative neglect of this group by both policy makers and scholars. All interviews were conducted in either natural or semi-natural settings (Blaikie, 2000). Typically, this meant meeting at job sites, in company offices, in stores, in homes, in cafe's, in public spaces including parks and pedestrian malls, and on one occasion, in an interviewee's work truck owing to excessive construction noise outside.

The first phase of interviews included seven interviews with subjects selected based on their breadth and length of experience and overall knowledge of the retrofit socio-technical system of provision in Vancouver. I used my own understanding and judgment regarding the green building sector in Vancouver to identify these seven interviewees. Six of the seven interviewees were male, and all were aged between

35 and 60. The subjects interviewed during this phase represented seven sectors: energy advisor; provincial government representative; designer / architect; energy and built environment NGO representative; builder / contractor; energy and environmental consultant; and, building trade association representative. Table 3-1 provides additional information regarding interviewees (i.e. sector, occupation, age, sex, function within the retrofit socio-technical system). The aim of these exploratory interviews was to confirm my conceptual map of the various occupational sectors and intermediaries implicated in the emergence of the retrofit practice, and my understandings of existing accords and tensions. As a result of this preliminary scoping process, I learned how the retrofit system of provision is understood by those in the middle of it, including: who are the main actors, how the system of intermediaries interfaces with retrofit policy at present, and general perspectives regarding the main barriers to broader retrofit uptake.

Table 3-1 Interviewee profiles - Phase 1

Identifier	Organization Type / Occupation	Function within the Retrofit STS and Length of service	Age	Sex
GT20321	Energy Advisor / Owner	Energy efficiency consultant to homeowners and developers / 15 yrs	35-45	Male
ST30811	Gov't Policy maker / Senior Policy Advisor, B.C. Ministry of Energy and Mines	Designs, implements sustainable and alternative energy policy in support of Provincial climate action priorities / 25 yrs	50-60	Male
SM30421	Designer, Architect / Principal	Green home designer and project manager / 12 yrs	40-50	Male
RP30131	Energy, Built Environment NGO / Chief Tech Officer	Energy efficiency and renewable energy advisor to local governments / 15 yrs	45-55	Male
FJ40511	Builder, Contractor / President & CEO	Builds and renovates private residences for clients / 18 yrs	45-55	Male
GH40121	Energy, Environment Consultant / Sole proprietor	Advises local governments and building associations on sustainable buildings / 20 yrs	45-55	Female
SM40122	Building Trade Association / Director of Gov't Relations	Tracks home building regulations and issues of concern for association members / 6 yrs	40-50	Male

Phase two interviews were identified subsequent to the completion of phase one. Of the thirty phase two interviewees, twenty-five represented intermediary groups operating in the Vancouver home renovation and retrofit sectors, one represented a homeowners association, two represented the City of Vancouver, and two represented senior levels of government. Six of the thirty subjects were female.

Table 3-2 provides detailed information about phase two interviewees. The intermediaries interviewed represented the most active actor groups operating in the retrofit space, according to a review of the literature and the opinions of phase one interviewees. These actor groups included: energy advisors; plumbing and mechanical contractors; electrical contractors; designers and architects; material suppliers; utilities; energy and built environment NGOs; builders and contractors; and, energy and environmental consultants. The subjects selected for this second group of interviews were identified using several techniques; some were located by snowballing from phase one, while others were contacted during industry sponsored home-shows or community meetings. The two representatives of the City of Vancouver were selected based on one's deep involvement with retrofit and climate policy, and the other's role as elected official with a strong alignment with the City's Greenest City Action Plan. Beyond the representative of the local homeowner association, with whom I made contact after a contractor I interviewed offered to connect us, all other interviewees were selected via convenience-based sampling among members of my professional networks and introductions initiated at business premises and work-sites. Interviewees with at least five years experience in the retrofit or construction sectors were selected, and subjects' views on issues of energy efficiency or climate change were not explored prior to their selection in order to produce a random sample. I stopped interviewing subjects when I had spoken with representatives from all the major sectors involved in the retrofit socio-technical system of provision, and I sensed I had reached saturation with respect to accords, contestations and normative understandings among all intermediaries.

Table 3-2 Interviewee profiles - Phase 2

Identifier	Organization Type / Occupation	Function within the Retrofit STS and Length of service	Age	Sex
LR60711	Builder, Contractor / Executive Project Mgr	Works with homeowners, in-house designers and trades to build / renovate homes / 9 yrs	25-35	Male
FC70203	Builder, Contractor / Site Supervisor, Carpenter	Responsible for supervising sub-trades and managing projects on multiple job sites / 6 yrs	25-35	Male
LS70204	Builder, Contractor / Working Foreman	Responsible for supervising sub-trades and managing projects on multiple job sites / 9 yrs	3-40	Male
YO70201	Builder, Contractor / Sole Proprietor renovator, builder	Provides homeowners with renovation design and construction services / 24 yrs	45-55	Male
BI60521	Builder, Contractor / Sole proprietor	Contracts with sub-trades to provide home renovation services to homeowners / 17 yrs	45-55	Male
LP01033	Builder, Contractor - President & CEO	Provides home renovation services through sub-contractors / 11 yrs	45-55	Male
JS50311	Energy Advisor / Sole proprietor	Provides energy efficiency audits to homeowners and developers / 9 yrs	35-45	Male
GM60321	Energy Advisor / Sole proprietor	Provides homeowners with thermal imaging services and energy retrofit advice / 4 yrs	30-40	Male
GS70111	Energy Advisor / Sole proprietor	Provides renewable energy supply solutions and project management for homeowners / 6 yrs	30-40	Male
PM01021	Materials supplier / Store Manager	Manages wholesale and retail building supply store / 12 yrs	35-45	Female
SS01221	Materials supplier / Owner	Owens and manages small chain of wholesale and retail building supply stores / 30 yrs	45-55	Male
WA70903	Materials supplier / Sales Representative	Provides commercial and residential clients with advice on plumbing fixtures / 15 yrs	30-40	Female
GD01031	Materials supplier / General Sales Manager	Supplies building materials to builders, developers and contractors across Vancouver / 13 yrs	45-55	Male
BG40921	Plumbing, Mechanical Contractor / Owner	Plumber, gas fitter, heating / ventilation system installer and designer / 11 yrs	45-55	Male
CK60422	Sub-Trade / Solar Roof Salesman	Leads solar roofing group within long-established roof installation company / 2 yrs	45-55	Male
LG60421	Electrical Contractor / Field Service Representative	Provides electrical installation advice and services, and does code compliance reviews of electricians / 25 yrs	50-60	Male
SP50131	Energy, Built Environment NGO / Executive Director	Advocates for building energy efficiency and climate mitigation action / 10 yrs	40-50	Male
WG60221	Energy, Built Environment NGO / Chief Operating Officer	Advocates for extremely high efficiency homes / 14 yrs	35-45	Male
VSD70301	Energy, Environment Consultant / Sole proprietor	Advises local governments and building associations on sustainable buildings / 10 yrs	45-55	Male
MA01821	Energy, Environment Consultant / Sole proprietor	Provides sustainable building expertise to construction sector in BC / 5 yrs	45-55	Male
BA11501	Energy, Environment Consultant / Sole proprietor	Advises local governments, corporations and building associations on sustainable buildings / 15 yrs	45-55	Male
KM60911	Designer, Architect / Sole proprietor	Designs new homes and renovations / 15 yrs	30-40	Male
LM70901	Utility (electricity) / Sr. Program Mgr Residential Mktg	Designs, develops, markets residential energy efficiency programs / 5 yrs	35-45	Female
RB70902	Utility (natural gas) / Program Mgr Residential Mktg	Manages conservation grants and natural gas appliance rebate program for utility / 7 yrs	35-45	Female
MT70221	Utility (electricity) / Sr. Program Manager	Develops new corporate energy efficiency and conservation programs in BC / 10 yrs	45-55	Male
CD70202	Neighbourhood Owners Association Representative	Represents informal group of homeowners concerned about development harming neighbourhood / 2 yrs	45-55	Male
PS70411	Gov't Policy maker / Green Buildings Mgr, City of Van	Manages Greenest City Action Plan initiatives to regarding retrofits and uptake of renewable energy / 17 yrs	40-50	Male
RA80501	Gov't Policy maker / City of Vancouver	Reviews staff reports and co-authorizes energy efficiency policy and by-laws / 10 yrs	40-50	Female
HJ70121	Gov't Policy maker / Sr Official, BC Buildings Safety Standards	Responsible for adapting national building, plumbing, fire and electrical codes for use in BC / 8 yrs	35-45	Male
WJ11211	Gov't Policy maker / Energy Planning Analyst, Gov't Canada	Provides sustainable energy policy advice for federal buildings research department / 14 yrs	40-50	Female

Knowing that my interests were principally concerned with subjects' unique, sometimes taken for granted, perspectives and values, I made efforts to ensure they all felt confident about their participation and that there was a bond of trust between myself and the interviewees. Trust building started from the moment of first contact and continued through to the post-interview 'thank you' message. All participants were informed that their identities would be anonymized in the research process and in the final thesis. Thus, quotes by subjects are attributed to generic titles, rather than interviewee names, followed by the date of the interview. During the interview process, I worked to maintain a friendly and humble demeanor, and used my knowledge of energy retrofits, Vancouver's culture and geography, and the construction sector generally, to establish an atmosphere of trust and ease. Rubin and Rubin (2005) refer to this as responsive interviewing, where trust liaisons like those described allow for more fluid conversations, and where subjects' responses act as signposts for the next question which ultimately fosters deeper exploration of a subject's idea or reflection. In many of my interviews, especially with intermediaries that do most of their work in people's home, I believe the assurance of anonymity coupled with my professional empathy helped to establish strong trust bonds that often yielded very frank, and on some occasions, somewhat self-incriminating testimonials.

All interviews were conducted in such a way that interviewees were encouraged to speak easily, and at length if desired, about issues they believe salient. At the same time, interviews involved a set of open-ended questions, asked in sometimes non-sequential order depending on the flow of the conversation. I kept interviewees from following tangents by reminding them of original, more productive ideas and nudging them gently toward these. The semi-structured interview permits the interview to flow with a degree of flexibility and spontaneity that often motivates the participant to talk about those issues that come to his or her mind (Blaikie, 2000).

Practice-based interviewing keyed in on talk that betrays the way people can alter cultural rules governing their more mundane acts through interpretation and improvisation. The conversational style adopted and my degree of familiarity with

their daily concerns was employed to make subjects feel as though they were safe to explain more complex ideas, and to help subjects "*develop a heightened sense of why they embody particular practices*" (Hitchings, 2012, p. 64). By adopting this strategy I took the stance of Hitchings (2012) who assuages the concerns of those who criticize practice-based interviews for being unable to generate subject accounts that reflect their mundane daily and what just feels natural. Hitchings (ibid.) argues that Bourdieu (1990) and Giddens (1986), in their work related to the habitus and structuration, respectively, both accept that subjects have at least some ability to interpret and improvise when performing practices. Hence, subjects can possess an ability to report out on these daily events to a researcher (Hitchings, 2012).

Interview questions, and the symbolic references embedded within them, were designed to "*reach meanings as they are shared by practice-collectivities and to probe into distributed practices at varying scales*" (Harvey et al., 2012, p.3). Rather than targeting energy retrofit and environmental values directly, questions purposefully focused on the details of what subjects identified as normal, regular ways of engaging in their field of business, and with other actor groups operating in the retrofit system of provision. The goal was to access the taken for granted norms and values concerning the practice of retrofit by encouraging subjects to talk about what they took to be important, rather than restricting the conversation to energy retrofit alone. Interview questions were designed to encourage subjects to reflect on their understanding of the normative rules, understandings and materialities of the retrofit system of provision, and their understanding of the behaviours, roles and responsibilities of themselves and other actors in the retrofit process. Participants were not told that the research saw them as intermediaries per se. Instead, they were defined as stakeholders in a retrofit system of provision made up of diverse actor groups, ranging in skill set, reason for being, and form. This approach permitted a more unfiltered exploration of intermediary networks and relations. Subjects were asked questions about their background and motivation for working in the field, in order to get at their values, interests and more practical information regarding the number of years in the field and relevant training. Other

questions probed subjects' perspectives on climate change science and policy, the merits of energy efficiency, and their personal comfort when talking about the latter with both homeowners and other intermediaries. A series of questions sought to reveal the identities of actor groups holding positions of influence within the retrofit system, and particular intermediary groups that influenced them most strongly. I also included questions that helped me access subjects' understandings and sense-making with respect to City of Vancouver climate action and home energy efficiency policies and regulations. Again, these questions probed both retrofit-related issues and routine interactions and perspectives on the city, both as institution and place.

3.3.2.2 Questionnaire

Following each interview with an intermediary, I asked each subject to complete a short network questionnaire. The questionnaire focused on several ideas, all within the context of the local retrofit socio-technical system of provision:

- intermediary's perceptions of self and relations with other intermediary actors;
- the direction and frequency of information flows between intermediaries; and,
- the intermediary's understandings of concepts related to climate change, residential energy efficiency, and their sense of agency as influencers.

The questionnaire was designed to produce a data matrix where each subjects' perceptions of the nature of trust and information flows between themselves and other intermediary groups were represented. Overall, the subjects interviewed represented eleven categories including: builder/contractor; energy advisor; electrical contractor; mechanical contractor; material supplier; sub-trades; trade association; designer/architect; energy/built environment NGO; energy/environment consultant; utilities (electricity and gas). In addition to the eleven intermediary categories listed, an 'Other' category was included in the questionnaire to capture additional groups of relevance for a subject. These included UK and US online green building and energy efficiency technology journals,

as well as the International Energy Agency. To reduce the time required to complete the survey while covering as much ground as possible, a Likert-scale of responses was used. These included five possible responses ranging from Strongly Agree to Strongly Disagree. The questionnaire generally proved easy to complete, although some subjects expressed a desire to associate themselves with more than one intermediary category. In this case, they were advised to select the one they felt most aligned with.

The aim of the questionnaire was to permit analysis of the different forms of connections between retrofit intermediaries working on retrofit, including their routine communication pathways, collaboration agreements, and trust relations. Studying these connections highlighted how the acceptability of certain ideas, values and rules about retrofits are reinforced. According to practice theories, these are key to the transfer, persistence and reconfiguration of practices and their constituent elements. The questionnaire served two purposes. One, the Likert-based questions facilitated network mapping that reveals graphically, normative relations and structures within the retrofit system of provision which are useful for understanding spheres of influence within the system. The resulting maps help illustrate how a retrofit practice-as-entity can be sustained via a nexus of sayings and doings, and linked through space by meanings, rules, norms and motivations. These trust, collaboration and communication relations also constitute a form of glue between intermediaries and their practices that together constitute the retrofit socio-technical system. They achieve this by controlling access to and participation in practices, and facilitating the circulation of common understandings and logics regarding the value that energy efficiency and conservation represents (Shove et al., 2012). And two, it provided an additional means, over and above assessing interview transcripts, to gauge and confirm subjects' beliefs and values concerning the value of energy efficiency or the justification for climate action.

3.3.2.3 Written and symbolic materials

Documents include "*the broad range of written and symbolic records, as well as any available materials and data, [and] practically anything in existence prior to and during the investigation*" (Erlandson, 1993, p. 99). I collected text-based, audio, film

and photographic documents throughout the research period in order to enhance my overall understanding of the theoretical and practical issues related to home energy retrofits, and to reinforce the integrity of my own primary data. These documents were collected prior to, during, and post-fieldwork and include: primary sources in the form of original research, City Council meeting minutes, by-laws, accords, photographs and technical reports; secondary sources such as reviews and critiques of literatures; tertiary sources like newspaper articles and online video news clips; and gray literature comprising online documents, web sites, promotional brochures, conference proceedings, City Council reports, energy and climate action plans, other government documents, technical reports and working papers.

While many of these materials were collected via library and internet searches, some were obtained from government institutions, organizations, or from individuals with whom I met or interviewed. Photographs were either taken by me or retrieved from archives. Bourdieu's (1984, 1977) practices, and Shove and Pantzar's (2012) practice elements, are heavily imbued with symbolic structures – streams of signs, symbols, discourses, or texts. Recognizing the important role that imagery, symbols and discourse place in inculcating ideas and collective understandings within daily practices, I endeavoured to collect samples from the diverse film and photographic content that circulates on the internet. These include static images produced by the City of Vancouver, trade associations, material suppliers and utilities, as well as web-based film footage of interviews with policy makers, homeowners and intermediaries. Again, these data were used to buttress the understandings of intermediaries, and contextualize the environment these import actors operate within, in addition to my own observations.

3.3.3 Data analysis

I assume the role of faithful reporter in this project, recording the unique points of views of research participants in a naturalist manner, letting them speak for themselves, and faithfully reporting on social phenomena in their natural state (Blaikie, 2000; Denzin, 1971). In accordance with this methodological stance, the research strives to link the thick descriptive accounts of the daily lives of retrofit

intermediaries with praxeological and intermediary dynamics terminology, so that a social scientific interpretation of their ways of life is possible. Such an analytical approach is sympathetic with Goodsell's understanding of 'thick description':

the investigator seeks to understand the repertoires that people deploy to make sense of and act within their social environment, and to articulate a sense of the ordinary lives of community members in the analytic strategy of thick description (Goodsell, 2008, p. 541).

Interview transcripts and relational data constitute the major primary data sources, but these were augmented by other secondary, tertiary and grey sources. These auxiliary data were used, where appropriate, to provide contextual information and to triangulate other research findings. Policy documents, including City strategic plans, by-laws, council reports, staff presentations, and building codes dealing explicitly with energy efficiency, climate change mitigation, or home retrofit issues were collected together with reports, plans and policies prepared by senior levels of governments, supra-national institutions, or NGOs. These documents were used to better understand the broader climate and energy efficiency policy context within which home energy retrofits unfold, and how local retrofit policy is actively co-constructed by numerous institutions and government departments operating at all levels, from the international right down to the local level. I was interested in broad climate and energy-related value statements that often foreshadow local government policy design and justification. I looked for evidence of policy coherence and alignment within and between different levels of government to unearth tensions with the potential to impede the uptake of a stable retrofit practice. I also looked for recurring and hence normative problem statements among policy documents, and the strategic actions, targets and aims that flowed from these. These were used to develop a generalized picture of the interests, motives, values and principles of retrofit policy makers.

Empiricizing practices

Social theories cannot be simply unpacked in the policy maker's office and called upon to produce recipes for intervention, however, they can offer new and novel perspectives with which the social world can be understood. To now, theories of social practice have been largely ignored in policy circles, hence there is little in the

way of concrete examples wherein its tenets have been applied purposively in practice (Hargreaves et al. 2008; Seyfang et al., 2010; Shove, 2010a). Why this is the case is likely due to the relative newness of the approach, as well as the epistemological challenges inherent in focusing on practices. As Schatzki argues, applying a practice approach to explicate subjects' lives and their worlds, requires analysts to reorient themselves to gain a fundamental understanding about how,

practices and arrangements hang together and connect to others [. . .], about the contexts in which activity take place, and about the histories [and trajectories] of the bundles. [. . .] This is detailed information that no one, including the subjects, possesses; at best, the knowledge that is distributed among the subjects and those who have studied them might, if pooled, cover much of these matters. Despite this, understanding these things is essential to understanding the subjects' lives and worlds and to anticipating and attempting to shape their future (Schatzki, 2012, p. 24).

There is a growing cadre of writers who appear tempted by the promise of practices and who are applying the approach to diverse issues, notably consumption and unsustainable lifestyles. Several thinkers including Pantzar, Southerton, Watson, Karvonen, Strengers and Maller are pioneering the application of the social practice ontology. They advocate for the adoption of a practice approach in policy circles and are using the ontology to probe practices as diverse as showering (Hand et al., 2005), DIY home improvements (Watson and Shove, 2008), Nordic walking (Shove and Pantzar, 2005), personal consumption (Shove, 2005), freezer use (Southerton, 2000), energy and water consumption (Strengers and Maller, 2012), energy retrofits (Karvonen, 2013), and digital photography and floorball (Shove and Pantzar, 2007).

All interview transcripts contain both the 'sayings', and reflections on the actual 'doings' and 'materialities' of intermediaries. In line with the research's ontological leanings, the transcripts reflect, in text form, the unique, constructed and audibly expressed realities of interviewees. However, they also contain textual evidence (albeit re-constructed by the researcher) of intermediary practices; that is, their sayings and doings, "*forms of mental activities, [...] background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge*" (Reckwitz, 2002, p. 249). The transcribed interviews thus constitute an important portal through which practices of intermediation are examined, in the same way

that Hand et al. (2007) use personal interviewee accounts, interpretations and reflections on bathroom and kitchen practices to understand increased rates of accumulation of consumer goods within domestic homes, and Barr et al. (2011) rely on interviews and survey questionnaires to examine environmental practices in the home and while on holiday. In this way, the analysis interrogated intermediary practices by examining their routine sayings and personal narratives about their material realities and embodied competences, without examining these directly.

The analysis of interview texts was conducted by coding transcripts using praxeological codes (Table 3-3) inspired by the practice literature, particularly the work of (Shove et al., 2012) on practice dynamics. To these were added other codes linked to themes that emerged as important to interviewees, and that also signalled processes of practice emergence, recruitment and reproduction, as these were deemed strongly influenced by intermediary network relations of trust, communication and collaboration. I was particularly interested in text that signalled dissensus concerning the logic of energy efficiency or climate action. I also looked for evidence of increased awareness or acceptance of new logics concerning energy efficient designs, technologies or materials. That is, as propositions underpinned by defensible and normative understandings, rather than as more niche or fringe endeavours. All coding was conducted using NVivo qualitative analysis software.

Table 3-3 Praxeological codes employed

Concept	Description	Examples
Practice-as-performance	Actual do-ing of actions by humans (i.e. through integration of meaning, competence, and materials)	Story of the task-related challenges encountered when applying caulking around window to prevent air leakage.
Practice-as-entity	Nexus of linked sayings and doings, linked across space by understandings, rules/principles, teleoaffective structures constituted by emotions, beliefs, projects and goals	Talk about the principles underlying effective draught-proofing.
Materials	Enabling channelling, prefiguring, facilitating and materials taking on meaning/intelligibility via practice performances	Blower-door ventilation fans, infra-red cameras, energy modeling software.
Element assembly	Humans assembling, grasping and knowledgeably deploying practice elements to constitute practices; no carriers means practice elements remain unconnected and devoid of meaning	Intermediaries promoting benefits of real-time and visual display energy consumption devices in homes.
Practice stability	Relative commitment levels of carriers, relative influence of practitioners on interpretation of practice, internal reward for practitioners, connectedness with other practices	Intermediaries enthusiastic and supportive of the logic of employing energy audit results to guide retrofit interventions.
Practice instability	Little internal reward for practitioners, practices not connected to other practices, there is mass defection, or one of their elements change	Intermediaries express doubts concerning the wisdom of combining easy and difficult retrofit interventions to ensure project comprehensiveness and consistency with house-as-system principles.
Practice travel - element assembly	Locating similar practices across space requires identifying the occurrence of the competences, materials and meanings that together enable the practice	Intermediaries recount their experiences with new high efficiency, demand boilers.
Practice travel - ideas exchange	Skills travel by mental processes among actors who exchange theoretical ideas with other actors who have the capacity to decode, adopt or reconfigure the skill	Intermediaries talk of learning new principles and techniques to construct low thermal bridging wall assemblies.
Practice travel and change	As a result of decoding and reconfiguration by recipients during transfer, skills can easily morph yielding new forms of the original practice	Intermediaries promoting energy consumption display technologies as smart tool rather than simple energy saving device.

Employing a practice lens to analyse the transcripts presented advantages and challenges. Above all, it provided a refreshing new way to look at the world of home energy retrofits, and a distinct move away from traditional 'individual-centred' conceptualizations. It provided an organizing framework to interrogate the texts and structure empirical analyses, but the abstract nature of some of the practice concepts made it difficult at times to ensure they were always being deployed in a consistent manner. Investigating practices requires careful attention be paid to the constructed worlds and realities of subjects, yet this objective was impeded by the need to re-interpret the subject's unique lived experiences according to a framework that is exogenous to this reality. I tried to retain the terms, phrases and language used by research participants, and put these alongside the vocabulary used in the practice framework in order to retain the integrity of the phenomenon under study. In this way the research assumed a rather hybridized low-stance/high-stance analytical flavouring (Blaikie, 2000).

Mapping intermediary network dynamics

The research sought to understand the form, function and relations of the intermediary actors implicated in the retrofit socio-technical system in Vancouver. By mapping collaboration patterns and communication channels between actors, rather than focusing on the attributes of the actors themselves, the analytical method contributes to the de-centering of the individual, a central tenet of practice theories. To better understand the nature of these relations between intermediary actors, I elected to map the intermediaries I interviewed according to three themes: communication and collaboration frequencies; perceptions of which intermediaries provided trusted information regarding retrofits; and, the degrees of separation between them and retrofit policy and programs specifically, and homeowners in general. This permitted me to investigate which intermediaries were most influenced by policy directives, and which exerted the greatest influence over other actors in the retrofit socio-technical system, by virtue of either their strategic position or their expert status. By understanding these relations I hoped to reveal intermediation pathways and better comprehend what role common understandings, mutual trust and collaboration arrangements among

intermediaries played in enabling new practice element configurations to emerge in the retrofit system.

Data collected via questionnaires were entered into spreadsheets, and then into relational maps using GEPHI, an open source mapping and visualization software package. Interviewee responses were used to reveal circuits of learning, information exchange, in-groups, out-groups, and exclusion and power dynamics. Relational mapping is used throughout the empirical work and helps to characterize system structure and relations of power, trust and influence between actants.

GEPHI (the visualization software used) employs the Louvain (2008) method (based on a community detection algorithm) to detect communities within networks and to calculate a network's modularity. Gephi's ForceAtlas layout algorithm specializes in detecting *small-world* and *scale-free* networks, making it ideal for detecting the presence of communities within the retrofit system network. Small-world networks are those in which most actors are connected with every other actor via a small number of steps (Prell, 2012). Scale-free networks are more theoretical and their existence in reality is often debated, however these networks contain a high number of hubs; that is, nodes that are connected to many other nodes (ibid.). Mapping was performed by representing actor networks via sets of actor groups (nodes) connected to one another via relational lines (edges) (Newman, 2006). Nodes can carry attribute data such as form or type intermediary, their scale of action, and number of connections with other intermediaries. Edge thickness denotes the strength of the relation between nodes and its direction (when designated) denotes the direction of influence. The nature of any social network is enhanced by visualizations that present the system in graphical form, and statistical metrics can be combined with graphical representations to enhance meaning and understanding.

The metric that illuminates community (or group) structure in networks is 'modularity'. Community structure, Newman suggests, is evidenced by "*the appearance of densely connected groups of nodes, with only sparser connections between groups*". Modularity is a key measure of any network (Newman, 2006, p.

1). 'Degree' is a measure of the number of edges, regardless of weight or direction, that connect to a node. This is an important measure of how active an entity is within a social network. 'Weighted degree' is somewhat different; it is a measure of the sum of edges, and each edge's weight. This metric captures the intensity of relations between nodes, and which ones are particularly critical to the system as a whole. 'Hubs' and 'authorities' are additional artefacts of networks. A 'hub' is a node with many edges directed away from it and toward other nodes, while an 'authority' is a node with many edges pointed toward it. In networks where direction of influence is relevant, it is useful to be able to see who is sending information (influencer), and who is receiving (influenced). Identifying hub and authority nodes depends on the nature of the relations between two nodes.

The relative influence of each group is important as it reflects power dynamics and paths along which practice assemblies can travel. Actor groups' influence levels were investigated through Likert scale based questionnaires that sought subjects' feelings of trust toward other actor groups within the retrofit system, and information regarding the frequency of contact and communications with other actors. Likert responses for trusted information sources (1-strongly disagree, 5-strongly agree) and communication frequencies (1-rarely/never, 5-weekly) were used as edge weights and thus constitute the nature of the link between two actors (nodes). The larger the node diameter, the higher the number of incoming edges. Nodes of similar shade are more densely connected internally than with the rest of the network, and thus constitute what may be considered communities. That is, they tend to have similar connections and kinds of relations (i.e. weight value) with other nodes with the same shading. The algorithm that allows for colour coding of communities also uses the proximity of one node to another to reflect the degree of connectedness or alignment between the two.

Methods integration

Applying a praxeological lens to participants' accounts of their daily experiences, and mapping intermediary positionality and relations based on quantitative questionnaire responses, provided the means with which to empirically link processes of intermediation with the emergence of a retrofit practice. Integrating

these two methods allowed for a fundamental re-defining of the retrofit challenge by focusing on the daily practices, understandings and situatedness of intermediaries, rather than simply homeowner values and attitudes toward energy efficiency upgrades. Moreover, verbal responses and testimonies contained in interview transcripts, together with quantitative data regarding intermediary relations, and textual evidence contained in policy documents, permitted cross-referencing of the realities generated by each method, and hence a more robust understanding of the collective reality shared by retrofit intermediaries. Cross-referencing was conducted using NVivo qualitative analysis software. Deploying a mixed methods approach that combines quantitative and qualitative interventions elaborates on earlier practice-based research and debate, especially that of Browne et al. (2014, p. 6) who flag mixed methods as a useful way to reveal different ontological realities.

Combining these methods revealed both the established information sharing paths and spheres of influence among intermediaries, as well as the nested and reinforcing relationships between processes of intermediation (e.g. interpretation, translation, filtering) performed by intermediaries, and the more retrofit-specific daily understandings, doings and sayings of these same actors. Through the integration of methods the research was able to bring into the open important, yet often mundane intermediary functions that have historically been either, black-boxed and treated as homogeneous, unknowable and largely benign to the success of retrofit policies, or simply ignored altogether.

3.4 Context: Vancouver, Canada as case study

In this section the focus is on the city of Vancouver, Canada, as the physical location wherein field research was conducted. Rather than the larger region of Vancouver, the case's geographical boundaries correspond to the jurisdictional limits of the City of Vancouver, which covers an area of 115 square kilometres. In the introductory chapter I provided a general overview of the city in terms of its population, geographical location, economic profile, and overall placement among other major Canadian cities, but these facts and figures do not do justice to the essential nature of the place. Thus, the reason for revisiting the topic of Vancouver is simple; place

matters where new building practices are concerned. Schatzki (2015, p. 1) takes practices to be "*inherently spatial*", and "*the spaces pertinent to social life [...] ever increasingly the product of practices*". Practices are constituted in place, and practice performances implicate place in their execution. Place is heavily implicated in the emergence of new practices, acting as both a physical and cultural backdrop that ultimately becomes infused within any practice element triad.

There are four local place-based memes carried in local imagery, discourse and histories that all help shape life in Vancouver, and hence, the daily sayings and doings of those that live and work there. These memes or collective understandings relate to its unique geographical context, the city's green (or sustainability) pedigree, pervasive imaginaries of Vancouver as a lifestyle or 'edge' city, and the city's special relationship with real estate, especially the single family residential dwelling. The cultural memes create tensions however. Vancouver's affinity for single-family detached homes (i.e. 70,000 of the 90,000 buildings in the city are detached houses (City of Vancouver, 2014a), and the resulting land-use and consumption implications of a low-density built form, contrast with its alter ego. That is, as a green 'Mecca' (City of Vancouver, 2010) with intentions to be the greenest city in the world by 2020, and its role as global environmental leader.

Using one city as a case allows for detailed analysis of one geo-political context that, while not necessarily transferable to other cities, can illuminate more general principles related to practice dynamics and intermediary functions. As the single family home represents a dominant housing form in many cities across North America, I chose to focus on this class of dwellings in this project so that conclusions will have relevance to as wide an audience as possible.



Figure 3-1 The single-family detached dwellings dominating Vancouver's Mount Pleasant neighbourhood, left (c.1950), same neighbourhood in 2015, right
Photographs: Left, courtesy North Vancouver Museum; Right, author's photograph.

The city of Vancouver acts as a critical case for several reasons, but principally because the city reigns supreme among Canada's 'green' cities, its home alteration activity levels are higher in the city than any other city in the country,¹ and its people and institutions provides an emblematic exemplar of progressive public environmental values and political will. As a consequence, Vancouver provides a context where one expects to encounter a high level of awareness regarding the links between energy efficiency upgrades and climate change, and where the retrofit system of provision and its constitutive actors are expected to be active and well developed.

The case is not a geographical area, workplace or a single house, rather it is spatially and organizationally diverse. It comprises a network of actors, organizations, and physical objects that interact with each other, by diverse ways and means in the process of undertaking home energy retrofits within the physical boundaries defined by the City's jurisdictional limits. The case setting is actually multiple

¹ In 2015 Vancouver's *Renovation and Repair* sector supported 33,858 jobs, \$CDN 1.9 billion in wages, and \$CDN 5.4 billion in investment, representing more than half of the province's totals (CHBA BC, 2015a). Globe Advisors' (2013b) claim the Lower Mainland area, which includes the city of Vancouver and 19 other municipalities, makes up about 50 percent of BC's entire renovation market. In 2012 the neighbouring municipalities of Richmond, Burnaby and Surrey - often seen as the closest competitors with Vancouver on various levels - generated only 13,225 jobs between them (Canadian Home Builders' Association, 2015).

settings, for in the process of contributing to a retrofit practice, the intermediaries in Vancouver connect with actor groups outside the city's boundaries and they also circulate among institutional buildings, private homes, architectural offices, consultants' offices, contractors work trucks, cafe's, and building material supply stores.

The city's global reputation as a green leader increases the likelihood that any policy innovations arising from the case study will be replicated and travel far. In addition to the city's green credentials, another reason for its selection is my familiarity with the green building industry in Vancouver. I employed my personal experience and familiarity with retrofit and construction practices in Vancouver to situate myself on the inside of the retrofit socio-technical system. This helped foster trust relations between participant and researcher, and helped me to better access the actor's meanings and interpretations.

3.4.1 A setting waiting for a city

Berelowitz (2005, p. 6) notes that 'Vancouver is inseparable from its setting'. Arriving in Vancouver by airplane, newcomers cannot but notice the striking geographical setting within which Vancouver is situated. Even if one was not explicitly aware of the Canada-US border a few kilometres to its south, it is impossible not to notice that the Lower Mainland of Vancouver is cornered between the 1500 metre-high Coast mountains to the north and east, the Pacific Ocean to the west, and further bisected along a east-west axis by the salmon-bearing Fraser River and its fertile alluvial plain. Looking westward across the Strait of Georgia, one can see many of the Gulf Islands that lie between nearby Vancouver Island and the Lower Mainland. Across the border to the south, Vancouverites can see Mount Baker in Washington State, USA, an active volcano that sports a year-round snowy summit. And if one heads northwest from the city by boat, Howe Sound - a steep-sided fjord with a narrow highway clinging to its banks - awaits. Alas, this proto-global city is situated in immediate proximity to mountains, rain forest, ocean, river, fjord, volcano, and island archipelago, that together cannot be ignored or silenced.

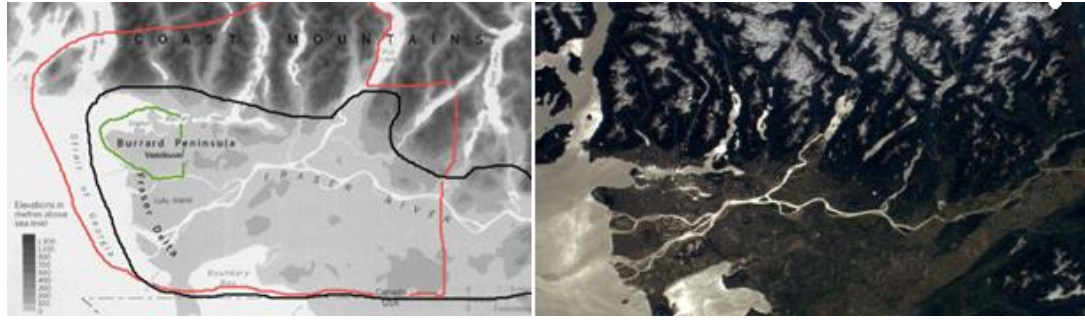


Figure 3-2 Metro Vancouver geography

(Left) Vancouver's topography with the City of Vancouver outlined in Green, Metro Vancouver in red, and the Lower Mainland in Black. Adapted from photo by Eric Lienberger. (Right) Lower Mainland of Vancouver from space.

Photographer: Tim Peake, International Space Station.

Water, particularly rain, plays an especially important role in defining Vancouver's DNA. The wall of nearby mountains intercept eastward bound clouds laden with moist ocean air, resulting in an overabundance of rain for the region, and reasons for and its nickname as the 'wet-coast' (Berelowitz, 2005). Rain defines Vancouver in many ways. In addition to its urban landscape that is preternaturally green, and lush rain forests within ten minutes drive of the city, the 1.5 metres of rain that falls on the city (over an average of 170 days each year) keeps gardeners busy, the streets clean, and natural water reservoirs full. The abundance of rain and a lack of water meters helps foster a strong non-conservation ethic among residents, businesses and industry alike. An additional effect that flows from Vancouver's remarkable rainfall patterns relates to electricity supply, and the fact that there is an intimate relation between water and electricity in British Columbia. Ninety-three percent of the province's electricity is hydro-generated (BC Hydro, 2016), so when it rains at lower elevations like Vancouver, it often snows at higher elevations, and melting snowpack is what fills a network of hydro reservoirs scattered across the province. As a consequence, many Vancouverites feel that electricity supply is as endless as the rain, and thus not altogether worthy of being conserved.

3.4.2 Place-inscribed imaginaries

As recent as one and a half centuries ago Vancouver did not exist. The city is young, even by Canadian standards. But during its short history, Vancouver has developed a distinct environmental pedigree that persists to this day. Greenpeace was

founded in Vancouver in 1971, and the Sea Sheppard Conservation Society, another strident environmental non-governmental organization, was founded nearby in the San Juan Islands. A passage from the 1990 Clouds of Change Report, the City's first foray into climate policy, reflects the city's unique and progressive outlook on the world, as well as its own reflexivity.

As one of the world's richest cities, we have a responsibility to address the causes of environmental decline. If a wealthy city such as Vancouver, with a concerned, well-educated populace cannot act on atmospheric change problems, how can we ever expect the less fortunate cities of the world to take action? (City of Vancouver, 1990, p. 21).

In 2010, Vancouver hosted the Winter Olympic Games, giving it an opportunity to firmly establish itself on the world stage as a truly green city. Based on its goal of making the games sustainable, the Vancouver 2010 Organizing Committee created a new sustainability reporting framework and a novel sustainability governance model for large sports events organizations. It also promoted its Olympic athletes village as the most sustainable ever built. Yet, as one participant points out, the city's impression of itself as a green centre of excellence is not always realistic,

Vancouver is not green at all. It has lots of trees. [...] there is an environmental awareness. But unfortunately, quite a few of the initiatives are, well, quite frankly, are pretty much flat. I mean, the [Olympic Athletes] Village is one of the super examples for this. The Village, and I don't mean it in any arrogant way or so, but it wouldn't have passed German Code from 1995, because it's just not performing well enough. And we call it a sustainable Village. So just [...] there is a huge discrepancy between what people would like to do, and what they're actually doing (Environmental NGO B, 22 June 2015).

Vancouver's experience with raising the bar for Olympic host cities is not the only time the city influenced understandings beyond its borders. Research by Wackernagel and Reese (1998) at the University of British Columbia in Vancouver, resulted in the ecological footprint concept, a sustainability metric known around the globe. The city's reputation as a hub of green experimentation and innovation, being on the 'left' coast of Canada, or being on the edge of the continent, looking outward at the rest of the world, all contribute to its reputation as environmental leader and its capacity to materially shape the green city zeitgeist.

3.5 Conclusion

This chapter started by describing the social problem the research aims to understand, and the ontological foundations upon which the research rests. From there, the discussion provided a justification for taking an interpretive and abductive approach to the generation of social scientific accounts of home energy retrofits, which are based on intermediaries' personal experiences and perspectives. The chapter moved sequentially through a discussion of the mixed methods used for data collection and analysis, making the case for their appropriateness in terms of research aims and objectives, and the theoretical resources deployed.

The use of the case method was justified on the grounds that the everyday practices and materialities of intermediaries working in the retrofit system of provision are difficult to distinguish from their context. Moreover, the method permitted a more fine-grained examination of the textures of the home energy retrofit landscape. My lengthy experience working in Vancouver's green building sector was consistent with the choice of the case method, as the latter relied on detailed and close-up examinations of social dynamics. By employing a practice lens to explain what was happening in the retrofit system of provision, the research tied itself to an ontology that can allow for other cases studied in the same way to be compared. The generalizability of the research findings was enhanced through the selection of Vancouver as a critical case, given the city is a global leader in sustainability, green buildings and climate action.

The methods discussed in this chapter are applied in the three that follow. In Chapter 4 the discussion concerning the reasons for policy incoherence and barriers to success is supported by participant testimony and data and information found in documents ranging from government policies, plans and by-laws to reports prepared by green building NGOs or the United Nations. In Chapter 5, 'Retrofit landscape', the analysis relies on the content of interview transcripts and written policy documents that address the actor groups operating within the local construction industry to characterize the diverse suite of intermediary actors operating between policy circles and homeowners. In the final analytical chapter,

'From intermediaries to practice and back again', a praxeological frame is deployed alongside relational mapping of intermediary groups and the testimonials of interviewees to analyze how intermediation practices and circuits of trust and information exchange influence the emergence of a retrofit practice in Vancouver.

Chapter 4 The co-construction of retrofit policy

4.1 Introduction

This chapter unpacks the broader policy context within which Vancouver's energy retrofit policies evolve to better understand why climate-induced retrofit policies and programmes are failing to achieve their desired effect. What is revealed are good intentions frustrated by a contested landscape of visions and understandings created by uncertainties around policy approaches, ideological gaps, and place-inscribed ambiguities. I present one of the self-proclaimed, greenest cities on Earth. Then, the broader policy landscape within which retrofit policies and programmes unfold in Vancouver is explored. The policy discussion shows that local policies and programmes urging home energy retrofits are nested within a set of varyingly aligned political agendas operating at multiple spatial scales. With respect to retrofit mandates, jurisdictional miscues and misalignments between all levels of government and NGOs are fostering fuzzy understandings regarding climate change and home energy efficiency among a spatially diffuse and diverse network of policy actants. The final section of the chapter examines points of incongruity between home energy efficiency logics and place-inscribed attitudes toward abundant natural resources, and proposes that these are aggravating policy confusion even further.

4.2 The Greenest City

Green is to Vancouver what “love” is to Paris, “history” is to Rome and “movies” are to L.A. (Ryan, Vancouver Sun online, 31 January 2016)

Aiming to be the greenest city in the world by 2020 is an ambitious goal. Not only is green-ness difficult for residents to measure, it is even more challenging to define or understand. Despite these difficulties, the City is channeling what it believes to be local residents' default mindset about the relations between the environment, community resilience and the economy. The discussion to follow shows that being green is not always easy, and when it comes to scaling-up home energy retrofits, good intentions can create unwanted tensions.

Vancouverites want to live in a city that is vibrant, affordable and sustainable. They cherish the beauty of this spectacular setting, and rely on the prosperity

that has been created from abundant natural resources. [...] They [...] deserve a bright, green future. Why green? Because in the highly competitive, highly mobile modern world, the elements that make a community healthy also make it wealthy. [...] Vancouver starts with a fabulous natural advantage: ours is often named as the most livable city in the world. But our environmental footprint is almost four times the sustainable level. [...] if everyone on earth lived as Vancouverites do today, we would need three to four planets to support that level of consumption. We only have one Earth, and Vancouverites are well positioned to show the world how to live, and live well, within its limits. We can be the greenest city on earth. (City of Vancouver, 2010, p.6)

It is remarkable to see how often Vancouver appears at the forefront of discussions regarding energy efficiency and climate policy best practice. It was one of the first cities in the world to recognize the serious threat that climate change represented (City of Vancouver, 2015a). In addition to being one of North America's first cities to commit to becoming 100 percent dependent on renewable energy, establishing the "*greenest building code in North America*" (City of Vancouver, 2012, p. 2) in 2011, and being recognized by the World Green Building Council for having the *Best Overall Green Building Policy*, the City of Vancouver is one of the co-founding C40 Cities Climate Leadership Group and the Carbon Neutral Cities Alliance. A few examples of Vancouver's environmental leadership include its rapidly growing bicycle infrastructure, infrared imaging of residential neighbourhoods to quickly detect, on a broad-scale, energy inefficient homes, and the City's requirements for home renovations to include stepped energy retrofit measures depending on the value of the overall project. Table 4-1 provides an indication of the City's recent performance on global ranking scales related to sustainability and green development.

Table 4-1 City of Vancouver Sustainability and Green City Awards Received

Year	Issued By	Award or Ranking
2011	Economist Intelligence Unit and Siemens	Green City Index: 2nd in North America
2011	Corporate Knights	Canada's Most Sustainable Mid-Size City
2011	Union of BC Municipalities	Climate & Energy Action Award
2011	Economist Intelligence Unit	Global Livability Index - Third
2012	Federation of Canadian Municipalities	Sustainable Community Award
2012	Canada's Top 100 Employers Project	Canada's Greenest Employer Award
2012	Economist Intelligence Unit	Global Livability Index - Third
2013	World Wildlife Fund	Earth Hour City Challenge: Global Earth Hour Capital
2013	Corporate Knights	Sustainable Cities Scorecard: Top 5
2013	Mediacorp Canada Inc	Canada's Top 55 Greenest Employers
2013	World Green Building Council	Best Overall Green Building Policy
2013	100 Best Fleets	Greenest Municipal Fleet in Canada
2013	Walkscore	Most Walkable City in Canada
2013	Economist Intelligence Unit	Global Livability Index - Third
2014	Global Green Economy Index	Top 10 Green City Perception Ranking
2014	Time Magazine	Healthiest City in the World
2014	Grosvenor Resilient Cities	Most Resilient City in the World (2nd)
2014	Federation of Canadian Municipalities	Green Champion Award (Municipal)
2014	Federation of Canadian Municipalities	Sustainable Communities Award: Transportation
2014	Mediacorp Canada Inc	Canada's Greenest Employers
2014	Government Green Fleet Award	Top 50 and Greenest Municipal Fleet in Canada
2014	Canadian Green Building Awards	Award-Winning Project
2014	Stewardship Centre for BC	Green Shores Gold Award
2014	Economist Intelligence Unit	Global Livability Index - Third
2015	World Wildlife Fund	Earth Hour City Challenge: National Earth Hour Capital
2015	Mercer Quality of Living Survey	5th overall globally; 1st in North America
2015	Mediacorp Canada Inc	Canada's Greenest Employers
2016	Arcadis Sustainable Cities Index	Most Sustainable City in North America
2016	World Green Building Council	Contributions to the global green building movement)
2016	Economist Intelligence Unit	Global Livability Index - Third, First in North America
2016	Community Energy Ass. Climate & Energy	Public Sector Organization & Local Government Collaboration
2016	Climate Disclosure Project	One of 10 Top Cities for Climate Reporting and Disclosure
2017	Canada Green Building Council	Inspired Educator Award
2017	Mercer Quality of Living Survey	Fifth overall globally; First in North America
2017	Mediacorp Canada Inc	Canada's Greenest Employers

The current City Council is committed to being a global environmental leader and securing its "*reputation as a Mecca of green enterprise*" (City of Vancouver, 2012, p. 14). It is important to note that there are two, sometimes conflicting notions wrapped up in the previous sentence. The first is the idea that the local population feels strongly about protecting the natural environment, and the second is that Vancouverites feel an almost moral obligation to lead on environmental matters.

By leading the switch to renewable energy to power and heat our homes, [...] Vancouver will also be doing its part as a member of a global effort to reduce climate change. We will be setting the standard for what is successful, thriving, prosperous city looks like and setting an example that other cities around the globe can follow. [...] We will show that it is possible for a city to thrive in balance with nature. [...] Vancouver is sharing this hope with cities around the world by becoming a model for green, sustainable living (City of Vancouver, 2010, p.6).

As a global green leader the City joins an exclusive club of pioneering cities around the world including Stockholm, Copenhagen, New York and Melbourne, all of which are competing in both a "friendly and fierce race" to be the greenest. The *Global Green Economy Index* currently ranks Vancouver the third most green city in the world, alongside iconic Scandinavian cities like Stockholm and Copenhagen. Vancouver has a vision for its future wherein the city is sustainable, resilient, green, and built to last. It is betting on its ability to attract the best and brightest based on its stated commitment to clean technology and products, sustainability and going green. At the heart of the City's development strategy is the Vancouver brand (City of Vancouver, 2012, p. 2). In her presentation to *Ecology Ottawa* where she was invited to share Vancouver's greenest city lessons learned, Andrea Reimer, Vancouver Deputy Mayor, reflects on the importance of the city's brand value.

Not surprisingly, the city of Vancouver's brand is very closely associated with clean, green and environmental values. The total value of the brand of the city of Vancouver is US\$31.5 billion. And because this is a very unique identity on planet Earth, being that clean that green and that well associated with the green economy, an oil spill would have a catastrophic impact on the ecology, on the health of our residents, on our economy, and then we would also have a US\$3 billion hit to our brand as a city (Reimer, 2015).

Vancouver's environmental reputation generally, and its stance on climate change and building energy efficiency specifically, have evolved over time. Widespread public opposition to inner-city highways, and the launch of Greenpeace in the 1970's started the eco-conscious ball rolling. Citizen engagement and interest in all things green continue to be strong in Vancouver. In 2010, a launch event for the city's Greenest City Action Plan, originally slated to take place in a 400 seat auditorium, sold out in 24 hours. Despite a \$10 entry fee the meeting was

eventually held in the largest publicly owned venue (with the exception of sports arenas) in the city.

As previously stated, progressive climate and energy policies figure prominently in city politics over the past few decades, and in the lead up to the development of the current Greenest City Action Plan. In 1976 the city hosted the first *United Nations Habitat Forum*, and in 1990 it released its *Clouds of Change Report* which took seriously the World Meteorological Organization's (WMO) warning to the world about the catastrophic effects of a changing climate. When *Clouds of Change* was released four decades years ago, its authors recommended Vancouver City Council adopt a target to reduce carbon dioxide emissions by 20 percent, and reduce GHG emissions through more energy efficient buildings (City of Vancouver, 2007). Between 2004 and 2005, the City first developed a climate action plan aimed at corporate operations (e.g. buildings, landfill operations, vehicle fleet, purchasing) then, via the newly formed *Cool Vancouver Task Force* (made up of stakeholders from across the city), it developed a similar climate action plan for the community as a whole (City of Vancouver, 2004, 2005). The former included a target for reducing corporate GHG emissions by 20 percent in comparison to 1990 levels, and being carbon neutral by 2012 (City of Vancouver, 2004). The latter plan included a target for reducing community-based GHG emissions from transport, buildings, and waste management to 6 percent below 1990 levels by 2012. *EcoDensity*, a vision to create compact, affordable and energy efficient developments appeared in 2006, but failed to get broad buy-in from the public (City of Vancouver, 2006).

The historical convergence of civic leadership in climate policy, a progressive public environmental attitude, a relatively dense and compact built form (59 percent apartments, 41 percent homes), abundant hydro-electric power, and geographic good fortune, help Vancouverites maintain one of the smallest carbon footprint (4.9 tons GHGs/cap/yr) in North America. Despite its impressive carbon profile, the City continues to push ahead aggressively with a raft of 'made-in-Vancouver' climate and energy plans that it hopes will transform the city from being one of the most liveable in the world, to the most green, sustainable, and climate-friendly (Figure 4-1). From a city development path perspective the Greenest City agenda

marks, as Westerhoff notes, a notable stage on the city's evolution from a liveable city to a sustainable city.

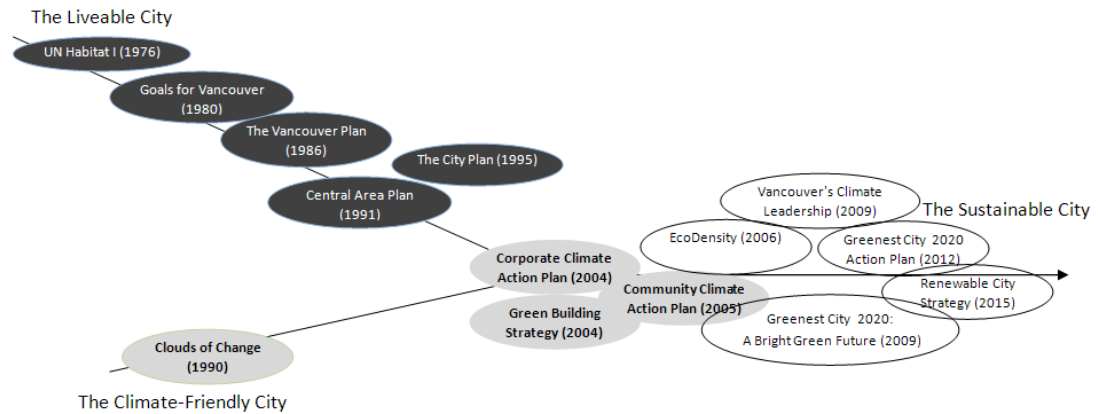


Figure 4-1 Vancouver's evolving eco-visions. Adapted from Westerhoff (2015, p. 67)

Today, the City is implementing concrete climate and energy objectives and targets embedded in the Greenest City 2020 Action Plan and its Renewable City Strategy: 2015-2050 (City of Vancouver, 2015, 2012). The former plan updates the 2005 community GHG reduction target, calling for a 33 percent reduction (below 2007 levels) by 2020, and requiring that all new buildings built post-2020 be carbon neutral in operations. It also includes a target for reducing energy use and greenhouse gas emissions in existing buildings by 20 percent below 2007 levels by 2020 (City of Vancouver, 2012). By achieving the buildings target, the city hopes to meet 20 percent of its overall GHG emissions reduction target; a total of 160,000 tons/GHG/yr (City of Vancouver, 2014). Energy upgrades to existing detached houses are forecast to contribute 23 percent of total reductions, the city's 77,000 detached homes are each expected to reduce their annual emissions by 0.5 tons (ibid.).

Jones (2012) observes however that sometimes cities like Vancouver can materially influence policy design at senior levels of government (OECD, 2009). The provincial government's 2008 climate targets were hailed as a strong and positive step

forward by many observers, yet it is important to note that these followed three years after the City of Vancouver's own GHG reductions target. Moreover, the City's Green Building Strategy, designed to reduce the environmental impacts that buildings have on the environment and climate change, is also recognized by the Province as best practice (City of Vancouver, 2005). Importantly, the city is seen by many other jurisdictions in the Metro Vancouver area as a climate pioneer, even though not all municipalities in the Region share the city's ideological perspective on the environment or climate change. Despite this lack of consensus, the City's aggressive support for initiatives like Passive House standards, solar-ready new homes, and enhanced energy efficiency requirements tend to 'pull' along in their wake, municipalities near and far, and often times, even the Province.

The race to be the greenest or most climate-friendly city in the world is not without its tensions and ambiguities. The *Greenest City Plan* and numerous other environment-related policies, turn on their head, some long-held public attitudes toward the city, its environment, and its historical economic drivers. An example of the City's perspective on the economy and the environment is included in the *Green Economy Capital* section of the Greenest City Action Plan:

Vancouver will be internationally recognized as a Mecca of green enterprise. Vancouver's economy, once dominated by natural resource industries, is fast becoming knowledge-based. The fish canneries and lumber mills are giving over to globally renowned clean tech, high tech, and green enterprises. (City of Vancouver, 2012, p. 17)

The City of Vancouver posted on their Instagram account on 26 May:

'cityofvancouver': An oil spill could impact our brand value by up to \$3 billion. See the full story: Vancouver.ca/vancouverbrand (cityofvancouver/instagram.com)

The posting garnered several comments including one that expressed frustration at the article's irony and provides an example of the tension between the city being 'squeaky green' and livable:

Vancouver runs on fossil fuels and its residents seem to have no reservations about its use to support their extravagant life style-massive homes, yachts and luxury cars-and yet they want all the benefits without the inherent risks, they

would rather leave that to the rest of the country. When Vancouver can go fossil fuel free, then they can take the so called moral high ground (thecranebird, 15 May 2016).

The linked aspirations of going green and transitioning to renewable energy are framed by the City, not as simple environmental goals, but rather as compatible strategies in the drive for a sustainable, resilient and economically dynamic city. Moreover, they are positioned as parts of a comprehensive economic strategy and a very real competition between Vancouver and places like London, Copenhagen, Sydney, New York, Seattle, San Francisco, Toronto and Paris. Being the greenest, most climate-friendly city is heavily implicated in the city's long-term ability to attract international investment dollars, highly trained workers, and talented entrepreneurs. The City is firm in its stance that climate action is not only good for the planet, but good for jobs, and hence good for residents. This is in contrast to the earlier Clouds of Change report that framed climate change as a formidable challenge requiring humans change their way of living, or risk a catastrophe on par with nuclear war (City of Vancouver, 1990). From a policy perspective, such a nuanced approach is tantamount to threading the eye of a needle; a little too much one way or the other, and the target will be missed. It is also not clear how, or if the public at large understands this ideological balancing act.

4.3 Vancouver's housing stock

According to the City of Vancouver, its 77,000 residential dwellings (including detached houses and duplexes) emit 31 percent of all building GHGs, use 64 percent of all energy consumed in the city, and natural gas (a powerful GHG with a warming potential 20 times that of CO₂) is the predominant energy source used for space heating (City of Vancouver, 2015a, 2015a). Roughly 40,000 of the city's 77,000 residential dwellings were built prior to 1960, and thus have numerous cost effective opportunities (e.g. weather stripping sealing, wall and attic insulation, furnace/boiler/hot water heater replacements, energy efficient windows) to reduce energy consumption and GHG emissions. Reducing the GHG emissions from the existing housing stock is one of the City of Vancouver's highest priorities (City of Vancouver, 2015a).

A staff administrative report to Council in June 2014 states,

Given that approximately 55% of GHG emissions come from buildings and that the number of new buildings constructed each year is relatively small relative to the stock of existing buildings, decreasing emissions from existing buildings will be essential in meeting this overall GHG reduction target (City of Vancouver, 2014a).

GHGs from buildings in Vancouver break-down as shown in Figure 4-2, and corresponding energy consumption percentages are given in Figure 4-3.

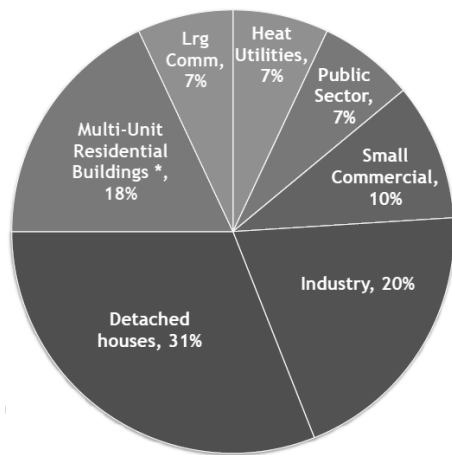


Figure 4-2 Building-related GHGs by building sector (2014)
Source: Adapted from City of Vancouver (City of Vancouver, 2014a)

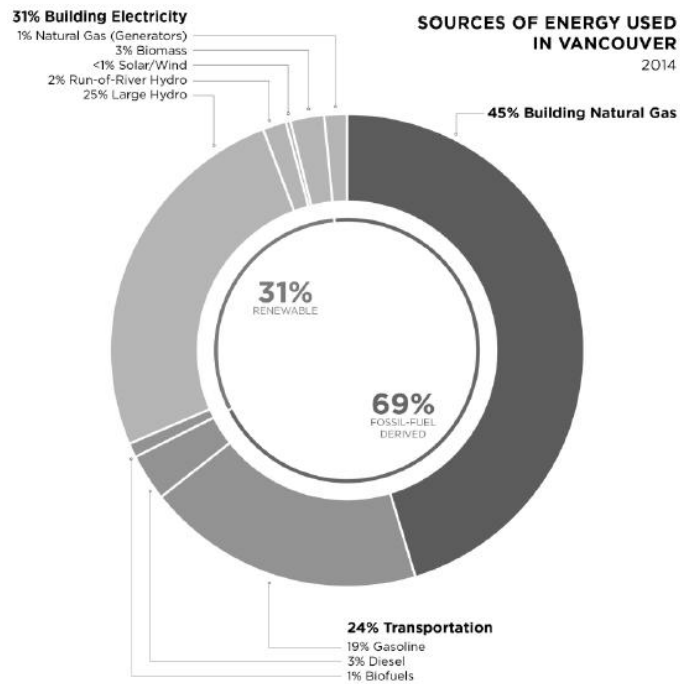


Figure 4-3 Sources of energy used in Vancouver (2014) (directly recorded and modelled)

Source: Adapted from City of Vancouver (2015c)

4.4 City policy tools

Robinson and Gore (2005) point out that cities like Vancouver have direct and indirect control of 52 percent of local-scale emissions as a result of their jurisdictional authority over land use, planning and development, building permits, and transport-related infrastructure, and hence are critically placed to act. The City of Vancouver is engaging with all three of these functional domains through the Greenest City Action Plan.

The appropriateness of local government action on climate and energy efficiency is reflected by the OECD who state,

experimentation and learning at the local level can provide essential experience and, when successful, lead to bottom-up diffusion of approaches between cities and regions as well as to influence national and even international levels of actions (OECD, 2009, p. 4)

The OECD has described cities as strategic sites for concrete actions in support of climate mitigation and the transition to a low-carbon economy. But given

Vancouver's special capacities with respect to by-law making, conferred by the Vancouver Charter, and its progressive green pedigree, Vancouver might be considered 'ground zero' for climate innovations. Under the Vancouver Charter, the City can guide urban design and development through zoning policies and land use regulations. The City also enjoys direct power to regulate building standards and protect building occupants (City of Vancouver, 2015b).

The City argues that wide scale home energy retrofits are impeded by a host of barriers including:

- Low uptake of financial incentives by homeowners;
- Competing priorities for their time and money;
- The public's lack of awareness of potential energy savings and competence to realize same; and,
- Poor understanding of Vancouver's specific retrofit market by BC Hydro and FortisBC who run the province-wide home energy rebate offer (HERO) programme (City of Vancouver, 2014).

Another significant impediment the City faces in their efforts to reduce GHG emissions from buildings is a lack of data on building energy use. While BC Hydro (electricity) and FortisBC (natural gas) collect data on metered energy use, they cannot associate it directly with detailed building characteristics (City of Vancouver, 2015c). Such a framing of barriers is consistent with those found in traditional rational choice, governance, and environmental behaviour literatures. And in response to these barriers, there are consequently myriad policies, programs, and incentives emanating from the City of Vancouver that must be navigated by homeowners and intermediaries working in the home energy retrofit space. Some are nestled within the Vancouver Building By-Law (VBBL), while others are integrated within permit approval processes, or compatible incentive programs being promoted by banks, utilities or senior levels of government. Above all is the *City's Energy Retrofit Strategy for Existing Buildings* (ERSEB) (City of Vancouver, 2014) that guides City efforts to reduce GHG emissions from the existing housing stock by 2020. The strategy aims to prioritize buildings based on expected impact,

focus on the least efficient dwellings, and employ the Vancouver Building Bylaw to achieve the its goals.

The Vancouver Building By-Law (VBBL) is central to the City's efforts to improve the energy efficiency of the housing stock and to achieve the target referred to in the staff report (i.e. 33 percent below 2007 levels by 2020). Whereas all other towns and cities in the province must not exceed the minimum energy efficiency levels set out in the BC Building Code (BCBC), Vancouver's Building By-Law has been amended, to include more stringent requirements for energy efficiency than those stipulated in the BCBC (City of Vancouver, 2014). This unique ability to move above and beyond provincial building requirements, originates from the fact that Vancouver is incorporated (by the Province) via the Vancouver Charter. With exception of the City of Vancouver, all local governments in British Columbia (BC) are delegated powers to guide community growth and development and provide services via the Local Government Act. Vancouver enjoys wide renown, and often admiration, for the special powers it is afforded by the Vancouver Charter. This special provincial statute, enacted in 1953, addresses only the City of Vancouver. Thanks to the Charter, as it is known, the City can effect legislation that typically lies beyond the purview of local governments, including building and energy efficiency by-laws.

Existing residential dwellings need only comply with the version of the code in effect at the time of their construction (BC Government, 2015b). Thus, amendments to energy efficiency requirements have historically only impacted new house construction, leaving existing houses unimproved. In 2014, Vancouver City Council officially amended the VBBL so that it now explicitly addresses the need for homeowners to retrofit existing homes as a condition of issuance of renovation permits. The amended VBBL includes three levels of minimum building code requirements (costed in Table 4-2) for existing buildings tied to renovation project values.

1. >\$CDN 5,000: Homeowners must have obtained an EnerGuide report within the last four years. The goal of the report, which by definition

covers the entire house, is to encourage consideration of deeper, whole-house energy efficiency upgrades during proposed renovation activities.

2. > \$CDN 25,000: Draught-proofing and weatherization (up to \$CDN 700) required if EnerGuide report shows high air leakage (i.e. > 5 air changes per hour).
3. > \$CDN 50,000: If current attic insulation levels are less than R-12, must be increased to R28. If current attic insulation levels are \geq R12, must be increased to R40 (City of Vancouver, 2014)

Table 4-2 2014 VBBL requirements for single-detached and duplex homes

Value of Permit	Action	Typical Cost	HERO Incentive	Typical Annual Savings
> \$5,000	EnerGuide assessment	\$300	\$0	\$0
>\$25,000	Assessment & weather sealing	\$300 + \$800 \$1,100	\$500	\$300
> \$50,000	Assessment, weather sealing, & attic insulation	\$300 + \$800 + \$1400 \$2,500	\$500 + \$600 \$1,100	\$600

The City expects that buildings will undergo some form of retrofit before 2050, and that retrofits are likely to occur for one of two reasons:

1. a house system or component has reached the end of its useful life (e.g. lighting, heating system, roof, etc.); or
2. the owner decides the dwelling needs to be updated to make it easier to sell or rent out, or to reduce energy bills (City of Vancouver, 2015b).

The frequency at which lighting, appliances and similar components are replaced is significantly faster than that for major components like walls, roofs or windows. Global market forces are driving efficiency improvements for those components replaced more frequently, but for major components that are replaced less frequently, the natural dwelling renewal cycle can be used to accelerate energy efficiency upgrades.

In the second case, where upgrading the energy efficiency of a home is desirable rather than essential, it is more difficult to motivate the owner to undertake retrofits. There are three policy challenges emanating from beyond the City's jurisdiction that impair uptake of retrofits. First, the ending of the federal government's EcoEnergy home retrofit incentives in 2012. Second, the termination of the provincial government's LiveSmart BC incentives in 2014. And third, the short time horizon and relatively low financial incentives provided by the Home Energy Rebate Offer (HERO); an incentive programme co-sponsored by BC Hydro and FortisBC. For three years, ending in July of 2017, the City offered its residents, in collaboration with BC Hydro and FortisBC, their own *Home Renovation Rebate Program* (HRRP). The temporary nature of energy efficiency rebates is flagged as a significant barrier by Globe Advisors (Globe Advisors, 2013) who claim that financial institutions are reluctant to partner with government and utility incentive programs as the latter are often too short-lived and unreliable over the long-term.

In addition to changes to the VBBL, the City is implementing numerous additional carrot, stick and capacity-building actions to help them reach their GHG emission reduction targets (Vancouver, 2015). Carrots include:

- Development and promotion of financing tools for building retrofits, specifically partnering with utilities (BC Hydro Electric Utility and FortisBC Gas) to promote the Home Energy Rebate Offer (HERO);
- Reducing permit fees in return for energy efficiency and greenhouse gas reductions in new and existing buildings;
- Working with stakeholders to help make financing available for energy efficiency upgrades;
- Developing a revenue neutral system where projects approaching net zero energy receive lower permit fees financed by higher permit fees charged to less energy efficient projects;
- Building Retrofit Innovation Fund to support the Building Energy Retrofit Strategy which targets most energy inefficient buildings;
- Height relaxation for green roof access, and solar or wind power installations; and,

- Wall thickness exemptions for increased insulation.

Sticks include:

- Introducing regulations that improve energy performance, reduce GHGs, and mitigate financial implications for building owners and developers
- Zero Emissions Building Plan: provides a gradual approach, reducing emissions from newly permitted buildings by 60 percent by 2020 and 90 percent by 2025, and 100 percent by 2030.

Capacity-building and engagement activities include:

- Working with partners to build capacity required for re-imagining Vancouver's building stock;
- Co-developing new tools such as social marketing, education, building labeling and benchmarking to enable occupants to make informed decisions about buildings.
- Voluntary programme for households interested in pin-pointing their energy losses via residential infra-red thermal imaging photos that show where a home is losing heat.

City incentives, regulations and by-laws constitute an impressive suite of policy levers, yet most of those interviewed are unaware of the majority of these. One builder sums up the situation.

Vancouver, it's introduced new code requirements, and to encourage energy efficiency they have adopted energy efficiency requirements that correspond with the most extreme weather conditions in the province of British Columbia. And from my discussions with folks at the Greater Vancouver Homebuilders Association I know of builders that just won't work in the city of Vancouver anymore because of all the regulations [...], they can avoid the difficulties of building to higher standards in Vancouver by simply working outside the jurisdiction (Builder F, 30 October 2015).

4.5 Where aspirations grow

Improving the energy efficiency of a dwelling brings a homeowner into direct contact with City policies, laws and regulations, but at the same time, they are also feeling indirect forces from a variety of organizations and institutions operating at

scales ranging from the global to the local. For the most part, dwelling-related climate and energy policy interests are conveyed to the homeowner via the local building code and utility-led conservation programmes, both of which are normally interpreted by the men and women who enter the home to do the actual physical work necessary to improve energy performance. However, these climate and energy-related plans, regulations, technologies, materials, targets and incentives must navigate in and amongst numerous other (more and less visible) building-related policies, laws, plans, and programs that reinforce existing normative rules and values of the established construction socio-technical system. The navigation process offers many opportunities for collisions and contestations that contribute to a blurring of what is meant by energy efficiency and climate action in the home. Figure 4-4 presents the more than 100 public and private sector institutions, multilateral accords, and policy documents that co-construct the values, principles and norms of Vancouver's retrofit socio-technical system.

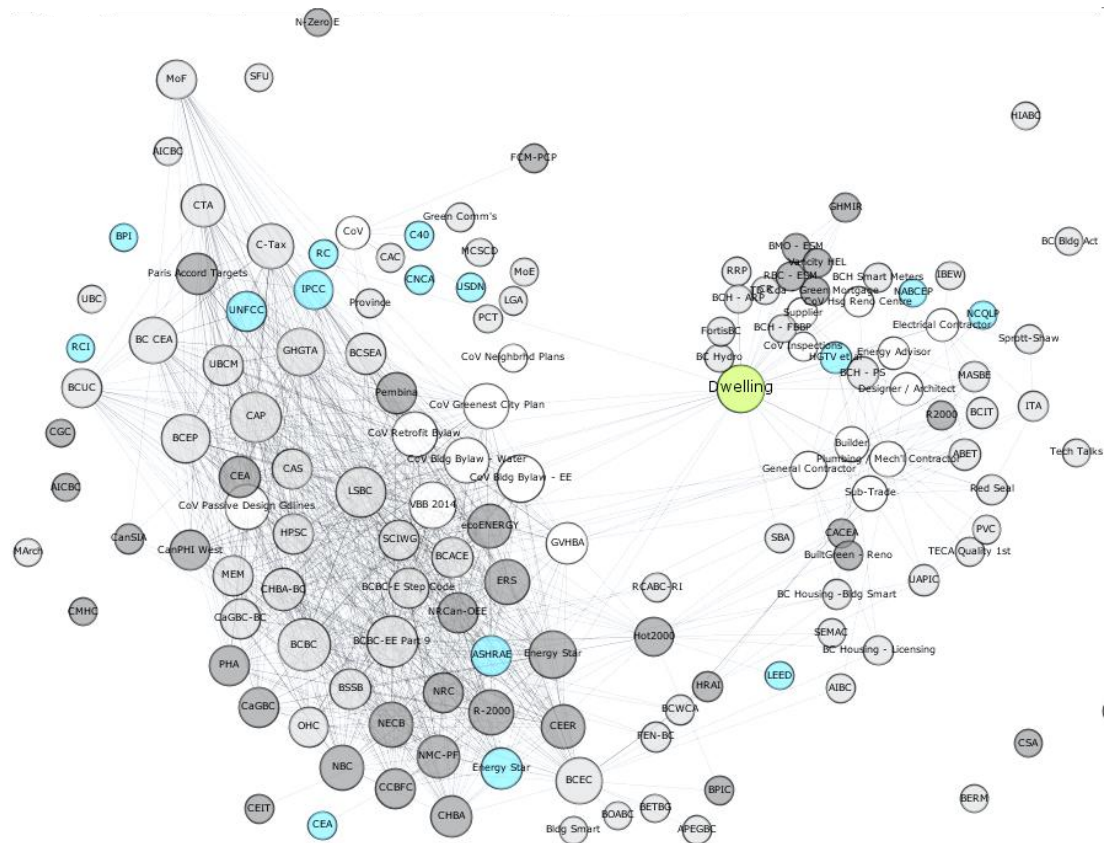


Figure 4-4 Network relations between policy actants (i.e. international (blue), national (dk grey), provincial (light grey) and local (white)) that influence retrofit policy development and implementation in Vancouver.

The network map shown in Figure 4-5 reveals two distinct groups of actants. One is characterized by a high degree of connectivity, while the other exhibits much less. Larger diameters represent a node's higher 'degree', or the number of relations (edges) it has with other actants (nodes) in the system. What is evident is the spatially diffuse nature of the actants that contribute (directly or indirectly) to retrofit policy in Vancouver. Both communities of actants include representation from groups at all three levels. Moreover, within the group on the left which has a high degree of internal connections, there is a visible hierarchy of 'connectedness' among the nodes, as represented by what appears to be three distinct node diameters.

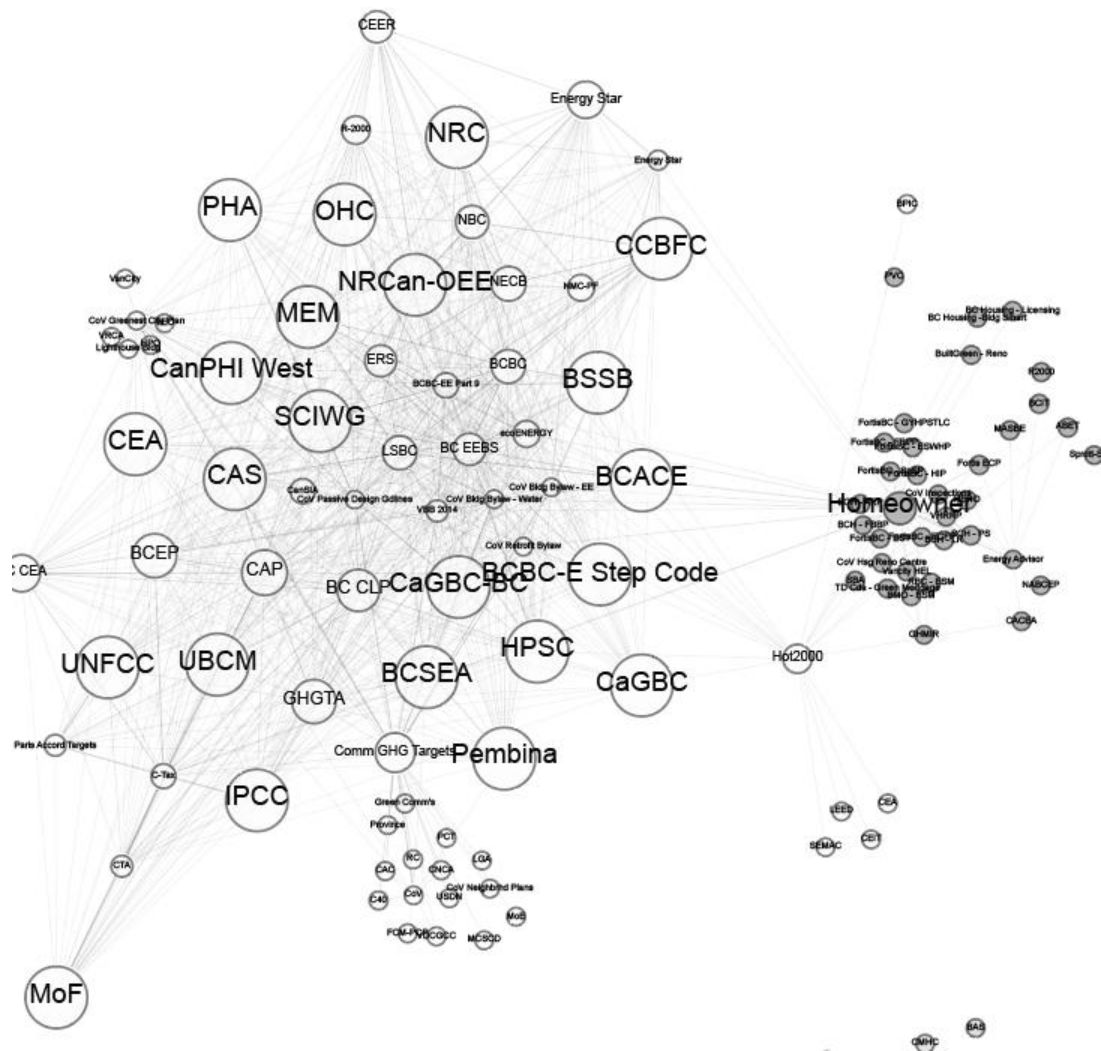


Figure 4-5 Retrofit policy actant 'communities' (i.e. light vs dark nodes) as measured by network modularity. Node diameter corresponds directly to each node's hub coefficient, or relative influence over neighbouring actor groups.

Need to change 'homeowner' to 'homeowners'

The community on the left (white nodes) is dominated by strong hubs (large diameter) of moderate closeness, while the community on the right (darker nodes) is smaller and comprised of actants that are far less dynamic in terms of their connectedness. They are however, very closely connected to the homeowner node (i.e. larger diameter node in the centre of the cluster). Figures 4-4 and 4-5 show that local retrofit policy is determined via the intersecting influences of geographically dispersed policy actants constituting two virtual communities; one made up of low-influence actants oriented more toward the homeowner, and the

other comprising policy actors that are more connected and send frequent signals to and sub-set of policy actants. The high number of relatively large diameter nodes, displaying moderate connectivity, suggests the system is dominated by several, moderately collaborative, vocal actors.

Rather than focus solely on the more 'home-economicus' barriers discussed earlier, this thesis proposes looking beyond these traditional culprits, toward the complex network of institutions and less formal actors spread across the country (and internationally) that may also impair the efficacy of retrofit policy. Each entity has its own set of aspirations, interests and spheres of influence, that when added to the policy process, can challenge the already vulnerable logic and coherence of techno- and finance-centric retrofit strategies.

4.5.1 Voices heard on high

The City of Vancouver is an example of a sub-national body leading on climate and energy issues. It continues to push for more leadership and help from senior levels of government, in particular, they urge more explicit federal policies and programmes to support energy efficiency improvements. Whether solicited or not, City retrofit policy is however influenced by numerous other climate and energy voices from above and beyond their borders.

International

Although it is not directly beholden to the declarations and accords managed by the United Nations Framework Convention on Climate Change (UNFCCC), the City of Vancouver is nonetheless impacted by accords like the Kyoto Protocol and the Paris Agreement, plus the regular reports, known as assessment or synthesis reports, released by the United Nation's Intergovernmental Panel on Climate Change (IPCC). These reports, released five times over the past 27 years, provide member countries, and ultimately sub-national bodies too, with objective climate science and related social and economic impacts (IPCC, 2017). The IPCC's data and forecasts paint a broad picture of climate change progress and impacts, and the ideas contained in these forecasts influence public policy makers at all levels of government, including councillors and planners at the City of Vancouver (City of

Vancouver, 2016, 2010). In addition to public bodies, IPCC reports also find audiences in environmental NGOs, consultancies and research organizations. Beyond their less accessible scientific reports, the United Nations' regular Conference of the Parties (COP) represent another, more political, avenue through which supra-national climate goals are communicated to national, provincial and local levels of government in Canada. The 21st Conference of the Parties (COP21), held in Paris in 2015, resulted in a global agreement to limit global warming by century's end to less than 2.0 degrees Celsius - the generally accepted limit if irreparable ecosystem damage is to be avoided. The City of Vancouver attended COP21 as a member of the official City Delegation. Leading up to COP21, national governments were asked to confirm their respective emission reduction commitments. To date, 137 out of 197 countries have stated their Intended Nationally Determined Contributions (INDC) which make explicit their GHG emission reduction commitments (NDC Registry). Canada's INDC establishes a national GHG reduction target of 30 percent below 2005 levels by 2030, a target that implicates all sectors of the economy, all parts of the country and all levels of government (Centre for Climate and Energy Solutions, 2017). The International Energy Agency (IEA) also exerts influence on the City's retrofit policies. The IEA actively promotes and publishes reports on energy efficiency in buildings, but mitigating climate change appears not to be the primary motivation for doing so.

Retrofitting existing housing and raising the standards of new housing can help occupants adapt to weather extremes as well as mitigate the effects of climate change by reducing energy consumption (IEA, 2014, p. 105)

IPCC publications explicitly link energy and climate change, whereas the IEA assumes a more neutral stance on the connections between the two. The different toned signals coming from these influential organizations fosters ambiguity where climate-energy relations are concerned.

National

Climate matters do not align well with Canada's constitutional structure given how it divides powers - over domains like resources, healthcare, education, and immigration - between the two senior levels of government (federal and provincial).

The Federal Government's most relevant policies related to energy efficiency are limited to infrastructure funding and planning, which helps explain why it tends to recuse itself from the urban housing agenda. Resource management and housing are provincial matters, and where environmental pollution is concerned, the federal government has sole jurisdiction only in those cases where international borders are concerned. Signing on to global environmental accords like the Kyoto Protocol and the UNFCCC falls within the strict purview of the national government of Canada, who in turn must negotiate with the ten provinces and three territories to implement actions in support of international agreements.

Between 2010 and 2015, the Canadian government took a decidedly hands-off approach to climate policy. Instead, it assumed a more innovation and market-based stance where energy efficiency was concerned. A change in government following the 2015 federal election allowed for Ottawa to re-engage itself with respect to energy and climate-related policies, but these generally ignore housing and tend to focus instead on transportation, oil and gas production and distribution, and generation of electricity (Government of Canada, 2016b).

After temporarily declining during the 2008 recession, Canada's emissions, after accounting for the effects of all federal and provincial emission reduction policies, are forecast to grow from a total of 702 million metric tonnes (Mt) in 2011 to 720 Mt in 2020. Canada's national emission target is 30 percent below the 2005 emission level by 2030, an ratcheting up from its earlier, less ambitious target of 17 percent below 2005 levels by 2020.

The Government of Canada continues to support pipeline expansion to facilitate the realization of oil sands potential. The GHG loadings associated with the continued extraction of oil sands threatens all of Canada's emission reduction targets and thus presents an uncomfortable, and a largely irreconcilable tension in national climate politics.

Where house construction and energy performance are concerned, the federal government contributes in several indirect ways. The *National Research Council* (NRC), in collaboration with *Natural Resources Canada* (NRCan) and the *Canadian*

Commission on Building and Fire Codes (CCBFC), develops National Model Codes for buildings that define minimum standards for fire, safety and energy. Canadian provinces are in turn free to adopt or adapt these codes for use within their respective jurisdictional boundaries.

NRCan's Office of Energy Efficiency (OEE) acts as a key pivot point between the federal government and the provinces and cities in relation to home energy performance. Principal among NRCan's contributions to the energy efficiency of the Canadian residential housing stock are the EnerGuide for Homes Rating System, the HOT2000 energy model that underpins it, and the certification of residential Energy Advisors. The federal government's level of engagement with home energy performance is reflected in the relative lack of staying power associated with a number of well subscribed incentive programs. The ecoENERGY Retrofit Program was launched in 2007 then eliminated in 2012, and a 15 percent Home Renovation Tax Credit (HRTC) (\$1,350 max value), applicable to certain home renovation expenditures and energy efficient goods, was offered for only one year between 2009 and 2010 (Government of Canada, 2009). NRCan's OEE, itself a federal office, is however a stand-out in terms of its commitment and influence over energy efficiency initiatives across the country. In partnership with organizations like BC Hydro, FortisBC Gas and several BC-based higher education bodies, it supports industry training and research and development in aid of improved energy performance of the built environment.

Provincial

Under Canada's Constitution, local governments "*exist at the pleasure of provincial governments*" (Ibbitson, 2011, p. 118), thus provincial policies and stances create a powerful operating context for cities. In line with its climate leadership stance, the Province of British Columbia became the first North American state or province to enact a carbon tax in 2008, thanks in large part to the climate leadership of the provincial Premier Gordon Campbell and his Finance Minister. The climate-friendly tax contributed to BC's reputation as one of North America's most climate-progressive jurisdictions. Launched in 2008 at 5\$/tCO_{2e}, the tax increased by \$5 per year until 2012. It now is equivalent to 30\$/tCO_{2e} and is levied on roughly 70

percent of fossil fuel emission sources in the province including the most common fuels (e.g. gasoline, diesel, propane and natural gas). As a revenue neutral tax, it is offset by reductions in personal income and corporation tax rates.

To encourage greener, compact and energy efficient communities, the provincial government established the Climate Action Charter in 2011. By agreeing to the Charter and going carbon neutral at the corporate level, local governments in BC, including the City of Vancouver, are eligible to receive up to 100 percent of carbon taxes paid.

Between 2007 and 2012, the Province enacted a raft of bills related to the nexus between energy and climate (Globe Advisors, 2013). Bill 44 (2007), the Greenhouse Gas Reductions Target Act, establishes in law, a province-wide GHG reduction target of at least 33 percent below 2007 levels by 2020, and a long-term target of an 80 percent reduction below 2007 levels by 2050 (BC Ministry of Justice, 2017). Bill 17 (2010), the Clean Energy Act, sets a legislated target of meeting 66 percent of new electricity demand through conservation by 2020 (BC Ministry of Justice, 2017). As a crown corporation, BC Hydro is materially implicated in achieving this target, and its Power Smart Program is its primary tool for doing so. Bill 32 (2012), the Energy and Water Efficiency Act, was designed to help reduce consumers' energy bills (BC Ministry of Justice, 2017).

The Province's *Energy Efficient Buildings Strategy* (EESB) helps achieve the government's goals of electricity self-sufficiency by 2016 and a 33 percent GHG reduction in emissions by 2020. The self-sufficiency program includes a number of initiatives relevant to the energy performance of BC's housing stock, including provisions in support of greening the BC Building Code, installation of residential smart meters for improved monitoring and measurement of energy consumption, and development of the *BC LiveSmart Energy Efficiency Incentive Program* (LSIP) that during its active years, provided a one-stop-shop for federal, provincial, and utility incentives (BC Government, 2007).

Minimum standards for building construction and alterations are enforced by the provincial government via the BC Building Code. Prior to 2008, the Code applied to

matters related to safety, health, accessibility, fire, structural integrity, and sewer and water risk management. Residential dwellings are required to conform to the edition of the BC Building Code in force when they were constructed, however existing homes need not be brought up to current standards unless they undergo an alteration or renovation, or mechanical/electrical systems are replaced. In concert with the suite of climate-related policies being launched around the same time, the BCBC was updated in 2008 to include minimum standards for energy and water efficiency in buildings. The current 2012 BC Building Code is sensitive to the province's unique climatic zones, yet modeled on the 2010 version of the model National Building and National Plumbing Codes of Canada developed by the National Research Council (NRC), National Resources Canada (NRCan), and the Canadian Commission on Building and Fire Codes. As a provincial regulation, the Code applies to all buildings in the province, except for some federal assets, and the city of Vancouver where the Vancouver Building By Law (VBBL) reigns supreme.

The City of Vancouver's 2014 building code is an example of energy efficiency innovation. Depending on the forecast renovation value, these measures include: performing an energy audit; upgrading the energy performance of some dwelling elements (e.g. wall or attic insulation, air tightness); or ensuring replacement boilers have annual fuel utilization efficiency ratings of ≥ 90 (City of Vancouver, 2014b). In 2017, the Province of British Columbia followed the lead of the City of Vancouver when it launched its more aggressive Energy Step Code as regulation. The regulation outlines a successive ramping up of energy efficiency requirements up to 2030 (BC Government, 2017). Although municipalities in British Columbia are not free to require homeowners exceed the minimum standards outlined in the BCBC, the new Step Code can be adopted on an accelerated basis by local governments, thereby giving them a legal means of accelerating improvements to the energy efficiency of their local housing stock.

With regard to residential buildings, the 2012 BCBC challenges traditional ideas about building envelope form and function, insulation levels, and interior space conditioning, by emphasizing the importance of reducing buildings' energy and water consumption. Relevant code changes include requirements to:

- make new homes solar hot water ready (where applicable);
- use only high-efficiency (low-flow) toilets;
- support increased use of non-potable water for toilet flushing and sub-surface irrigation;
- install mechanical ventilation systems and heat recover ventilators;
- improve air barrier and air tightness performance of envelope penetrations (e.g. exterior windows, doors and skylights); and,
- install hydronic heating systems such as solar, geo-thermal, and heat pumps.

As policies go, the BCBC is largely a prescriptive document. That is, the Code tends to specify, at least implicitly, envelope composition, materials, and technologies, by its very wording. This is quite unlike performance-based building regulatory models, more common in Europe, that simply require a completed building to perform at a certain level with respect to issues of safety, structural integrity and energy efficiency (i.e. prescriptive) (Globe Advisors, 2013). The approach implied by the BCBC favours routine and rule following among those in the construction and renovation sectors, and discourages innovation and bespoke solutions that can often result in above 'minimum efficiency' buildings. The Code is available for sale, either in print or digital format, but my research suggests many builders and trades people manage easily without owning their own copy. Several of those builders and trades people I interviewed confirmed they either did not have a copy of the current Code and relied instead on peers and verbal updates by building inspectors, or they simply did the best they could using old, outdated editions. "*I have a friend who is an architect and structural engineer. This is where I am getting [the code] from*" (Trade Person D, 24 June 2015). Again, the prescriptive nature of the Code and the relative absence of the written building code on job sites facilitates a 'recipe' approach to home construction and renovations.

The LiveSmart Program ran between 2008 and 2013 as a supplementary program to the federal ecoENERGY Homes Retrofit Program (available at the time), and empowered residents to undertake home energy audits and retrofits. The Province partnered with BC Hydro (electricity) and FortisBC (gas and electricity) to jointly

implement the Program. The Province's investment of \$CDN 110 million in LiveSmart, coupled with \$CDN 67 million in federal funds, and a further \$CDN 11 million in investment from the province's two utilities between 2011 and 2013, helped the Program reach almost 95,000 homeowners (8 percent of the 1.2 million eligible homes), save approximately 4,500 terra joules of energy, and reduce GHG emissions by 2.8 tons per household per year (BC Government, 2015a). To receive LiveSmart incentives, homeowners were required to have an NRCan Certified Energy Advisor (CEA) conduct pre- and post-retrofit energy audits. As an example of multi-level government cooperation, NRCan agreed to share the energy modeling data that resulted from these audits, with the Province, thereby helping the latter more effectively assess LiveSmart.

In 2014, the Province terminated the LiveSmart Program and withdrew its funding for residential energy efficiency initiatives. It then deputized, through its influence over the BC Utilities Commission (BCUC), BC Hydro and FortisBC as the principal delivery bodies for energy efficiency incentive programs in the province. The Home Energy Rebate Offer (HERO) emerged in the wake of this decision. HERO, co-sponsored by the province's two energy utilities, provides financial and technical support for BC homeowners interested in improving the energy efficiency of their homes. While their position within the energy supply and demand system makes them likely candidates for delivering HERO to homeowners, there are some awkward political economic realities that impair their efficacy in the home energy retrofit space. For instance, there is a general lack of trust for utilities that one hand, exist to sell a product (i.e. energy), yet on the other, claim they want consumers to purchase less of what they sell. Also, from a purely climate mitigation perspective, increased consumption of relatively low-carbon hydro-electricity should be encouraged, and much less high-carbon content natural gas should be consumed. FortisBC Gas has private shareholders, while BC Hydro's single shareholder is the Provincial government, so reducing sales of the former and increasing revenues of the latter create poor optics. Moreover, Vancouver argues that the two utilities are "*not as familiar with Vancouver specific market needs and opportunities as the City is*" and hence unlikely to manage the HERO programme

effectively within city boundaries (City of Vancouver, 2014). BC Hydro and FortisBC are both regulated by the BCUC, which in turn is controlled, to a large extent, by the Provincial Government who appoint most of the Commission's board members. In addition to regulating the provinces two natural monopolies (BC Hydro electricity and FortisBC gas), BCUC is mandated by the Province to maintain low and affordable electricity rates for BC residents and industry. As a consequence, BC enjoys the third lowest electricity prices in North America (Figure 4-6).

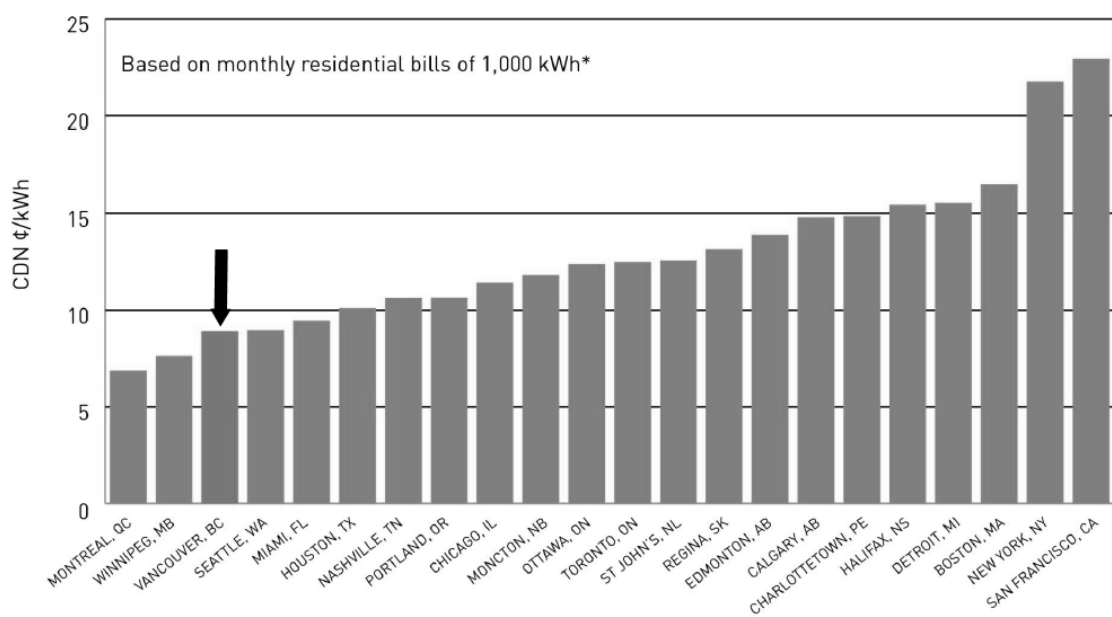


Figure 4-6 North American residential electricity rates

Source: Presentation by (Bill Bennett, Minister of Energy and Mines and Minister Responsible for Core Review, 2013)

While efforts are being made by political leaders to encourage home energy retrofits, ideological schisms foster confusion among homeowners and intermediaries working in the retrofit space. On one hand, BC's mountainous terrain has given rise to a relatively low-carbon economy, thanks to abundant hydro-electricity, but at the same time, the same mountains have also given rise to a strong environmental movement in the province. This paradox is seen in BC's relationship with coal; a resource it chooses to export rather than use domestically. BC produces 89 percent of Canada's coal exports, yet the GHG emissions associated

with this fossil fuel are attributed to the provinces that burn it, not to BC, the province that extracts it (Business Council of British Columbia, 2013). The same sense of resource abundance engenders a collective view that cheap electricity is an inalienable right, and government policy, BCUC rulings and BC Hydro practices buttress this perspective. Integrated electricity distribution networks permit energy trading (via BC Hydro's wholly-owned subsidiary *Powerex*) across provincial and US borders. Peculiarities in power generation strategies means that *Powerex* often purchases electricity from neighbouring jurisdictions produced from the burning of coal. Consequently, BC's 'famous' clean and renewable electricity is not always 100 percent so. BC hydro is required to shed a light on the impacts of these trades by regularly updating the carbon-intensity of the electricity it provides its customers. The technical nature of this data means it is not widely discussed, except in some more environmentally aware circles. The uncertainty on this issue is demonstrated by the explanation provided by a representative of a building association.

In BC most of the homes are powered and heated with lower carbon-emitting and GHG-producing sources than would be most jurisdictions in Canada. For example, we don't burn coal to generate power like Alberta and Saskatchewan. Most of our power is generated by hydropower. You know they have [...] BC Hydro has a stand-by natural gas generator. I think there's a small amount of energy that is sometimes purchased at peak times from Alberta, so there's some amount that is coal-generated. But for the most part, I think [...] and you know and most of the houses are heated either electrically or via natural gas which is you know, the best. It's probably better than coal-generated electricity or oil. So, [...] I think British Columbia and probably much of Vancouver in general is probably in a better position than most other jurisdictions in terms of the amount of GHG generated by housing. (Trade Association A, 21 April 2015)

This uneven level of knowledge that results from some knowing this 'dirty' little secret, and some not, is a source of tension. In addition, when BC Hydro is mandated by the Province to invest in demand-side management and conservation programs, and simultaneously encourages consumption through low electricity rates, it undermines the utility's credibility and generates confusion among homeowners and home retrofit actors. The complex political economy of BC's energy generation and consumption are also evidenced by the Province's transfer of its responsibility for LiveSmart to BC Hydro and FortisBC. Distancing itself from

the climate and energy efficiency nexus, gives the Provincial Government greater freedom to pursue its principal economic goals which involve expanding the oil and gas sector in the province. This simultaneous support for a low-carbon economy, including energy efficient housing, and support for an expanded fossil fuel industry, sends discordant signals to all audiences and impedes development of a unambiguous understanding of home energy efficiency and transitioning to a low-carbon economy in the province.

4.5.2 Non-governmental actors

Operating within Vancouver's home energy retrofit system of provision are numerous non-governmental organizations, policy think tanks, trade associations and consultancies. While some of these entities are located in Vancouver, many are located in other parts of the province, the country, or overseas. The roles played by these actors include advocacy, research, policy design, awareness raising and information sharing. But it needs to be noted that these actors do not always share the same interests or views held by those promoting home energy efficiency improvements and climate action. The following claim by a member of a trade association reflecting their view that energy conservation is largely irrelevant in Metro Vancouver, reflects this misalignment of beliefs.

But you have this thing about the Lower Mainland of course is that we don't spend nearly as much energy simply because of the climate [...] of the weather to heat our homes. So, you know all you got to do is you got to look at the gradient of degree days [...] heating degree days in Canada and you will just see that you know, we don't have to spend as much money you know and much on energy in Lower Mainland. So, to that extent you know there's, if you look at the percentage of total GHGs emitted by housing in Metro Vancouver compared to other jurisdictions, it's probably quite a bit lower (Trade Association A, 21 April 2015).

In general, this class of actors does not have direct contact with homeowners, yet they still play a key role in helping to construct a consensus where the motivations, meanings and values underpinning home energy retrofits are concerned. Key non-governmental actors operating in Vancouver were identified through interviews with intermediaries and a review of government and industry reports concerned with improving the energy performance of the building stock.

With the exception of Vancity Savings Credit Union, that offers home energy efficiency loans, and the Greater Vancouver Home Builders Association, all the other non-governmental actors operate in and outside of Vancouver's boundaries. The preponderance of actors with operations beyond the local illustrates the degree to which local understandings and values regarding energy retrofits are influenced by actors with far larger geographic spheres of influence and concerns. Powerful examples include the popular *Home & Garden* television channel based in Knoxville Tennessee, the well-known C40 Cities Climate Leadership Group based in London, and the Canadian Institute for Energy training located in Toronto.

Dente (2014) provides a policy framework that categorizes NGO actors according to their behaviours and goals in the policy design and delivery process helps to show how these actors can influence energy retrofit policy in Vancouver. Roughly 15 percent of all NGO intermediaries can be referred to as *general interest*, that is they based their claim of intervention in the policy making process on the idea that they "*represent subjects and/or interests that cannot defend themselves, or that are not structurally able to act directly*" (Dente, 2014, p. 49). These include organizations that are interested in promoting climate action (e.g. C40 Cities), renewable energy (e.g. Renewable Cities), or urban sustainability (e.g. Pembina Institute), and thus often have a vicarious, rather than a single and direct interest in retrofit policy development within the city of Vancouver. These organizations typically implicate home energy performance improvements in broader societal projects like urban sustainability and the low-carbon transition in order to establish clear links between home energy consumption and these challenges. Almost 50 percent of the actors can be characterized as *special interest*. Those for whom the "*choice among the possible alternatives directly influences their interests, meaning they totally or partly bear the costs, and/or draw benefits from it*" (Dente, 2014, p. 49). The actors in this class are represented by industry associations, NGOs, financial organizations and educational institutes operating at all scales. With very few exceptions, this group is dominated by industry associations for whom changes to building practices and materials may well result in increased costs (both financial and transactional) for their members. For some general interest actors, actively engaging in home

energy retrofits represents an opportunity for differentiation and hence increased market share for their members. A further 35 percent represent *experts* according to Dente (2014). These include those actors that "*have the necessary knowledge to structure the collective problem and/or to find the most appropriate alternatives to solve it*" (Dente, 2014, p. 50). Within the retrofit space in Vancouver there are several high-profile and highly motivated expert actors. Examples include organizations that promote solar hot water and electricity generation, geothermal energy, passive house principles, energy audits and high-performance homes, all of which are well allied with Vancouver's retrofit policy aims. However, all of these actors are based outside of Vancouver, in which case they are unlikely to be able or willing to align themselves completely with Vancouver's strategic actions or local operating context. While it is tempting to assume that only professional experts possess the necessary skills to make judgements about a collective challenge like climate-induced home energy retrofits, Dente (2014) warns that experts can often be wielded as resources for politically driven actors with alternate visions. Thus, experts, while integral to most policy processes, cannot always be assumed to be impartial and neutral. When looking at those expert actors operating in Vancouver's retrofit space, we find organizations like the Passive House Institute West, the Canadian Association of Certified Energy Advisors, BC Advanced Conservation and Efficiency Association, and the Canadian Solar Industry Association, all of which hold strong vested interests related to seeing progressive retrofit policies developed in Vancouver. Expert organizations with missions and interests that may not always be so well aligned with the City include the Association of Energy Engineers, the BC Industry Training Authority, the BC office of the Appraisal Institute of Canada, and Home and Garden TV.

4.6 Place-inscribed policy

An additional proposition introduced at the outset of this chapter is the idea that notions of place can also permeate retrofit policy and practice. The city's physical, historical, environmental and socio-cultural imagery co-create the context within which home energy retrofits are conceptualized, designed and implemented. Norms, values and practices concerning resources like energy, raw materials, water,

even space, reflect resource abundance, unbridled nature, and optimism that emanate from every corner of the 'place' known as Vancouver. These symbols help to keep city residents connected with nature and comfortable living in it. Yet, in opposition to these eco-centric sensibilities, is an equally strong sense of entitlement to nature's bounties that can blur the logic behind conserving resources like energy.

To be a Vancouverite is to be an environmentalist, not in a tree-hugging sense, but rather in the sense that the natural environment is simply too grand to be ignored or not respected. The close links between the human made city and the natural environment are particularly evident in the residential housing stock. In a sense, houses represent a reconfiguration, according to architectural and construction principles and practices, of the wood that is harvested from the abundance of trees that surround the city like protective sentries. The design of roof pitches and eaves on most of the city's single family homes respond purposefully to the area's extremely high precipitation rates, while window sizes and orientations reflect Vancouverites' near constant search for precious sunlight. However, there is a tension between the city's geophysical setting and its own self-perception; the same rainy weather and natural environment that shrouds and burdens the city's sense of itself, also informs it. As the Vancouver Sun's McMartin (2017) says, "*its geography [has] seeped into the everyday lives of its citizens like nowhere else in Canada*".

4.7 Conclusion

This thesis urges that retrofit policy stop, look and reconsider its underlying assumptions. The aim of this chapter was to demonstrate how contextually situated and fuzzy retrofit policy is in the city of Vancouver. I have shown how the city's environmental roots are congruent with the its greenest city ambitions, bold climate goals and home energy efficiency ambitions, but contrasted this coherence with examples of tensions arising from unsustainable development patterns that threaten to disrupt the dominant 'green city' discourse. Vancouver's climate policy arsenal was unpacked to show its breadth, but also its limited reach and techno-centricity. After looking at the City's strategic approach to dwelling retrofits, I

introduced a suite of policy actants that in ways, both small and large, constrain the nature of Vancouver's retrofit project. I then argued that Vancouver is not alone in its climate ambitions; it is both assisted, and at times impeded, by the interests and administrative functions of organizations both near and far. I also introduced a typological framework to categorize policy actants according to their 'interest' in retrofit policy, and their functional role in supporting same. The last section of the chapter explored the bio-physical and cultural imaginaries that background life in Vancouver, and inscribe themselves into policy. While this chapter has not explained why Vancouver's climate-induced retrofit policies, programmes and incentives, are falling short of targets, it has shed light on some of the jurisdictional miscues and misalignments, ideological contestations, and place-based values, that together help foster fuzzy understandings regarding climate change and home energy efficiency.

Chapter 5 Retrofit landscape

5.1 Introduction

Lying between climate-induced retrofit targets and the homeowners they implicate, sits a largely undiscovered world of highly skilled and diverse intermediary actors that make home energy upgrades happen or not. This chapter opens up for viewing the landscape occupied by these intermediaries, paying particular attention to the professional and taken for granted relations that exist between these actors, and the ways with which these help shape their practices and the practice of retrofit. The intermediaries of interest include both formal and informal actors engaged in activities related (directly and less directly) to energy efficiency upgrades to the housing stock. These actors are found to hold fluid understandings of the City's retrofit goals that provide uncertainty, and hence another impediment for the City to overcome if it is to achieve its retrofit policy aspirations. To better understand the nature of these important actors, the relations between them, and their unique and collective realities, I try to situate them within a retrofit socio-technical system of provision. I propose a distinction be made between in-situ and ex-situ intermediaries, and suggest insufficient attention has been paid to the influence these differentiated actors can exert over the emergence and form of the practice of retrofit.

The chapter opens by introducing an anonymized person representing a local homeowner association in Vancouver, founded on the premise of preserving local neighbourhood character from rapid urban development. He embodies the average homeowner that policy makers believe exist, but frequently know not. Moreover, his individualized account of home energy retrofits in general, shines a light on typical homeowner motivations for improving the energy efficiency of their homes, shows how socially constructed understanding of home is, and how both of these mental frames influence home energy efficiency performance. Two other personalities, Bob and George are also introduced. These two characters represent typical building trades people working in Vancouver's retrofit socio-technical system of provision. By individualizing the concerns of Garth, Bob and George, I attempt to demonstrate that retrofits are more social in nature, than purely

technical and rational undertakings. After slipping into the work boots of Bob and George, and exploring other intermediary actors engaged in home energy upgrades, the dissensus between all three poles in the regulator, consumer, intermediary triad becomes clear.

In section 5.5 I identify two types of intermediaries (i.e. ex-situ and in-situ) to draw attention to two distinct groups of actors; one that is oriented toward retrofit policy and institutional goals, and another that orients itself toward the more practical and on-site aspects of home energy efficiency upgrades. Distinguishing between these two types reveals relational patterns and pathways that reflect ideological echo chambers, and environments that enable some sayings and doings to thrive, and others to struggle and fade. I analyze the lived experiences of service and product suppliers, and institutions that determine how, in material terms, energy retrofits unfold. This reveals an energy retrofit landscape dominated by diverse motivations and understandings, uncertainties, and debate concerning the value of home energy efficiency investments, and a still forming retrofit practice.

5.2 The world according to Garth

In speaking with Garth, a representative of a local homeowners association, I wanted to understand three things related to home energy retrofits: 1) common motivations for improving home energy efficiency, and how these related to broader home renovation projects; 2) common homeowner understandings of the connections between home energy consumption, local climate policy, and climate change itself; and 3), the nature of the relations between retrofit intermediaries and homeowners. In order to capture the interpreted nature of the retrofit process, the discussion that follows individualizes Garth's accounts, even though they are not and instead attempt to relay in a personal way, the views of all the homeowners Garth represents.

Where the contractor is concerned,

[W]e had a good contractor. Those contractors are very interesting characters; they have to ride two worlds. They have to be part of the trades world and yet, communicate with the owners who are likely to me, to connect up in a different way. And he was good, he understood exactly what we wanted. We

could communicate with him, step by step, as he was going through the process. When we were feeling that he wasn't doing what we wanted, he was always responsive. We trusted him. We trusted him for the most part. He wasn't taking us for a ride (Homeowner A - 'Garth', 2 July 2015).

Garth did not refer to any formal industry association databases of qualified or vetted experts, like those maintained by the Greater Vancouver Homebuilders Association (GVHBA, 2016b) or the Homeowner Protection Office (BC Housing, 2017), to locate a contractor. Instead, he entered the retrofit network of intermediaries via his interior designer, with whom he had a previous, and trusted, professional relationship.

Garth wanted to lighten his ecological footprint and use resources wisely, evidenced by his decision to move to a smaller house in a more complete and compact community. But Garth's feelings of environmental responsibility do not however include a clear and straight-line relationship between the design and operation of his home and anthropogenic global warming. As he says, when asked about his understanding of climate change,

I guess I think of greenhouse gases trapping heat in the atmosphere and slowly starting to heat up the planet. [...] I draw a direct correlation between burning fossil fuels and economic and military activities and the billions of dollars we spend on sending soldiers all over the Middle East [...] I think of that more than the operation of our houses. I see some interesting studies that suggest that greenhouse gases come more from the agricultural industry than cars. So I'm not sure. I know it's us but I'm not sure quite sure what it is. When I think of the use of energy the first thing I think of is not green buildings and energy efficiency, I think more that we need to take control of our own energy supplies and we should stop spending billions of dollars in the Middle East, killing tons of people. That's what makes me feel guilty. One documentary I saw talked about agricultural practices and that cow flatulence makes the burning of fossil fuels almost insignificant. Not only that but the house that you operate contributes one-hundredth or one-thousandth of the greenhouse gases that it takes to create a hamburger (Homeowner A - 'Garth', 2 July 2015).

Garth has a friend who keeps him apprised of popular home design trends, including the desirability of stainless steel appliances, 9-foot ceilings, home automation technologies, air conditioning, and open plan kitchens equipped with two dishwashers. Garth admits that this builder friend also speaks of improved air

ventilation and energy efficiency in new homes, which motivated Garth to ask his own contractor about the forecast energy efficiency of his home, post-renovation.

He said, "we're gonna put in the latest insulation, you're gonna have double glazed everywhere and this will be a completely different experience than your last home". But there wasn't really a specific approach, like well we could do this, and here's the data on this, and here's the choice between this product and a product. There wasn't any of that sort of specific information. It was much more generalized (Homeowner A - 'Garth', 2 July 2015).

Garth's lack of knowledge with respect to the building materials, techniques and technologies inclines him to trust (in the same way he trusts his house-builder friend), that between the building code and his contractor's skills and expertise, his newly renovated house will satisfy his financial, social, and environmental goals, despite the fact that his contractor does not offer any detailed information, nor real enthusiasm for energy efficient alternatives.

Garth and his family embrace their new NEST, smart thermostat; a wall-mounted, IP-enabled, learning thermostat that helps him and his family reduce energy consumption by monitoring heating demand patterns and occupant activities. The information collected by the thermostat is used to automatically turn the heat down when no one is home, and turn it up to energy efficient temperatures when the house is occupied ("NEST," February 2017). Adopting an energy management tool like this was not part of the original plan for Garth and his wife. Garth is not aware, but the City's 2014 Energy Retrofit Strategy for Existing Buildings includes *New City Action 15*, which highlights the energy saving potential of learning thermostats and recommends they be included in all home retrofits.

'[S]mart' appliances and home energy control technologies are rapidly evolving. Recent improvements . . . have made these devices affordable, easy to install, and simple to use (even remotely using a smart phone). A \$250 - \$350 smart thermostat may reduce heating energy use, which typically represents just over a half of a house's annual energy use, by a reported 20% (City of Vancouver, 2014, p. 13).

Rather than learning about this technology from the City, he learns about it following one of his many conversations with Dave, the senior, on-site carpenter, a man Garth describes as a natural born trouble-shooter and a jack of all trades.

He was just a guy who could do everything. He would end up doing the things on-site that nobody else could do. [...] he basically built the whole house himself [...] He convinced me with two words: [NEST] is inexpensive and it's easy to use. [...] it's like an Apple computer (Homeowner A - 'Garth', 2 July 2015).

The thermostat is the clearest manifestation of the relationship between the home's occupants and energy. The circular disk-shaped thermostat is mounted on a wall that marks the crossroads of daily family circulation patterns. It is modern in design and catches the eye of all passersby. As Garth points out,

essentially [the NEST] is telling us what we already knew. It's common sense to turn the heat off in the summer when you don't need it, but it breaks it down . . . It tells us exactly what's going on and tells us how much money we're saving. [...] We enjoy our house and love our house more. Because we say, look at this, this is our energy consumption. We have more of a relationship with our house for sure. It's kinda like getting a report card. [...] To see that you're consuming less than half of the energy is great. We consume probably a third of what we did. It's confirming constantly that we made the right decision and we feel good about it (Homeowner A - 'Garth', 2 July 2015).

The overwhelming impression one gets from hearing Garth speak is that the NEST thermostat makes people like him feel smart and modern, not necessarily climate wise. This suggests that homeowners can engage with climate, energy efficiency and their homes on their own terms, and not necessarily in the ways imagined by official public policy that aims to improve the energy performance of the housing stock.

Garth's motivations are common but complex, and reflect a blend of two of those listed in Figure 5-1. Namely, a desire for better space and improved energy efficiency. His previous family home in the leafy Shaughnessy neighbourhood was where he first became frustrated with oversized and energy hogging houses situated on super sized lots.

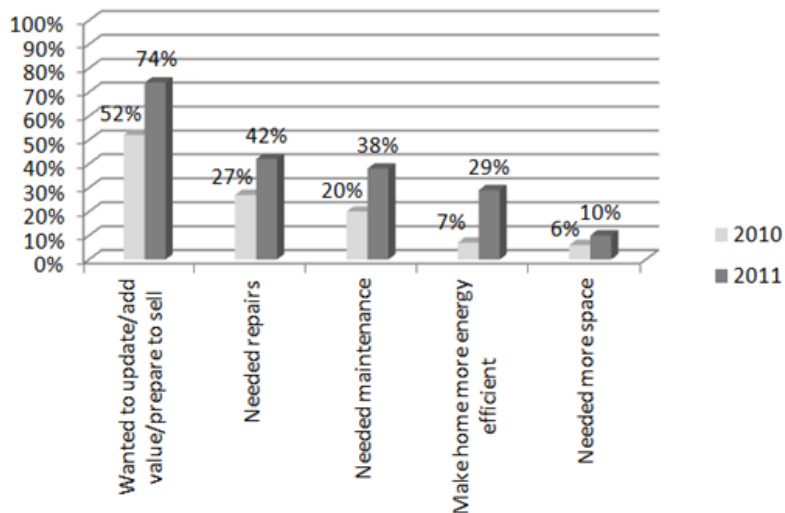


Figure 5-1 Reasons for renovating in Canada. Adapted from (CHMC, 2012)

Many of Vancouver's old houses are a challenge to heat as their design and construction often render them less airtight and insulated than more recently constructed homes. This was in fact Garth's experience, and that which contributed to his desire to upgrade an old house in a more vibrant neighbourhood.

It was huge lot, [...] that was just sucking up energy and resources. And the house itself consumed a lot of energy. [...] we realized there is no insulation in [the] house. There's not even newspaper. And our house was freezing in the winter. We could not pump enough heat into that house to keep the rooms warm. We literally could not. In our bedroom it was freezing it was a completely inadequate heating system. Basically we are heating the neighbourhood (Homeowner A - 'Garth', 2 July 2015).

Where energy is concerned, Garth is driven primarily by a thrift ethic, rather than a save the environment or stop climate change imperative. A sentiment echoed in his lamentations regarding his previous inefficient home.

[W]e knew what the bills would be because we were used to it. So every month it was high. And it really bothered me. [...] it was unnecessary. There was no reason for the waste. It was just a lot of money and it was a lot of energy. It was ridiculous to have to have the heat on all the time (Homeowner A - 'Garth', 2 July 2015).

The importance of power and trust emerges several times in conversation with Garth. He shares, upon reflection, how potentially vulnerable he and his wife were to the competence and judgement of his contractor.

Going in, I didn't get going in to what extent [the contractor's] job was really what we were paying him for. If he had mismanaged diverted resources, it could've taken three times as long as it did and we would never have known the difference. There's a fair amount of trust that you instill in someone like that (Homeowner A - 'Garth', 2 July 2015).

Unable to find an empty lot to build new, Garth and his family ultimately chose to buy and update a character house and convert into their dream, energy efficient home. It is important to emphasize that improving the energy efficiency of the home was not the central driver for Garth and his family, rather it was an assumed (and intrinsic) benefit of upgrading and modernizing the house in general. In this case, energy performance improvements are subsumed and intertwined within a complex web of emotions and motivations related to home.

Data collected by Natural Resources Canada indicate that over 7,900 Vancouver households (roughly 10 percent of all homes) spent an average of \$CDN 6,880 to upgrade the energy performance of their homes between the years 2007 and 2015. However, only 24 percent of households likely limited their home alteration interventions to those related to energy efficiency (Wilson et al., 2013). Like Garth, the majority likely undertook other, more traditional upgrades related to home comfort and function, alongside energy retrofits. This observation reinforces Garth's testimony and confirms this data and how entangled energy efficiency upgrades and non-energy related home alterations often are.

5.3 Bob the builder

Having explored the concerns of a typical homeowner, 'Garth', I want to turn to 'Bob', one of the intermediaries interviewed for this research to whom I gave this popular pseudonym. Bob is one of Vancouver's thousands of sole proprietor builders who work on small home alteration projects. I recount Bob's story in much the same way he relayed it to me in an attempt to accurately represent his perspectives.

Not long after he sold his automotive business, Bob landed his first job as a renovator in Vancouver. He never intended to enter this line of work, a fact reflected in his observation that with respect to his career as a builder, he "*sort of fell into it*" (Builder F, 'Bob', 25 June 2015). Despite the happenstance nature of his

career launch, Bob exudes an air of confidence regarding his decision to become a general contractor.

I don't want to characterize myself as a misfit, but I do think that there is an artistic part in it. So as an individual you have your own style of how you operate. I don't think I could go and work for anybody else. I worked for myself for so long that when I think about going and working on a construction site with others it would drive me crazy (Builder E, 'Bob', 25 June 2015).

"Every day is different, no two jobs are the same", and he is proud of his autonomy which is why he prefers to "stay small" and avoid taking on employees (Builder E, 'Bob', 25 June 2015). Bob's daily practices and conversations with homeowners, suppliers, designers and building trades people, go relatively unobserved by the tax² and building authorities, policy makers, and the community at large. Even his work truck is discrete as it could easily double for a family-owned recreational vehicle. In contrast, the impact of his work is entirely visible for his clients, their visitors, and their neighbours. He builds patios and decks, he adds on bathrooms and dormers, he upgrades kitchens and heating systems, and he replaces damp and draughty windows. What is particularly striking about Bob is how informal and intimate his work is. He has no formal training in construction, he holds a business license rather than a diploma in construction or a related field, he isn't a member of any associations, and he prefers to learn on-site rather than in a classroom.

I'm a slow learner, but there's nothing like learning on-site for me. If I have a question I'll look it up on the Internet and I'll see videotapes that other people have posted. I have to also be sceptical because not everybody knows how to do everything. I've often seen videos where the guy demonstrating has got it wrong. I don't attend workshops or seminars. I also learn in supplier stores by reading whatever brochures they have (Builder E, 'Bob', 25 June 2015).

He relies exclusively on repeat customers and word-of-mouth referrals to sustain his business, and he spends the greater part of his days in the intimate and tucked away spaces of his clients' homes.

I get business through word-of-mouth. I get repeat customers. They just keep calling. [...] This current project started because they had a broken toilet, but

² In their 2015 annual report, the Canadian Home Builders' Association of BC confirms it is working with the Canada Revenue Agency to combat the underground economy of residential construction industry. The CHBA national *Get It in Writing!* campaign warns of the risks that come with under-the-table deals and encourages homeowners to obtain proper written contracts before work begins, and to never accept a verbal agreement with a renovator (CHBA BC, 2015b).

the bathroom was well past its best before date. [...] Now the project has morphed into the bathroom, cabinets the kitchen. That's often the way it goes with jobs. People often start with an idea or a vision for a project and as soon as the project starts other things come up and the project grows (Builder E, 'Bob', 25 June 2015).

Bob does not talk to his clients about energy efficiency or the links between home energy consumption and climate change, but he will get involved in some circumstances.

If I was asked to do an estimate on job and I recognized that a wall wasn't insulated but the homeowners were just saying they want to ignore it, I'd definitely suggest ripping off the rest of the drywall and insulating during the job because if it adds value it makes sense (Builder E, 'Bob', 25 June 2015).

Enhancing Bob's substantive construction skills and know-how and his sincere desire to provide his clients with good value, is his ability to win his clients' trust and convince them that he can help them undertake a quality home renovation successfully. He sees himself as playing a honest broker role between his clients and the confusing world of construction trade practices.

Ultimately I'm working for the homeowner and I'm trying to get them value for their money. They're looking to me to advise them and guide them in the renovation process. They don't know what it costs to employ an electrician and they see that as of value to them to have me sit between the two parties and make sure they're getting good value (Builder E, 'Bob', 25 June 2015).

Above all Bob values his ability to help those who say they need his expertise by creating solutions to stubborn challenges, maintaining his independence and control over his daily life, and securing a reasonable and regular income for himself and his girlfriend. Bob is not alone. There could be as many as 7,000 other operators like him in the Lower Mainland of Vancouver.³

5.4 Curious George

George has 20 years of experience as an electrician in Vancouver. He is a Field Service Representative (FSR) which means he is able to inspect other electricians' work and obtain electrical permits from the City. Ticketed electricians and builders cannot obtain electrical permits as FSR's can. George, like most of his professional

³ Statistics Canada's 2012 data indicates there were 13,900 residential construction establishments registered in BC, and if half of these are active in the Lower Mainland, this would mean that as many as 7,000 residential construction establishments could reasonably be operating in or near to Vancouver.

colleagues maintain a relatively low profile in the retrofit system. Despite the importance of their work, within the construction sector they tend to receive, rather than give direction.

Everybody has different kind of... How I would say? Feeling about what he's doing. Homeowner, they want to see the look of fixtures. If I'm hired by contractor, general contractor, he gives me some kind of directions, what to do. And then the architects can come, he can change everything. And the designer comes, he changes everything. And then I'm between all of them, you know? (Trades Person D - 'George', 24 June 2015).

Retrofit projects and small renovations often do not require more than one electrical tradesperson, so these actors tends to work alone. George laments that contrary to his early career experiences in the former Czech Republic, where continuous training was required every five years, he no longer has opportunities to share knowledge and know-how with fellow electricians. Electrical trades people in Vancouver (and all of BC for that matter) require no such regular training. Once an electrician has obtained his ticket by passing the Training and Qualification (TQ) exam, he or she is not required to ever return to the classroom. Even FSR's who are responsible for checking the work of electrical trades people are not required to undertake continuing education after passing their original FSR test. George feels very strongly about the need to regularly demonstrate one's technical competence which is why it made sense for him to undertake the FSR training and certification. He worries however about the overall skill level of the electrical trades in BC. "*Many guys would not pass the test here. There are a lot of electricians who finish their TQ and never go back [to school]*" (Electrical trade, 24 June 2015). George confirms that without regular testing requirements or an active trade association to facilitate professional networking sessions, electrical trades must rely on other means to learn about advancements in technologies and practice. Electrical trades rarely meet each other during their regular work routines, thus they tend not to benefit from each other's experiences. "*I meet [other electrical trades people] in the houses, right, and I know only a couple of them. But to sharing, there's not much sharing, unfortunately.*" (Electrical trade, 24 June 2015). This sentiment of isolatedness is exemplified as George reflects on the nature of the relations between electrical trades people.

You know, there are unions of workers, [...] unions of teachers, there are unions of the [...] They call themselves these unions. There is union of electricians, but that union is only for employing the electricians. But doesn't unionise the electricians. Which means we don't discuss together anything, mostly because we are kind of, you know, like taking from each other's jobs, I would say. Not officially, but it is that way. We are, you know, competing on the market. So we don't talk too much together as contractors. Only if I, you know, meet them at some kind of meeting, and I'm with them around the table, then probably it's kind of friendship. But it's not actually the trade friendship. I am missing that part, [...] And it's true, you know, like to get together all electricians would probably not be easy (Trades Person D - 'George', 24 June 2015).

His operating context and normal work practices, which are dominated by isolationism and no organized learning structures, mean that he is not very aware about climate change science or policy innovations where the City's energy efficiency is concerned. As he says when asked for his views on climate change and private dwellings, " *I'm not a scientist, I don't know exactly the calculations or how much the house is producing and what it is producing.*" And when asked how he translates the idea of energy efficiency to his customers, and whether or not he mentions the environmental benefits he responds,

Yes, mostly the efficiency, the energy efficiency, yes. Definitely, as I said, how big an impact it has on the environment, I'm no scientist, I don't know. I usually go by the technicality of the product which saves energy that's the way, you know, how I tried to explain it (Trades Person D - 'George', 24 June 2015).

5.5 Toward an intermediary typology for the retrofit sector

The motivation to improve the energy efficiency of one's home is often wrapped up in complex emotional, financial, and practical considerations. While it is true that people often decide to undertake discrete projects to seal and caulk around windows and doors, upgrade windows, add insulation, or purchase a more energy-efficient boiler, most homeowners nestle such practices within a broader suite of value-add and comfort-based projects (CHBA, 2017). This view is reinforced by one interviewee who works as a trades person in the retrofit space,

Usually [the homeowner] either need more space in the house or they're just doing a major renovation. So the actual retrofit or energy upgrade are part of a bigger scope, they're not really the driving force behind what's happening (Trades Person B, 29 April 2015).

This I argue, is what the present research reveals as being the typical case in the city of Vancouver. The main implication of this suggestion is that where energy retrofits are concerned, it is important to engage, not only with intermediaries with a stated interest in home energy efficiency, but also with those intermediaries for whom energy efficiency might be neither a key concern nor a normal business offering. That is why this research is particularly interested in those instances where improving a home's energy efficiency is a real possibility, but not a principal project driver. Taking all home alteration events as opportunities for energy efficiency upgrades, by definition implicates a much broader group of housing construction, maintenance and renovation intermediaries.

Central to the notion of an intermediary is its in-betweenness; it negotiates between interests to create common visions and agreements. By definition it always sits between stakeholders, be these designers and user groups, or producers and consumers. Intermediaries in existing literatures are rather formal and impartial third-party organizations, strategically designed and positioned to foster beneficial outcomes among opposed interests, all the while operating under a clear mandate and rules of engagement (Beveridge and Guy, 2009; Howells, 2006; Moss, 2011). These unique actors are taken in the literature to possess a bounded rationality and limited agency as they go about building relations, communicating ideas, transferring knowledge, and brokering agreements in aid of stimulating economies, facilitating market integration and hastening innovations (Allen and Santomero, 1997; Cronin, 2004; Freeman, 1991; Kazis, 1998; Newell et al., 2012). Consistent with this characterization, these intermediaries maintain a rather neutral or indeed positive reputation as wheel-greasers and market builders (Allen and Santomero, 1997). They can, as Howells (2006) suggests, be thought of as brokers, middlemen, or bridge builders. The expanded group of retrofit intermediaries that operate in Vancouver do not fit neatly into traditional definitions of intermediary. While they do negotiate between policy circles and homeowners, the majority are not classically formal entities, and they cannot be described, universally at least, as ideologically aligned and 'wheel-greasers' with respect to the overall aim of government retrofit policies and programmes.

This thesis thus argues for a reconceptualization of 'intermediary' in the context of energy retrofits. One that recognizes the emergence of less formal and sometimes politically polyvalent actors operating between policy circles and homeowners in Vancouver. The City's home energy retrofit policies tend not to recognize any retrofit intermediaries per se, instead reference is typically made to a few general groups such as contractors, energy advisors, utilities, service organizations, and installers that play a role in implementing energy upgrades to the housing stock (City of Vancouver, 2014; Vancouver Heritage Foundation, 2015). Although contemplated in the literature (Community Energy Association, 2014; Vergragt and Brown, 2012b; Webber et al., 2015), I suggest that policy and academic circles have treated these groups either too superficially, often tending to consider them as passive or as parts of a homogenous 'black-box'. That is, considered "*without an indication of their history and their inner working*" (Rip and Kemp, 1998, p. 329). More troubling, practice and research has largely failed to engage with a broader group of construction-related actors that operate alongside these more usual, and higher profile suspects in the middle world between policy and homeowners.

I propose a more nuanced framework with which to categorize retrofit intermediaries. It understands today's home energy retrofit as essentially the result of activities carried out by intermediaries navigating among ongoing tensions between science-based policy and political or social rules and norms. Closely linked to this science-politics chasm, is one of the central arguments of this thesis; that is, energy efficiency interventions in the home are strongly influenced by processes of negotiation, translation and interpretation driven by intermediary actors who operate between science-based policy and the politics underpinning home energy consumption. Framing retrofit activity in this way is in alignment with David Guston's (2001) theory of *boundary organizations*, which focuses on the organizations that lie in the boundary space between science and politics. Thinking of the intermediaries in the Vancouver retrofit system as boundary organizations is useful, yet this conceptualization fails to adequately recognize issues related to scale and intent, issues addressed by van Lente et al.'s (2011) work on *systemic intermediaries*, and Marvin and Medd's (2004) thinking on *strategic intermediaries*.

The intermediaries at the centre of the present research do indeed bridge between science and politics, but they also work within and across scales, and vary in terms of their understandings about the links between energy efficiency and climate change, their strategic positioning within the system, and the degree and means with which they influence energy retrofit practices. In an effort to include these characteristics in a typological framework fit for purpose, I suggest there is utility in an organizing framework that breaks down intermediaries according to their capacity to influence retrofit values, norms and logics directly through their work in homes. In this scheme, intermediaries can be divided into those that regularly work in homes, or immediately proximate to homes and homeowners (*in-situ intermediaries*), and those that operate beyond the dwelling site level (*ex-situ intermediaries*).

Those individuals and enterprises that are responsible for making physical alterations to existing dwellings on a more or less daily basis, who normally liaise with homeowners in their private homes, and who are materially engaged in shaping the collective values and understandings regarding energy efficiency in the home belong to the in-situ group. These intermediaries include groups like renovators, energy advisors, design professionals, contractors, roofers, window and insulation installers, plumbers, handymen, electricians, plasterers, wall-boarders, carpenters, and flooring installers. Ex-situ intermediaries on the other hand, operate in closer proximity to policy networks at diverse temporal and spatial scales where they influence retrofit agendas, understandings, rules, projects and motivations through their daily activities and materialities. They are equally important to their in-situ contemporaries, yet these actors are not typically included as members of the construction industry. They include actors like material suppliers, industry associations, utilities and environmental NGOs, hence they hail from a variety of sectors. Despite their relative distance from the private home setting, ex-situ intermediaries play a vital role in home energy efficiency upgrades. It is important to note that the boundary between ex-situ and in-situ intermediaries is porous, some actors can function as either depending on the situation. What this classification provides is a useful way of thinking about how intermediaries

contribute to practice persistence or change. Table 5-1 represents the list of intermediary actors broken down according to this organizing scheme.

Table 5-1 In-situ and ex-situ intermediaries, by category, operating in Vancouver

In-situ Intermediaries		Ex-situ Intermediaries	
Builders/Contractors	Energy Advisors³	Sub-Trades	Energy/Built Environment NGOs
Residential home builder/renovator	Blower door technician	Drafts people	Community Energy Association
Contractors and/or supervisor	Energy auditor/advisor	Building envelope consultant	BC Sustainable Energy Assoc
	Thermal imaging professional	Steamfitter and/or pipefitter	Passive House Canada
Sub-Trades		Cutter, driller and/or blaster	Built Green BC
Plumber	Designers/Architects	Ironworker and/or structural fitter	Cda Green Bldg Council - BC
Insulator (mech'l ductwork,piping)	Architectural designer/draftsmen	Sheet metal worker	
Insulator (blown cellulose, foam)	Interior designer	Construction millwright	Utilities
Building envelope technician		Concrete finisher, flooring	BC Hydro & Power Authority
Carpenter- finishing	Electrical Contractors	Steel forming worker	FortisBC Gas
Carpenter- forming	Electrician	Tilesetter	
Carpenter- framing	Home automation experts	Welder and/or machine operator	Material Suppliers
Construction manager	Solar PV installer	Cost estimator	Retailers
Roofer and/or shingler			Wholesalers
Sheather/rainscreener	Mechanical Contractors	Energy Advisors	Distributors
Painter and/or decorator	Heating technician	Rating system professional	
Plasterer, installer/finisher	HVAC technician (HRV)	Energy modeler	Building Trade Associations
Glazier	Hydronic technician		Electrical Workers
Window manufacturer/installer	Gasfitter	Designers/Architects	Home Builders
Trades helper and/or labourer	Geothermal technician	Specification writer	Plumbers
Demolition	Solar thermal technician	Technical drafter	Thermal Environmental
Door manufacturer/installer		Mechanical/electrical designer	
Exterior finish applicators	Material Suppliers		
Floor covering installer	Retailers ⁴	Energy/Environment Consultants	
Bricklayer		Green building consultant	
Concrete installer	City of Vancouver	Weatherization specialist	
Cladding (membrane) installer	Home inspector	Sustainability consultant	
	Utilities³		
	BC Hydro & Power Authority		
	FortisBC Gas		

Source: Adapted from Globe Advisors (Globe Advisors, 2013c)

This typology permits a more disaggregated view of different intermediaries and the various ways in which their activities reinforce existing practices, and hence how these same acts, if altered or influenced in some way, may contribute to the emergence of a new retrofit practice.

5.5.1 In-situ intermediaries

The people hired to complete energy upgrades on homes are known colloquially in Vancouver as builders, contractors and sub-trades, or 'builders and their subs'. These are the actors that commonly come in direct contact with homeowners in the

⁴ Utilities like BC Hydro and FortisBC, some energy advisors, and building material suppliers selling to the retail market can act as both in-situ and ex-situ intermediaries given their unique characteristics at the nexus between materials, imagery, skills, homeowners, and builders.

normal course of a work day, and whom I refer to as in-situ intermediaries. From a practice perspective, these actors engage in the actual do-ing of retrofit-related actions (e.g. weather stripping) through the integration of meaning (i.e. reduced air leakage through strategically placed insulative strips), competence (i.e. ability to create an air barrier), and materials (i.e. actual weather stripping). Such a praxeological perspective emphasizes the role of repetitive performances of relatively mundane and normal activities in the persistence (and possible mutation) of retrofit practices.

Contractors tend not to 'swing a hammer'. Instead, they are often found in larger and more formal companies, and generally spend their time quoting on jobs, supervising workers and sub-contractors, communicating with homeowners, and managing budgets. Contractors often do not get directly involved with energy efficiency issues on the job site due to the fact that they are often quite 'hands-off' during projects, and sometimes will have no technical training at all. Builders on the other hand, tend to work directly alongside the carpenters and labourers which they lead. To be a builder in Vancouver, one must be skilled in carpentry and framing as wood constitutes the principal building material used to construct residential buildings. It is for this reason that most builders are carpenters first, and team leaders second. Both contractors and builders tend to interface with energy efficiency issues from a distance, leaving wall and floor assembly details to junior carpenters, airtight drywall to the boarders and plasterers, insulation matters to the installers, and heating and ventilation concerns to the plumber or mechanical sub-contractor. According to a 2013 BC residential construction industry profile study, the trades most implicated in energy efficiency projects include: carpenters and framers (i.e. activities related to window and door installation, air sealing, identifying and eliminating thermal breaks, weatherization, and general building science); and, plumbers, electricians and HVAC professionals (i.e. mechanical ventilation and make-up air systems, hydronic heating / cooling systems, lighting and controls, HVAC system integration, balancing and commissioning, etc.) (Table 5.2) (Globe advisors, 2013b).

Table 5-2 Key building and construction actors in the energy efficiency retrofit process

Retrofit stage	What is involved?	Who is involved?
Rough framing carpentry	Rough framing and sheathing of new internal and external walls and roofs, floors.	Carpenters
Window and door installation	Windows and doors are installed prior to air barrier and building enclosure. Shimming and insulation around frames, wrapping of air barrier material.	Glazier, window manufacturer or contractor (may be a finishing carpenter), door manufacturer or contractor (may be a finishing carpenter). Shimming, sealing and wrapping by carpenter.
Building wrap, air barrier	Install Tyvek or similar air barrier, (may be building paper, or similar spray foam insulation/air barrier combined)	Carpenter, specialist insulator, energy performance assessor
Rough-in for piping, radiant heating and plumbing fixtures	Piping (hot and cold water) and connections rough-ins to new equipment	Plumber
Electrical wiring and rough-in	Wiring and connection rough in for electrical outlets, lighting, controls (e.g. thermostats, meters, etc.), switches and wiring before new insulation goes in	Electrician
Ductwork	Cutting, forming and taping new or modified metal ductwork for heating, ventilation, exhaust systems	Sheet metal worker
Thermal insulation	Insulation must be done while walls and ceilings are still open. May be blown in via small holes made in the drywall. Should only be installed once building is enclosed.	Fiberglass batt insulation (walls and attic) - no specialist skills beyond general contractors labour, general help. Wall and attic blow-in cellulose - thermal insulator specialists. Wall and attic spray foam - thermal insulator specialists. Flat roof rigid insulation board - roofing contractor or general contractor's own forces. Rigid insulation board for walls and foundation walls (e.g. basements) - no specialist skills beyond general contractors labour, general help.
Vapour barrier	Polyethylene vapour barrier to exterior walls and attic as required	General contractor's own forces, labourer, general help. Carpenter
Retrofit stage	What is involved?	Who is involved?
Wallboard	Installation of wallboard along with the enclosing of mechanical and electrical piping in wiring. Building inspection by regulators required before drywall enclosure.	Drywaller
Heating plant installation and replacement (gas)	Furnace, boiler, heating fireplace installation.	Gas-fitter, plumber. Hydronic technician.
Heating plant installation and replacement (electric)	Installation of heat pump, etc.	Electrician, heating technician, hydronic technician, manufacturer's specialist
Hot water heater installation and replacement (gas)	High-efficiency/insulated tank or on demand.	Gasfitter, plumber
Hot water heater installation (solar)	Solar panels to roofs and storage tank/heat exchanger. Flashing around roof penetrations	Specialist solar technician. Roofing contractor.
Hot water heater installation and replacement (electric)	High efficiency/insulated tank or on-demand water heater.	Electrician, plumber
Ventilation equipment installation	Bathroom and kitchen exhaust fans, heat recovery ventilators (HRV)	Electrician (fans). HVAC technician (HRV)
Plumbing fixtures	Rough-ins, copper, PVC or flexible piping runs and finish connections for hot and cold water to new equipment (e.g. solar hot water)	Plumber

Source: Adapted from Globe Advisors (Globe Advisors, 2013a)

Unfortunately, builders and trades people, taken as a group, do not align unambiguously with any traditionally defined construction-related sectors, which makes their objective identification and study by policy makers difficult. In fact, intermediaries in the retrofit sector can sit simultaneously within and beyond the boundaries of several discrete sectors including the residential building construction sector (Figure 5-3). The figure shows the overlaps between construction, renovation and repair, specialty sub-trade, and retrofit sectors, with respect to definitions of constituent occupations and trades, and associated annual contribution to BC GDP by annual expenditures (2014). They include parts of the overall *Residential Building Construction* (Statcan, 2007) sector, may indeed overlap quite nicely with the *Renovation and Repair* category used by the Canadian Home Builders' Association of British Columbia (CHBA BC, 2015c), and probably intersect

at several points with the *Renovation* sector as understood by the Canada Mortgage and Housing Corporation (CMHC, 2012). Despite the parallels, there are important differences between these three classifications in terms of their constituent labour groups that make them difficult to assess with respect to statistics related to employment levels.

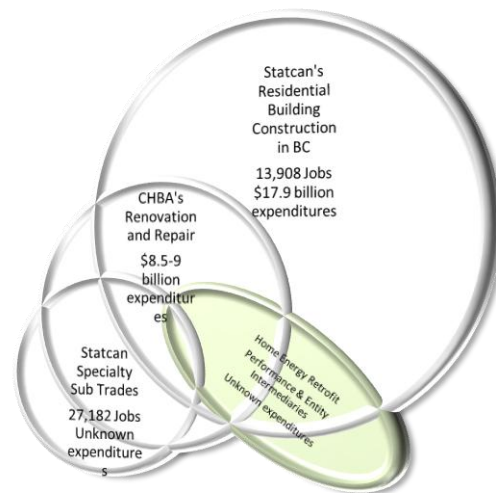


Figure 5-2 Construction-related sectoral boundary overlaps

The *Residential Building Construction* sector includes residential housing general contractors, builders and re-modellers of dwellings,⁵ residential project construction management firms, and residential design-build companies, but excludes *Specialist Trade Sub-Contractors* that perform many specialized (usually on-site) tasks on residential, commercial and industrial projects (Statcan, 2007). It could be argued that *Specialist Trade Sub-Contractors*, that comprise establishments⁶ that usually (but not exclusively) work under contract to general contractors to carry out a component (e.g. masonry, carpentry, or electrical work)

⁵ BC's residential construction market includes the new construction and renovation of single-family, semi-detached, apartment buildings and row housing.

⁶ An *establishment* differs from both an *enterprise* or *company* by statistical measures. Statistics Canada defines an establishment as a statistical unit that maintains accounting records for a business (principal inputs, revenues, salaries, and wages), whereas an enterprise or company can comprise a number of establishments active in multiple locations. Statistics Canada reports on the more numerous establishments which are the dominant type of entity in the small business-dominated construction industry.

of an overall project, are quite well aligned with many of the actor groups providing products and services implicated in home energy retrofits. However, as these sub-contractors engage in commercial and industrial construction projects in addition to residential work, the employment and expenditure data for these intermediaries cannot be solely attributed to residential construction. CHBA BC's *Renovation and Repair* category lacks any clear definition as to what trade or occupational groups fall within it and what specific activities it covers, so it too does not provide reliable data. CMHC's *Renovation and Home Purchase Report* (2012) provides yet another perspective by defining the *Renovation* sector as comprising those unspecified enterprises that work to add value, extend the useful life, or keep a property in working condition or maintain its appearance. It should be noted that neither CHBA BC's *Renovation and Repair* category nor CMHC's *Renovation* sector category are recognized by Statistics Canada (Statcan).

The fluid and relatively amorphous group of retrofit intermediaries form part of the residential home construction sector, and as such, contribute significantly to overall economic activity. What is clear is that with currently available datasets, accurately tracking and monitoring expenditures for the informal renovation and retrofit sectors specifically is next to impossible. Policy makers must rely on best guesses and estimates provided in industry association and market analyst reports (Altus Group, 2015; Statcan, 2015; CHBA BC, 2015b).⁷ Based on the data in these reports, the level of investment in residential renovations is greater than the contribution to the GDP made by the mining, quarrying, and oil and gas extraction sectors put together, and represents 4 percent of provincial GDP and 4.6 percent of provincial employment (BC Government, 2014).

As many have pointed out, the construction industry is dominated by small-scale and informal operators, and the situation in BC and by extension, Vancouver, is no different (CHBA BC, 2015a, Globe Advisors, 2013d).

⁷ For instance, according to the Altus Group (2015), who rely on a combination of their own, and Statcan data, \$CDN 70.1 billion was spent on renovations in 2015 across Canada (i.e. 4.2 percent of the GDP of all industries), over \$CDN 20 billion more than that which was spent on constructing new dwellings (Statcan, 2015). At the provincial level, between \$CDN 8.5 (Altus Group, 2015) and \$CDN 9.0 billion (CHBA BC, 2015c) was spent on residential renovations in British Columbia in 2014, including expenditures for residential alterations, improvements, conversions and repairs.

I'd say there's quite a bit of variability in terms of people's level of interest. It's pretty easy to get involved in this business but it's harder to stay up-to-date over the long run (Builder F, 'Bob', 25 June 2015).

The shifting and transitory nature of the residential construction industry means that actors within this community display a relatively low level of interaction with certifying bodies, trade unions, industry associations and trade organizations, which reinforces the popular characterization of the sector as one which is fluid, informal and un-standardized (CMHC, 2003, Globe Advisor, 2013d). In a 2013 province-wide industry survey, 65 respondents representing companies that either do home renovations, provide an associated specialty service, or install energy efficiency related equipment in homes, declared a combined total of 117 professional memberships or affiliations with 37 industry associations and trade organizations. This suggests an average of two memberships per company. While this number might give the impression that renovators, trades people and energy efficiency companies in BC are reasonably engaged with industry bodies, it should be noted that the respondent companies were contacted via formal industry databases, and hence are considered to be more established, engaged and visible than the average industry actor (Globe Advisors, 2013a). Moreover, in the same survey, 63 of the 117 memberships held memberships with only four industry organizations: Thermal Environmental Comfort Association (TECA) (30); Canadian Home Builders Association of BC (CHBA BC) / Greater Vancouver Home Builders Association (GVHBA) (19); FortisBC electricity utility (9); and, Built Green building rating system (5). The remaining 54 memberships were distributed among 33 diverse associations and organizations. The same trend is seen in Vancouver, where only 82 of an estimated 2,800 renovation companies were members of the Greater Vancouver Home Builders Association in 2016, suggesting that only 3 percent of companies were part of a more structured industry association.⁸ Moreover, a search within the database of licensed residential envelope renovators in Vancouver, maintained by the provincial Minister Responsible for Housing, returned only 35 companies,

⁸ A review of business license data for the city of Vancouver, suggests that there were approximately 2,800 home renovation, repair and alteration outfits operating in 2016 (City of Vancouver, 2012b).

despite there being 2,800 builders holding valid building licenses in the city (BC Housing, 2017).

Of the 13 interviewees that identified themselves as being a part of the builder, trades, or supply sectors, three were not members of any association, six were members of one association, one had two memberships, two had three memberships, and one was a member of four associations. This works out to an average of one association per company, half that rate found in the Globe Advisor's study. My research findings reinforce these survey data and the assertion made by some, that many of the "*businesses and workers within the residential construction industry have historically been very hard to reach*," operating informally and beyond the influence of traditional structures like those offered by industry and trade associations (Globe Advisors, 2013d).

5.5.2 Ex-situ intermediaries

Traditional approaches to analysing home energy retrofit programmes have focused on well-defined, what I refer to as field intermediaries, like contractors and builders as the principal middle actors. I suggest that a more useful conceptualization brings the many other relatively invisible and lesser known actors (e.g. designers, energy advisors, NGOs, industry associations, utilities, material suppliers, etc.) into the discussion as others have encouraged (Community Energy Association, 2014; Globe Advisors, 2013c; Killip et al., 2013). I conceptualize these actors as policy intermediaries because, rather than participating directly in more discrete and physical retrofit activities, they instead play an important role in fostering a "*dispersed nexus of [retrofit] doings and sayings*" (Schatzki, 2012, p. 14) by coordinating and enabling the reproduction of retrofit performance practices across time and space (Schatzki, 2012). I argue that differentiating between intermediaries can help interrogate the furthest corners of the retrofit STSP, and help policy makers and researchers better understand the diverse ways in which intermediaries influence retrofit activity in the field. Failing to engage with both types of intermediary, is to almost guarantee that energy retrofit policies fall short of expectations. What follows is a brief survey of influential policy intermediaries, their modes of operation, and their role in influencing retrofit practices.

Energy advisors

Professionals specializing in assessing the energy performance of homes have emerged in the retrofit STSP recently. They act as both an in- and ex-situ intermediary given their modes of operation within the system. They appeared in Vancouver as recently as 2007 (Sundberg, 2015) and typically work alone or in small, young companies. They employ their energy efficiency expertise and knowledge of building science to assist both homeowners and contractors identify design, and sometimes implement, equipment and building element options in support of overall energy performance improvements.⁹ One of the central functions of the CEA's working in Vancouver is to conduct EnerGuide home energy efficiency evaluations on behalf of a Natural Resources Canada (NRCan) licensed service organization. These evaluations require CEAs interview homeowners regarding normal home operating conditions (e.g. number of occupants, heating regimes, ablutions, etc.) and conduct an overall home inspection to gain an understanding of the technical aspects of the house. The advisor must explore the entire home from top to bottom to familiarize themselves with the daily habits of the occupants. Information collected might include: expenditures on energy bills, occupants' personal habits and preferences regarding energy and water use, environmental values and ethics, and sometimes even more personal dynamics that exist between the homeowner and his or her home. The home visit can sometimes last up to four hours as interviews can sometimes be protracted events, and many measurements and assessments must be performed on-site. These include: floor, door and window area measurements; space heating/cooling/ventilation systems and equipment information; building envelope materials and profile specifications; and an assessment of the house's air-tightness using a blower-door test.

The output from the visit is a data-rich energy audit report and an EnerGuide rating or score between 0-100, (1 being the most efficient), and a list of potential improvements (NRCan OEE, 2011). CEA's provide third-party expert advice rather than being direct employees of a Government agency. Depending on the CEA, the report may be presented to the homeowner in person, allowing for discussion and

⁹ A 2013 industry report found that 50 percent of companies offering energy advisor services employed four or fewer staff, and 28 percent of the company's included self employed business owners with no employees (Globe Advisors, 2013a).

interpretation of results, or simply sent in the post with an invitation to call if the homeowner has questions. The home energy audit report can only be requested by a homeowner which presents some challenges.

They [energy advisor] are working directly for the homeowner, who doesn't have a freaking clue in most cases about what is said, right? It would be a lot better if they were dealing with somebody that is going to be doing the work. Like, we we're the ones doing the work. And we're the ones that should be the frontline on it, right? (Builder A, 15 April 2015).

Interestingly, among the CEA's I interviewed, all reported that they rarely, if ever mention the idea that building operations and climate change were connected, and that the topic of climate change was rarely raised by clients. CEAs, by way of their quasi-governmental status, regular contact with both homeowners and government institutions, make them powerful intermediaries. Their capacity to influence understandings, norms and meanings is enhanced by their ability to move freely between the two domains.

Electricity and gas utilities

Energy utilities are key intermediaries in Vancouver's retrofit STSP, and like energy advisors can be seen as both an in- and ex-situ intermediary. They are deeply implicated in both policy circles and the daily lives of local residents and businesses.

BC is blessed with abundant hydro-power resources and natural gas, and as a result, the political and economic landscape of the province is fundamentally underpinned by a strong sense of resource abundance and entitlement. The links between resource abundance and the daily lives of British Columbians is reflected in the BC Hydro's stated purpose: "*The electricity generated by our dams and delivered by our transmission and distribution infrastructure has powered B.C.'s economy and quality of life for generations*" (BC Hydro, 2016). The focus on maintaining notably low electricity tariffs, and a pricing structure that does not account for peak and off-peak use for end-users, ironically removes incentives to conserve, despite BC Hydro's efforts to promote energy conservation which are delivered via its Power Smart program (Murphy and Jaccard, 2003). As one participant explains,

electricity is coming from 80 percent out of hydro. And because it's focused on GHG emissions rather than energy efficiency, it is relatively easy to calculate everything kind of nicely because the emissions are relatively low. But a lot of hydropower is used. So that doesn't mean it's energy-efficient, and it also doesn't mean it's green. [W]e keep energy prices on the low. At least, for us currently, that's true, because hydro is not fully priced. [...] Our electricity is so cheap because it's subsidized (Environmental NGO B, 22 June 2015).

British Columbia also enjoys enormous natural gas reserves in the Northeast of the province. Via a complex network of wells, purification plants and distribution pipelines, this resource is distributed to homes and businesses in every corner of the province by FortisBC, an investor-owned corporation. Together, BC Hydro and FortisBC comprise the principal utilities engaged in the energy retrofit space in Vancouver. As each operates as a monopoly in their respective energy supply domains, both are regulated by the BC Utilities Commission (BCUC).¹⁰

BC Hydro's PowerSmart energy efficiency program started in 1989 and to this day, promotes energy efficiency investments to all BC residents, businesses and industries. In its early days, the program encouraged energy conservation among its customers through actions including energy bill inserts and information kiosks at community events. When the program started, BC Hydro successfully argued to BCUC that expenditures on energy conservation be treated the same as capital expenditures, and hence deserving of a reasonable return on investment. As a result, BC Hydro can recover the cost of all of his energy conservation initiatives, including the PowerSmart program, by increasing customer tariffs. BC Hydro's substantive entry into the home energy retrofit space was triggered vicariously in 2007 by the launch of the federal government's ecoEnergy Retrofit program that provided financial support, on a 50/50 cost-shared basis with the provinces, for energy-saving home retrofits (NRCan OEE, 2007). Once in, the Province of British Columbia created a home energy efficiency rebate program called LiveSmart BC in 2008, and requested that BC Hydro partner with it to help deliver the program. In a June 2008 press release, Environment Minister Barry Penner launched LiveSmart, a

¹⁰ The Commission is an agency of the provincial government charged with regulating rates and standards of service quality provided by natural gas and electricity utilities operating in the province. BCUC is also responsible for approving utility infrastructure plans and ensuring reasonable returns on invested capital, and government energy policy is practically implemented.

"campaign to help British Columbians make better energy choices and explain how the province of B.C. plans to handle climate change issues" (BC Ministry of Environment, 2008). As a Crown corporation, and for the first time in its history, BC Hydro became intimately associated, and hence aligned, with a Provincial program aimed explicitly at addressing climate change through home energy conservation.¹¹ Today, BC Hydro is a key intermediary in the housing retrofit system; it jointly delivers the *Home Energy Retrofit Program* (HERP) with FortisBC which involves an awareness campaign and provision of financial incentives to upgrade insulation, replace windows, draught-proof windows and doors, and replace inefficient boilers, heating systems and appliances (BC Hydro, PowerSmart, 2017).

BC Hydro is generally seen as a legitimate source of practical and reliable information pertaining to home energy consumption. However, despite senior levels of government linking energy efficiency and conservation directly to climate actions, such an association is almost completely absent within BC Hydro's energy efficiency initiatives. Whereas the provincial government engages directly and strategically on the issue of climate change, BC Hydro's Integrated Resource Plan, and indeed its entire website (including the PowerSmart and HERP sections), make little or no mention of climate change (BC Hydro, 2017, 2013b). Where mention is made, it speaks to the potential risks that climate change represents to BC Hydro's operations and infrastructure, or the relatively low GHG emissions associated with hydroelectric power. One place where BC Hydro does explicitly link the two is where they compare their electricity tariffs and GHG intensities (seen in grey cloud) with those of other power utilities (Figure 5-4).

¹¹ Thanks in large part to BC Hydro's long history with energy conservation campaigns, and the climate-friendly beliefs of the province's premier between 2008 and 2010, BCUC approved BC Hydro's *Integrated Resource Plan* requiring two thirds of all new demand for electricity be met through increased energy efficiency (BC Hydro, 2013b) including through interventions like home energy retrofits.



Figure 5-3 BC Hydro electricity tariffs and GHG intensities compared with Australia's

Source: Adapted from <https://www.bchydro.com/accounts-billing/rates-energy-use/electricity-rates/residential-rates/generation-rates-co2-comparison.html>

Energy efficiency and conservation is a much less developed part of Fortis' business model than BC Hydro's, which is seen as a North American leader (FortisBC Rep, 09.07.15), even though according to the senior manager I interviewed, "*the company has been engaged in energy conservation for close to 20 years, and demand-side management (DSM) for six*" (FortisBC Rep, 9 July 2015). DSM has been strongly encouraged at FortisBC by BCUC, with the latter organization approving an increase in spending from \$3 million in 2008/2009, to \$34 million in 2014/2015 (FortisBC Rep, 09.07.15). FortisBC, (known as Terasen Gas in 2008), was also asked to partner with the Province to implement the LiveSmart BC program. Both BC Hydro and FortisBC were deputized by the Province to act as traditional intermediaries to further provincial climate change and energy efficiency goals. As the sole distributor and retailer of natural gas in the Province, FortisBC was well positioned at all points within the existing energy market, and eminently qualified to grease the wheels of the new energy retrofit program. Yet in doing so, FortisBC threatened its own shareholder profits, due to reduced consumption or fuel-switching, and it created a confusing and incongruous situation by advocating for climate action on one hand, and actively selling a GHG-producing fossil fuel on the other. By situating Fortis between itself and BC residents, the Province is able to exploit the expertise and market knowledge of this investor-owned company, while

distancing itself from ideological debates concerning energy conservation and climate change. Like BC Hydro, FortisBC's mission statement focuses on safety, reliability and cost, rather than on environmental concerns. The annual report states boldly, "*We're working to deliver the energy our customers need every day—safely, reliably and at the lowest reasonable cost*" (FortisBC, 2015). Thus, partnering to help deliver the LiveSmart BC program and promote energy efficiency and climate action, alter the values of the company somewhat. A memorandum of understanding (MOU) between BC Hydro and FortisBC sheds light on this change in ideological approach.

The MOU, dated 13 August 2012, recognizes the respective expertise of both enterprises, the customer benefits of combining DSM resources and marketing, the positive links between DSM measures and economic growth, and, the differing corporate structures and mandates of the two organizations with respect to DSM. The stated shared objectives include:

- *To provide the most cost-effective DSM programs on behalf of customers and ratepayers, and to reduce customer and marketplace confusion related to energy efficiency and conservation.*
- *To reduce overall energy consumption and net greenhouse gas (GHG) emissions.*
- *To coordinate each party's efforts in support of BC Government's goals.*
- *To share knowledge and research findings* (FortisBC and BC Hydro, 2012, p. 2)

The wording above is interesting as it explicitly mentions GHG emission reductions, and it recognizes customer "*confusion related to energy efficiency and conservation*". Unlike the publically available brochures and website narratives relating to HERP, and published jointly by BC Hydro and FortisBC, the MOU between the two entities reflects a good degree of candor regarding the climate policy interests of the provincial government. Moreover, it illustrates how these two key, and strategic intermediaries, interpret and translate terms like climate change, GHG emissions, and energy efficiency as they navigate between

homeowners (i.e. their customers) and the climate policy (i.e. the provincial government), showing a responsive face to both audiences (Guston, 2001).

Designers and architects

Professional architects, designers and engineers, are relatively absent from the residential buildings sector in Vancouver, yet they do provide an important structuring force to energy retrofits in the city. The City requires architectural drawings for larger renovation projects, however rather than employing professional architects to produce and stamp these drawings, they are commonly prepared by non-certified actors including draftsmen, interior designers, and sometimes homeowners themselves. For many small home alteration projects, for which permits are either not obtained or required, drawings can be simple sketches, or schematic details of just the more complex building elements, for which professional architectural fees are not seen to be justified. One interviewee claims,

It's only the upper percentage that'll afford an architect's services. Not only do they cost money [...] but the design is more elaborate, higher end and more expensive to build. So for the majority of the residential houses out there, it's not suited, it's really not warranted [...] some of the other designers I know did complete the same [BCIT building technologist programme], but a lot of them are self-taught or drafts people (Designer B, 19 June 2015).

Another common practice contractors use to minimize client stress and foster their partner networks is to include renovation design services in their suite of offerings. "So our designers going to decide for you which HRV system to go with. [...] which lighting to use, which you know, air conditioner" (Builder G, 17 April 2015). Design services can therefore come bundled with contractor services, or be secured via sub-contracts with designers who have demonstrated their ability to provide hassle-free designs at non-professional rates. This is reflected by Designer B who reported that historically his clients were split quite evenly between homeowners and builder/developers, yet as he states, "It's moving more to the builders/developer [...] Most of my contacts [are coming] through [...] the builders I work with" (Designer B, 19 June 2015). Thus in terms of designers, the field of actors is again broad and diverse. The dearth of regulatory oversight in the house

design sector, the general sense that professional architectural designs are not worth the expense where houses are concerned, and the proliferation of less formal designers and draft people willing to follow (rather than provide) design advice, represents a challenge for the retrofit sector as the influence of energy efficient design advice is heavily diluted by this relatively impotent sector. Architects and designers are administratively well organized in BC, and among the most highly educated intermediaries within the retrofit STSP. These intermediaries, by way of their training and expertise, have the potential to standardize energy efficient designs, but their voices are rarely heard. Their relative low influence in the housing sector is a reflection of the informal and "*unregulated [construction] industry in BC*" (Designer B, 19 June 2015).

Non-governmental organizations and energy/environmental consultants

If retrofit intermediaries sit in the middle of homeowners and policy circles, then NGO and consultant actors can be thought of as sitting in the middle of the intermediaries. Green building associations and institutes, and sustainable energy advocacy groups play a critical role in capacity building and framing alternate visions of home design, construction, and energy consumption. Among those interviewed, I discovered people motivated by the prospect of enculturating an energy efficiency ethic across all of society, but particularly among those who are responsible for designing, assembling and commissioning energy efficient buildings. The energy and environmental NGOs and consultants working in Vancouver's retrofit STSP are listed in Table 5-1, but looking at the Community Energy Association (CEA) as an example provides insights into how this group of intermediaries tend to operate.

The CEA is dedicated to helping local governments across BC to develop and implement climate and energy plans. In doing so, the CEA geographically cross-inseminates ideas and practices. They are funded through membership dues and project revenues gained from convening local mayors and councillors in a Climate Leadership Council, organizing stakeholder workshops and training, preparing climate action and community energy and emissions plans, and advocating senior levels of government in favour of climate action and related topics, including energy

efficiency. The City of Vancouver is a member of the CEA. The NGO is very much visible within the retrofit STSP; they are true idea brokers and vision makers where energy efficiency is concerned. Importantly, CEA staff rarely make contact with homeowners directly, and almost never work on dwellings directly. However, their work at the community scale nonetheless provides a powerful structuring force for common retrofit principles and motivations. Their mission and values are clear, and interestingly, they take efforts to remain apolitical, neutral information providers. As their Climate Leadership Council website proclaims, the CEA "provide[s] *visible, inspiring local leadership that goes beyond politics as usual*" ("BC Municipal Climate Leadership Council," accessed 12.3.17).

Consultant organizations provide research services to the City, and also prepare technical reports for Council or in support of climate action plans and policy papers. These intermediaries are afforded a high degree of legitimacy and objectivity by local governments, largely due to their tendency of remaining impartial and refraining from taking ideological positions on issues. Importantly, many of the consultants operating in Vancouver, also provide services across the province, and sometimes the country. Despite the fact they never engage in actual in-home retrofit practices, their geographic spheres of influence, combined with their sense of professionalism and expertise, allow these intermediaries to act as powerful retrofit policy influencers.

Material suppliers

Often located within close proximity to areas of high product demand and transportation corridors, both big-box style retail outlets and smaller-scale building supply businesses constitute an important element in the home energy retrofit landscape as they represent a dynamic nexus point where the materialities, normative ideas, practices, and networks of people implicated in the construction world intermingle. The spatial organization of intermediaries engaged in the energy retrofit sector is highly mobile given the broad distribution of residential dwellings. In the city of Vancouver there are approximately 77,000 privately owned homes among which intermediaries can be found on any given day. The network of

material supply outlets scattered throughout the city represents the single place, however distributed, where all intermediaries normally appear on a daily basis.

I'll swing by a supplier on route to the job site. [...] I go to different suppliers. Location is important. I often work on the west side so I have one building supply store that is always well-stocked that I like to go to but I won't go any further than that one good store because it's just too far. I go to different suppliers for different things. I probably visit 6 to 10 different suppliers in an average week (Builder E, 25 July 2015).

Material supply stores can be thought of as the retrofit field intermediaries' 'water cooler', where otherwise highly mobile operatives can bump into each other and share experiences.

Their spatial distribution follows renovation and construction market activity as noted by one interviewee.

The East side is where the renovation market is really, really strong. So [the supply store owner] made a conscious decision to take his whole business to East Vancouver because that's where all his trucks are going now (Builder D, 2 July 2015).

Many of the supply companies operating in Vancouver are owned by a single corporation that acts as a buying group for all of its subsidiaries, a practice that effectively locks in local suppliers to specific product inventories and marketing campaigns. The parent company in this case operates across the country, and along with a few other national corporations, plays a key role in defining the building material market in Vancouver. Supply stores play a key role in educating other intermediaries, especially performance intermediaries, that routinely install materials and technologies in homes. In-store displays, and supply store staff, are regularly used as proxy training media by some intermediaries.

[Builders] would have to come up with a solution [...] And so they would ask us for certain products, [...] it was just understanding what [their] needs were so we could bring in the right products. [...] Well people come to us for solutions, as we've been here offering expertise, so people come asking us (Supplier C, 22 October 2015).

Another interviewee notes,

You know, they [electricians] go to wholesalers. [...] They have displays of the new products. [...] Because it is their way, wholesalers. So they can find a lot of information there. And when they see, once they see the product, they can, you know, like post that to the customers, right? Oh, I just saw this and this, this is how many times new products actually come to us, through the wholesalers (Trades Person D, 24 June 2015).

Material suppliers wield significant influence over the retrofit STSP in that they serve as conduits through which new ideas and products are introduced to the Vancouver market. Interestingly, none of those I interviewed recognized themselves as playing any sort of industry education role. In-store displays are considered normal sales practice, rather than educational initiatives.

Construction Trade Associations

As discussed before, the various associations for mechanical technicians and plumbers, electricians, and homebuilders participate in the retrofit sector, but each has varying degrees of influence over retrofit projects. For instance the Canadian Home Builders Association of BC (CHBA-BC) and the greater Vancouver Home Builders Association (GVHBA) admit that their memberships capture but a small subset of all the builders, contractors and installers operating in the field. Various reports from these organizations indicate a desire to formalize the construction industry generally and professionalize many of the companies or individuals who currently work in the sector without certification, training, or education. By contrast, membership in the Thermal Environmental Comfort Association of BC (TECA) is common among plumbers and mechanical companies, likely because TECA provides insurance and licensing for these actors. As a result of its centrality, TECA is able to influence industry norms and understandings more than the other industry associations.

The CHBA-BC actively lobbies the provincial government and senior levels of government concerning building code changes and building material cost controls, priding itself on defending the interests of the construction sector to policymakers. The overriding impression one gets from the CHBA-BC is that they view energy efficient homes as cost prohibitive for both builders and homeowners alike, and any links between climate change and home-related emissions, as of minor relevance.

[O]ur builders they are you know technically well read, they're savvy, they understand, they're well trained. They know how to do this and so it's not a quantum leap for them to do it. The problem is that if they put it [energy efficient systems and equipment] into every single one of their houses because of the additional capital cost and the long pay-back, it puts them at a competitive disadvantage (Trade Association A, 21 April 2015).

Instead, their focus is on maintaining a robust construction industry in the province by lobbying for investment in training and streamlining building regulations. This entails promoting the economic output of the sector and the skills and capacity of their members to construct new and renovate existing homes, lobbying to keep construction costs as low as possible, and advising homeowners on how to engage with builders and contractors while avoiding poorly trained, fly-by-night operators. The CHBA-BC is very much aware of the construction industry's poor reputation as a haven for under cash-only jobs. This is reflected in a recent annual report which reports on the association's ongoing collaboration with the Canada Revenue Agency to daylight the many cash deals that are typical in the sector (CHBA BC, 2015b). Although it wants to clean up the industry's image through increased training, certification, and engagement with builders, it will likely continue to struggle to influence the bulk of builders and trades people engaged in home energy retrofits in Vancouver as its organizational reach is simply not deep enough. The CHBA-BC is shaping the politics of the construction industry too. Paradoxically, it may be contributing to a two-tier construction industry in the province. It does this by actively condemning informal and un-certified builders and renovators, and vigorously promoting their members which tend to be operating at the higher end of the market with more staff and resources at their disposal. The CHBA-BC does not appear to have any strategy in place to expand its engagement with the larger and more informal group of operators in the sector, which means that divisions between these two groups are likely to remain.

All of these associations offer training courses for their members, many of which are voluntary. The CHBA-BC for example, offers a series of courses, some of which relate to house-as-a-system, and energy efficiency. It also publishes a weekly newsletter that provides members with updates about building related issues. Although some of my interviewees reported being a member of this association,

these individuals were typically associated with more formal and professional enterprises, rather than the more numerous and informal one-man enterprises. In contrast, Builder F, who in many ways is most representative of the bulk of the individuals renovating homes, is not a member, has never attended any training offered by the CHBA-BC, and has never been approached by the Association. In all likelihood Builder F is invisible to the CHBA-BC.

5.6 Conclusion

All policies encounter challenges, and examining Vancouver's retrofit intermediary landscape juxtaposed to fluid homeowner values and interests, confirms that this is indeed the case in this Canadian city. While retrofit and energy efficiency policies rely on stable assemblages of related materials, know-how and motivations among intermediaries charged with upgrading the housing stock, the research finds this not to be the case. The research suggests neoliberal and non-conservationist values related to the energy performance of homes tend to sit more comfortably and commonly with intermediaries working in the retrofit system of provision, than relatively fuzzy arguments that couple climate action, high levels of home energy efficiency, and community resilience. Using socio-technical systems and intermediary lenses, I then showed how there are, in the middle of this ideological tension, strategically placed yet remarkably diverse intermediary actors that are fashioning a collective vision regarding energy improvements via their normal daily practices and processes of sense-making. In contrast to previous thinking on energy retrofits, the research highlights an intermediary landscape characterized by many more actors than previously thought; a plurality of daily business concerns and interests, varying appetites for new ways of configuring private homes in favour of energy efficiency, and wide ranging perspectives on the relationships between climate change, the home, and energy efficiency. In the face of this contested situation, a practice-inspired intermediary typology was proposed that seeks to distinguish between those intermediaries who influence building practices directly through repeated daily performances of physical acts (in-situ intermediaries), and those who influence building practices more indirectly through the reinforcement of collective visions, norms and principles through space and time (ex-situ

intermediaries). Distinguishing between different intermediary types allows for more granular views of the furthest corners of the retrofit STSP, and can offer policy makers and researchers a new avenue by which to interrogate the diverse ways in which intermediaries influence retrofit practices. Having laid out for the reader in Chapter 4 some of the reasons why retrofit policy is being impeded, and discovered the ecosystem of middlemen implicated in their emergence in Chapter 5, the next chapter looks at how intermediaries contribute to the formation of new retrofit practices, and possibly, a new retrofit practice bundle.

Chapter 6 From intermediaries to practice and back again

6.1 Introduction

This chapter seeks to build on theories of practice by connecting the practices of intermediaries to the emergence of novel retrofit practices and practice bundles. The proposition running through this chapter is that the retrofit practices visible today in Vancouver are determined via a co-mingling of intermediation acts of trust-building, interpretation, and translation, alongside routine and rather mundane activities and relations of intermediaries operating in the retrofit STSP. Referencing a praxeological epistemology, I contend that although levels of commitment and understandings of internal reward among intermediaries does vary, these important middle actors continue to materially influence the emergence of a new way of configuring the physical organization and energy performance of residential dwellings.

The chapter opens by exploring the relations of trust, collaboration and information exchange between intermediaries, and arguing that these materially shape collective understandings concerning retrofit logics among these same actors. I propose that intermediaries are being called upon by climate-related policy goals to reorder relations between both existing and new practices, and in the process, act as a largely invisible medium for retrofit policy. In the third section I show how practices of translation, interpretation and gate-keeping are being employed by intermediaries to shape broader understandings of home energy efficiency logics. The chapter concludes with empirical evidence of recognizable retrofit practices, and what may be, emerging retrofit practice bundles.

6.2 Intermediary relations and the practice of retrofit

The discussion below examines the relations between the intermediaries (in-situ and ex-situ) operating in Vancouver's retrofit space, as I argue that the network configurations of intermediaries in the space between policy makers and homeowners plays a determinative role in the evolution of retrofit practices. To this extent I first explore who interviewees understand to be the principal actors in the retrofit system, and then compare this picture with the professional collaboratives within which these same intermediaries participate on a daily basis. This is then

followed by a look at retrofit information dissemination channels and levels of trust between intermediary groups. The section closes by examining an example where these network relations facilitate a reconfiguration of practice elements and the subsequent evolution of the new practice.

All interviewees were asked to list whom they believed were the main actors in Vancouver's retrofit space (Figure 6-1) in terms of their influence over the process of energy retrofitting homes. The responses paint a picture of what intermediaries or groups of intermediaries constitute the retrofit system, shed light on how its workings are understood by intermediaries, and reveal which group may have the most influence over collective retrofit skills, materialities and meanings. The aggregated verbal responses of subjects reveal the perceived influence and importance of in-situ intermediaries (e.g. builders, contractors, designers and sub-trades) in the delivery of energy retrofits, and the relative unimportance of ex-situ intermediaries (e.g. building associations, engineers and senior levels of government) (Figure 6-1). Shove et al. (2012) remind us that skills travel by mental processes among actors who exchange theoretical ideas with other actors who have the capacity to decode or adopt the skill, so knowing which intermediary group holds the power to influence how a practice is interpreted and reconfigured stands to enhance policy design and implementation.

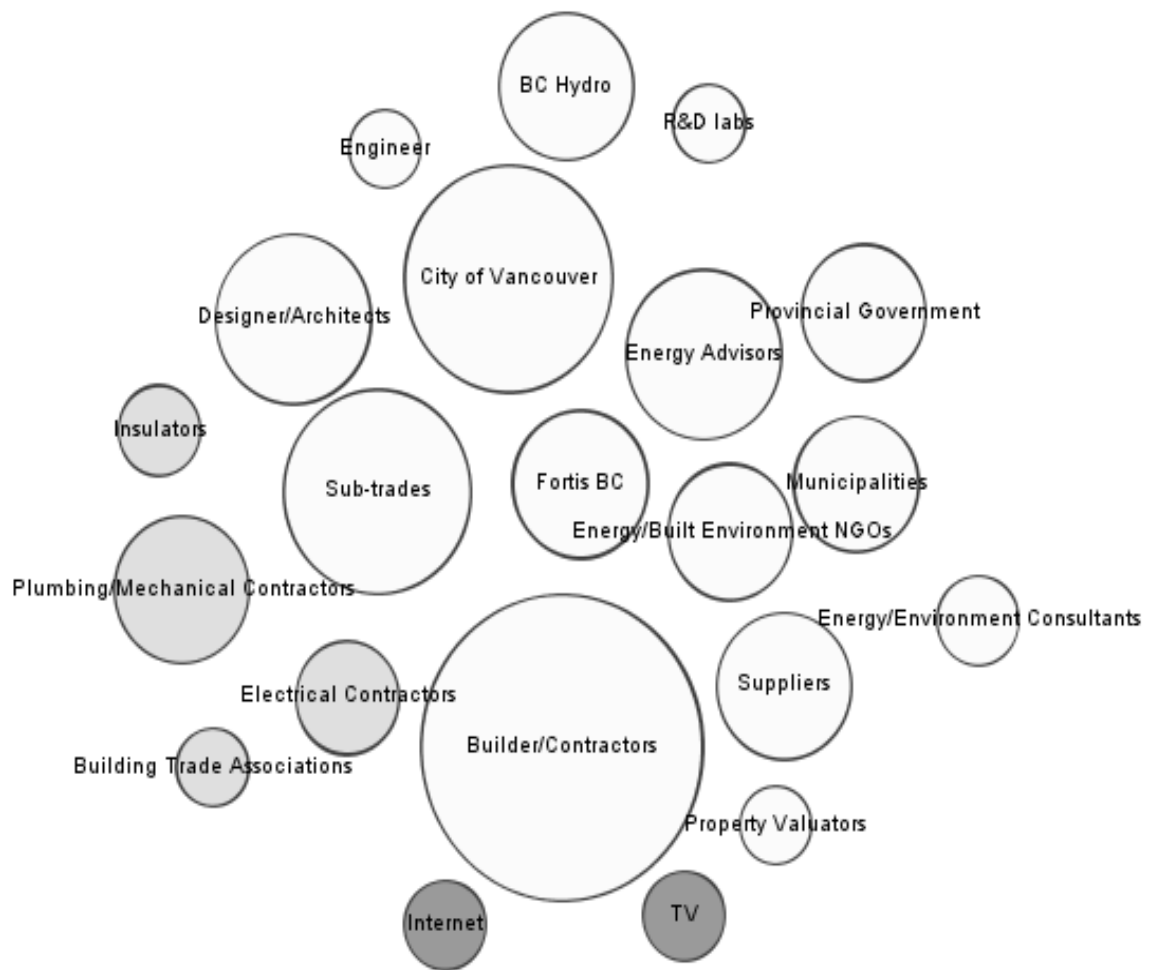


Figure 6-1 Interviewees understanding of the most influential (diameter) actor groups (shaded) in Vancouver's retrofit system

What is interesting to examine is how intermediaries' perception of the system they work within aligns with their own daily collaborations and working relations with other intermediaries. Figure 6-2 provides a different, relational map showing which actor groups, selected from a list, are deemed the most important when the subject engages in retrofit work.¹² These normal, day-to-day partnerships are critically important as they help establish regular communication channels and information exchange opportunities. The figure highlights the actor groups that all interviewees collaborate with the most and depicts a slightly different picture than that presented in Figure 6-1, as a mix of in-situ and ex-situ intermediaries (e.g. energy advisors, the provincial government, BC Hydro, the City of Vancouver, and

¹² It should be noted that retrofits may only constitute a portion of an intermediary's sphere of competence.

suppliers) are identified as common partners. It also illustrates in more concrete terms how a retrofit practice-as-entity is sustained via a nexus of sayings (i.e. communications between intermediaries) and doings (i.e. project activities undertaken in partnerships), and linked through space by understandings, rules, norms and motivational goals.

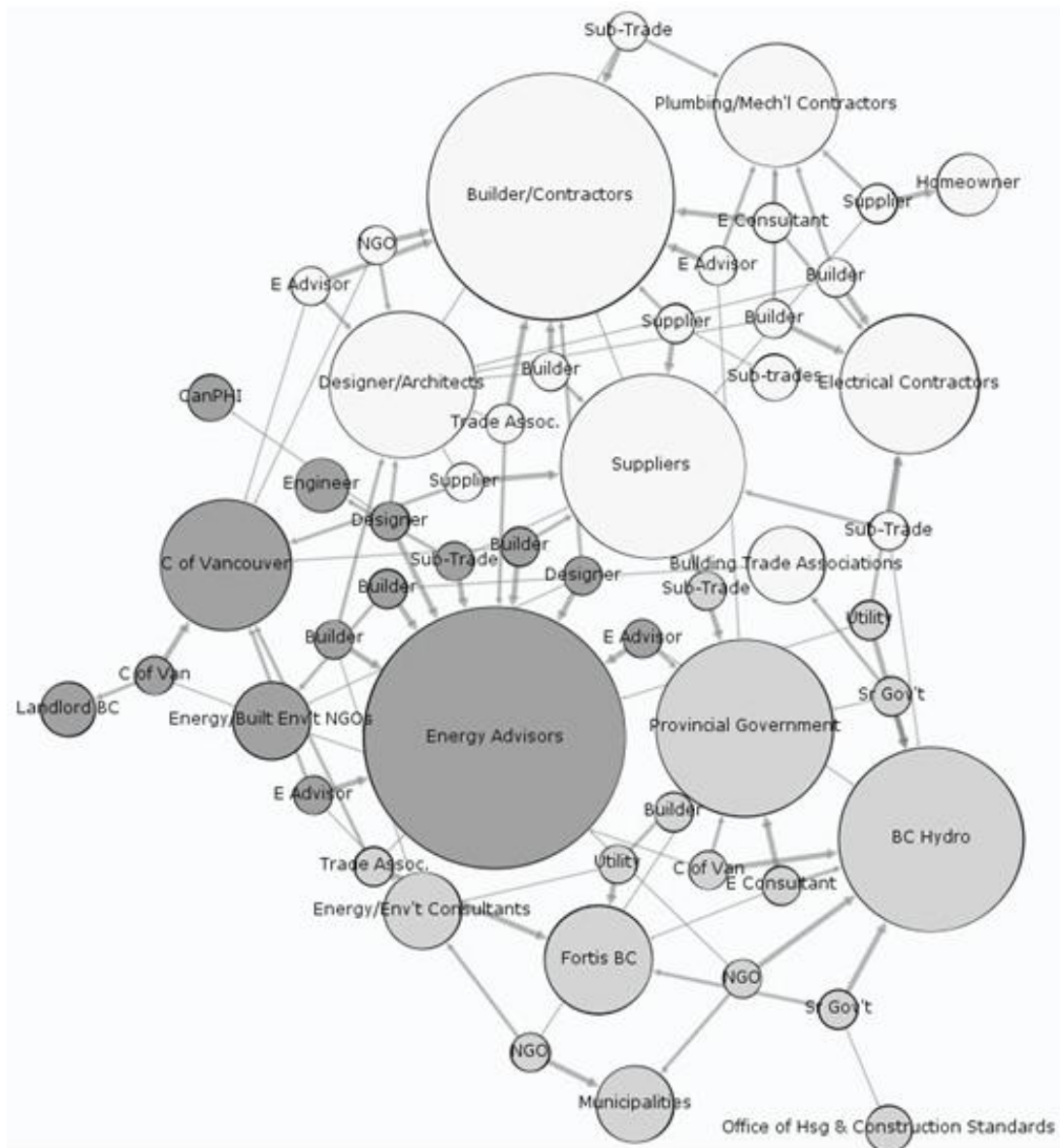


Figure 6-2 Network map showing regular patterns of collaboration between intermediaries.

Shaded collaboration clusters showing those intermediary groups (varying diameter spheres) interviewees (small spheres) most frequently collaborate with to deliver retrofit projects.

These network maps allow for three key observations. One, there is only partial overlap between the retrofit intermediaries that interviewees believe exert the most influence on the retrofit socio-technical system of provision, and the intermediary groups that the subjects themselves collaborate with on a daily basis. Two, ex-situ intermediaries are underrepresented in collaboration arrangements; the intermediary groups most often partnered with by other intermediary actors are almost always in-situ intermediaries. This pattern is consistent with the practical aspects of retrofitting homes, and the fact that ex-situ intermediaries typically operate beyond this scale, but their relative absence signals a likely impediment to retrofit practice stabilization which requires broad-based, and collective understandings, motivations and rules. Three, there is considerable variability among participants with respect to which groups they regularly partner with (whether in-situ or ex-situ intermediaries), despite often working in the same professional sector. This suggests that where fostering a common set of meanings, values and norms is concerned, the system lacks a dominant or clearly defined thought leader. In its place, the evolving retrofit system in Vancouver reflects the voices of several, similarly influential intermediaries, surrounded by a constellation of far less influential intermediary groups. Such a fragmented network structure impedes the formation of an unambiguous retrofit practice.

Levels of professional trust between intermediary actor groups is presented in Figure 6-4. The map edges (connecting lines) shown in Figure 6-4 include only those participant responses where they either strongly agreed (dark) or agreed (lighter) that a particular actor group provides practical information on matters related to home energy retrofits. For in-situ intermediaries who spend much of their time in people's homes, having trusted information sources is particularly important as they often have no one to turn to for advice except themselves.

Two thirds of all responses were either 'agree' or 'strongly agree' to the question of trusted information source, with only four out of 484 responses indicating, 'strongly disagree'. Figure 6-4 shows that there is a generally high level of trust for the information that flows between intermediaries in the retrofit system, regardless of its source. It also shows, given the existence of four weakly defined communities

(i.e. low density), that certain groupings of actors tend to undertake intra-group exchanges of information more frequently than they do with other intermediaries. For example, the reliability of retrofit information from sources including energy advisors, BC Hydro, NGOs, the City of Vancouver, and consultants may well be understood in the same way by a subset of interviewees including builders, energy advisors, and an NGO, but not by two other groups of interviewees. Moreover, the idea of home energy efficiency makes good sense to several interviewees representing green building NGOs, energy advisors and utilities, whereas this concept enjoys far less acceptance among trades people who actually intervene directly in those systems. One participant, when reflecting on those intermediary actors he perceives as being supporters of home energy efficiency, suggests,

there are a few groups somehow working the same direction. I mean, there is the Canadian Green Building Council, there is, for example, Light House [Sustainable Building Centre], even if that's a really small and local influence. But there is the Canadian Wood Council, [...] And certainly, plumbers and electricians are probably kind of the last ones, in terms of pushing (NGO B, 22 June 2015).

Exchanges of information and theoretical ideas related to retrofits can facilitate the travel of practice skills and meanings, and thereby increase the chances of a new practice taking hold, so these communication channels are key. The data presented in Figure 6-3 reveals some of these communication channels. In-situ and ex-situ intermediaries tend to communicate more frequently with their own (i.e. white bars), while communication channels between members of the in-situ group and policy circles is notably lower than those channels between ex-situ groups and policy makers (i.e. black bars generally lower on left of graph than on right).

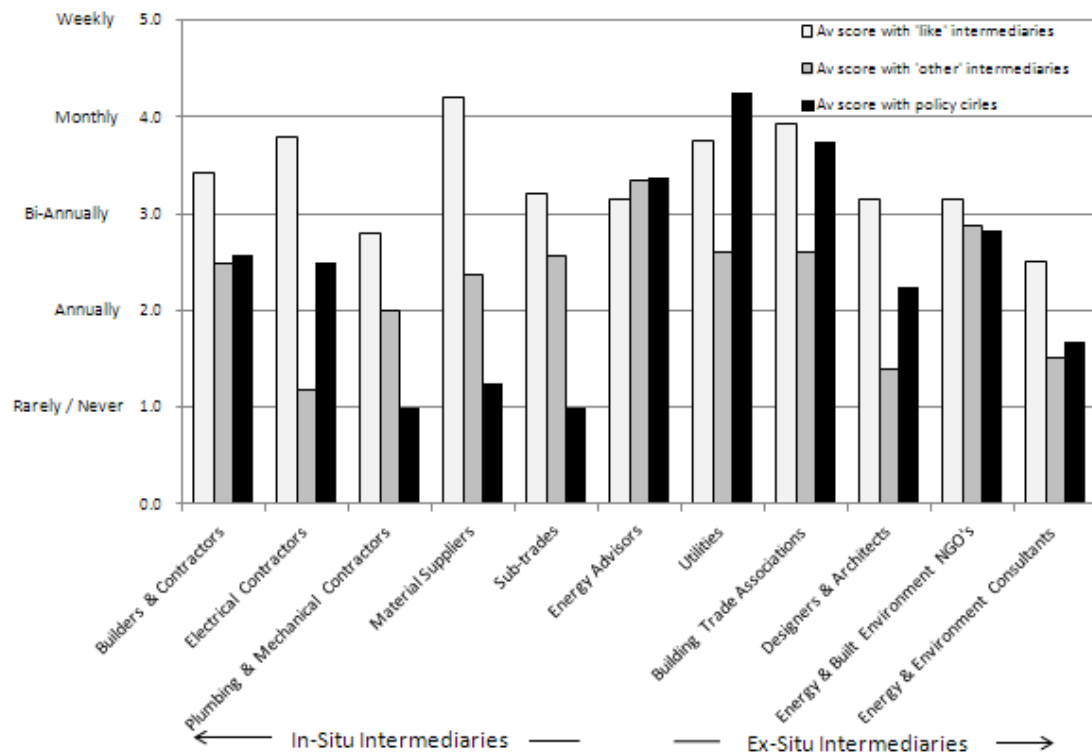


Figure 6-3 Intermediary communication paths and frequencies

The hybridity of energy advisors and utilities is also reflected in Figure 6-3, as these groups display more uniform rates of exchange with all groups in the system. The data also suggest a fair degree of fragmentation between intermediary trust circles, which indicates that no single intermediary group within the retrofit system of provision stands out in terms of providing trusted, practical information. A situation that can impair the creation of system-wide understandings and norms. This sort of trust between intermediary groups is also manifest on job-sites. One sole proprietor builder expresses how trust relations impact his client relations.

Certainly the trades have quite a bit of power. Homeowners are always looking for somebody to guide them and they often turn to the trades because they have expertise. If I had a different opinion than a tradesperson then it would certainly make it difficult for me to get my way in front of the customer (Builder C, 25 June 2015).

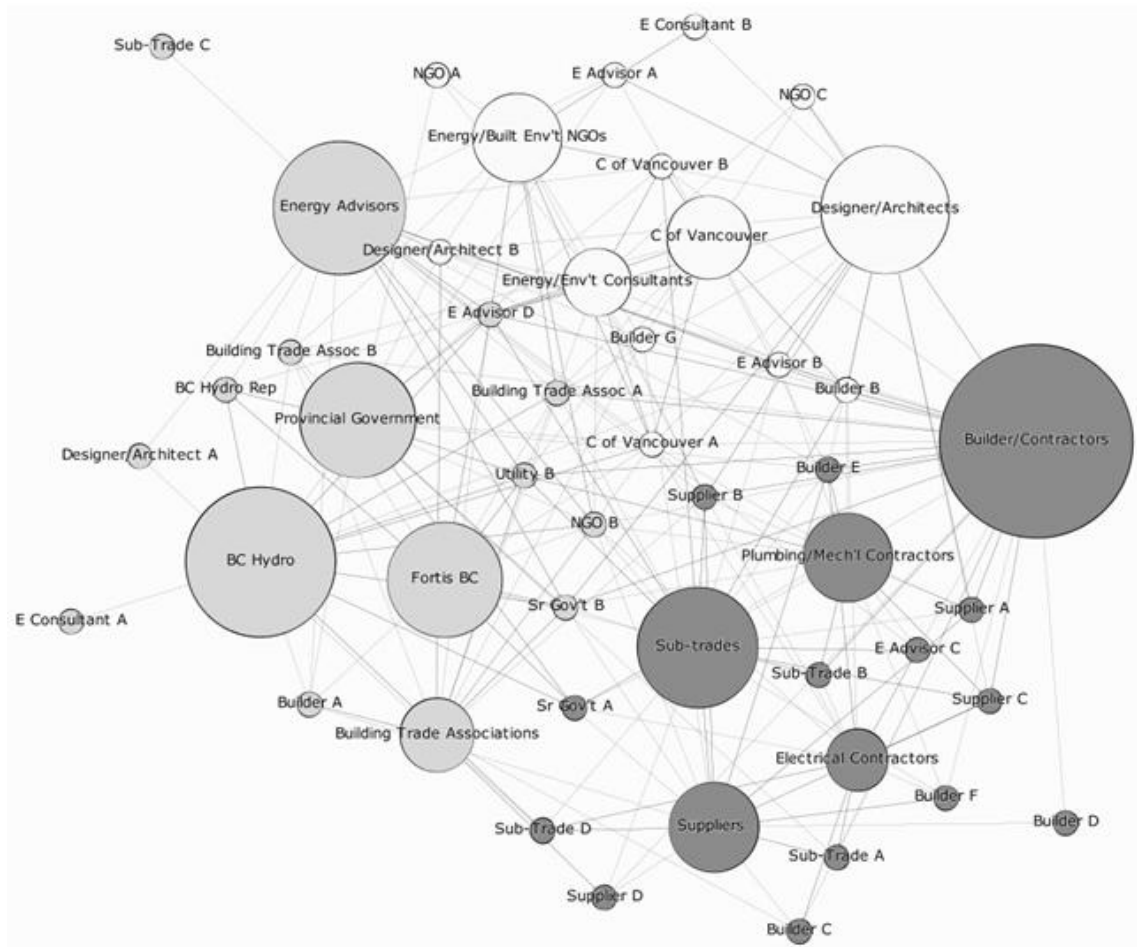


Figure 6-4 Map of information source trust levels
 Interviewees' (small-diameter circles) levels of trust in information flows from intermediary groups. Diameter of intermediary group reflects aggregated interviewees' trust levels, and shade denotes groups structured on trust.

Practical skills, know-how and norms regarding energy retrofits are transferred via common communication paths between retrofit intermediaries. However, the persistence of the know-how, values and concepts passing between retrofit intermediaries within emails, technical notes, bulletins, sales brochures, material specifications, code updates, reports and even telephone calls, is constrained by the recipient's capacity to decode and interpret the signals embedded in these. Further, the travel of a practice through space is heavily linked to the proximity, accessibility and mobility of its constituent elements, and also to existing skills and meanings shared among local carriers. That there appear to be distinct and separate circuits of trust, communication and collaboration among intermediaries in Vancouver's

retrofit STSP, suggests that the channels through which practice elements can travel are underdeveloped and less likely to facilitate retrofit practice adoption by carriers. One intermediary's reflections on learning preferences is consistent with this observation:

I gather information from a variety of sources. Every day I'm looking like at newsletters or websites and things like that. I do watch video on [solar installations]. I think the most valuable thinking time for me is when I'm by myself and I can digest all of that [...] perhaps I grab a little idea or small innovation or approaches to certain problems and that's when I really learn them. I mean, I can teach myself (Trades Person C, 24 June 2015).

Beyond the contents of these information flows, the paths themselves are also important. They constitute connective tissue that reflects relations between intermediaries, which in turn play critical roles in creating and maintaining practice structures. The situation described by a builder in particular offers a good example of the routine ways in which arrangements of materials and meanings travel. In this case, Builder E recounts how he routinely learns about new products and technologies during visits to material supply stores.

If I have a question I'll look it up on the Internet and I'll see videotapes that other people have posted. [...] I don't attend workshops or seminars. I learn in supplier stores by reading whatever brochures they have (Builder E, 25 June 2015).

This reveals how these kinds of daily activities, not only provide an opportunity for the transfer of new ideas or reinforcement of existing ways of making sense of the actor's world, but also highlight a principal conduit through which building materials are appropriated by intermediaries and transferred from the manufacturer to the private dwelling.

Where information flows among intermediaries in Vancouver's retrofit space are concerned, Figure 6-4 reveals two principal dynamics. The first is that builders and contractors are the most active communicators within the system, followed by the two local utilities (BC Hydro and FortisBC), energy advisors, and designers. However, a participant representing a utility reveals how collaboration is impaired by concerns over legal liability:

[...] from the utility's perspective, and I think this applies to both utilities, we're very hesitant to associate ourselves with contractors because of the potential risk and liability for us in the long term. So if we're telling a customer, go get your insulation done by this contractor, and we've done stuff like this in the past with previous programs that's come back to bite us eventually because something goes wrong with that job either next year or 10 years from now, it's the utility that ends up owning it. At least from the customer's perspective, because they see us as a very . . . well we were pushing that program or contractor (Utility Rep A, 9 July 2015).

The frequency of communications from the City of Vancouver and the provincial government is less, despite the stated desires of these two levels of governments to kick-start the retrofit industry. This observation is however consistent with the present research's proposition that governments routinely fail to connect with many intermediaries active in Vancouver's retrofit STSP.

The second dynamic that is visible in the network map depicted in figure 6-3 is the appearance of some quite well defined groupings. As mentioned above, the similarly shaded nodes suggest that these nodes, and the nodes connected to them, are more interconnected with each other than they are with the other nodes or communities in the overall network. One community appears in the bottom right corner and largely consists of in-situ intermediaries that are heavily implicated in the actual doing of energy retrofits. This group includes builders, contractors, suppliers, plumbers, electricians, and other sub-trades. To be clear, builders and contractors are disseminating information to intermediaries beyond this smaller subgroup, but there is still a considerable amount of information circulating within a single subset of the larger network. At the same time, two other groups (left and top) display similar community characteristics, pointing to a situation where three virtual echo-chambers are co-existing within the same retrofit STSP.

The left side of the network map shows another community that appears dominated by more formal and institutional actors including energy utilities, the provincial government, and building trade associations. Unsurprisingly, the majority of actor groups receiving information from these organizations include consultants, designers, senior government officials, and utility staff. This group could be described as institutionally related to home energy retrofits. At the top of the same

figure is a third community. Unlike the other two communities, this community appears to be less engaged in disseminating information to other intermediaries. It includes the City of Vancouver, designers and architects, energy consultants, and NGOs, actor groups that traditionally sit furthest away from the site of the home, but whom ironically exhibit the strongest desires to see a robust suite of retrofit practices emerge.

Intermediaries in Vancouver have a unique understanding of the system of provision within which they operate. While trust levels, in terms of an intermediary's perception of another intermediary's ability to provide practical, credible information about retrofits, are universally high among those interviewed, the flow of information regarding retrofits is not so evenly distributed throughout the system. Some groups like builders, contractors, energy advisors and the utilities appear loud and vociferous, while other groups like the sub-trades, building trade associations, consultants, and NGOs are far more muted. There does appear to be evidence of sub-group clusters of intermediaries talking amongst themselves and possibly creating their own echo-chambers. Mapping these dynamics is important if we are to understand how norms, know-how, and practice innovations move through space and time. In this case, it has permitted the day lighting of three otherwise invisible and autonomous communities. Moreover, these insights may be able to guide policy interventions, the success of which depends on effective messaging to particular intermediary audiences.

6.3 Those who talk together, act together

How then do these network relations between Vancouver's intermediaries contribute to the creation and evolution of a new retrofit practice or retrofit practice bundle? To answer this question, the emergence of on-demand boilers is used as an example. A long established home alteration practice like replacing a home's boiler can be reframed as an energy retrofit practice by adopting a new material or technology, or by reorienting the logic or motivation behind the practice performance. This in many ways is what is happening in Vancouver's retrofit space today.

On-demand boilers have been common in Europe since the mid-twentieth century. As their name suggests, they heat water (whether potable or used for space heating) only when need is signalled by a thermostat or an occupant opening a hot water tap. These boilers are considerably smaller than the traditional North American hot water tank with integrated boiler, and they negate the need to continuously store hot water at between 55 and 60°C. In addition to their space saving qualities and the energy benefits resulting from not having to constantly heat 100 to 150 litres of portable water, integrated flue-gas heat recovery allows on demand condensing boilers to reach efficiencies often greater than 95 percent. This is considerably higher than the 60-70 percent efficiencies observed in North American hot water tanks.

Plumbers and heating/mechanical specialists have long been aware of on-demand boilers, but the inertia of the standard hot water tank model in Vancouver and concerns regarding the need to wait for hot water to arrive at the tap, have kept demand for this technology low. In recent years however, global sales and distribution networks and improved boiler performance have encouraged local suppliers to stock this technology and more aggressively market it to their trade clients. Product familiarization and technical training sessions are offered to plumbers and mechanical trades people by manufacturer's representatives in collaboration with suppliers. The relations of trust, mutual respect and frequent communications among members of the same profession, facilitate the transfer of theoretical and practical ideas between these two actor groups. Those who talk together, act together. The practice of installing on-demand boilers is thus in the process of traveling from Europe to Vancouver, due to enhanced local access to a new technology, and recently developed skill sets and know-how.

Viessmann were the guys to really start selling the on demand heater. Others have come since and there are now some local companies building this stuff. It's only recently. It's only in the past few years that things have taken off. And the efficiency's going up and up, and the units are getting smaller and smaller. So you can take a mechanical room that maybe used to be five by ten. Now, I can put all the mechanical equipment in a room less than four by four, including the vacuum (Builder D, 2 July 2015).

The availability of locally manufactured on-demand boilers over the past decade provides an example of the transfer of material artifacts and know-how through space, in this case between Europe and Canada. So whereas the actual technology and the expertise regarding on-demand boilers first came from Europe, one builder confirms that he uses a local manufacturer, located some 60 km to the east of the city, to provide his high-efficiency on-demand boilers. The interviewee points out that where the Viessmann on-demand boilers are concerned,

[I've] moved on from them. But I love their stuff, I think it's great. [...] But I picked a local supplier because they're built in the Valley and their service is incredible (Builder D, 2 July 2015).

The recognition that suppliers are legitimate decoders of construction-related concepts is reflected in my conversations with in-situ intermediaries. Suppliers appear to act as important information clearinghouses and are generally well trusted by their clients. Consequently, it is common for trades people to develop a sense of what technologies and materials 'make sense' during their frequent and regular interactions with suppliers. In this way, supply stores are elaborated as learning spaces by the practice of upgrading the energy performance of water boilers.

This suggests that for new ideas, and new equipment, easily accessible customer support is seen as essential. It also provides an interesting example wherein technologies structure practices, and practices materially structure technologies. In many ways the arrival of on-demand high-performance boilers from Europe represents a disruptive technology for the local Vancouver home heating market, but the local practice amongst home alteration and retrofit professionals of seeking local suppliers and partners to maximize accountability and minimize business risk, exerts a reciprocal structuring force by redefining acceptable technology manufacturers. In this case, the builder/contractor is connecting the on-demand boiler with several key concerns. First, is the goal of increasing efficiency and reducing energy costs for his client. Second, the builder perceives increased liability and risk when utilizing relatively new and untested technologies, and thus actively seeks to reduce financial and performance risk through having ready access to local

technical support. Third, the builder is very aware of the potential to reduce the amount of space needed for mechanical equipment, and hence increase the amount of liveable space in the house. He knows that usable and sellable space is of critical importance to most homeowners, and he turns to this sensitivity to promote a technology he believes makes sense. What this indicates is that the practice of boiler replacement to improve a home's energy performance can include variants of itself depending on the relations between its elements, and that the structure of these relations can vary depending on which intermediaries are involved in its performance. In the present example, a high-performance, condensing, on-demand boiler, connects to the two other elements in the practice of boiler retrofit through relations of understanding and motivation related to increased livable/sellable area and energy cost reductions for the homeowner, risk mitigation for the builder, improved energy efficiency of space and water heating, with no explicit mention of satisfying climate goals.

The intermediaries operating in Vancouver's retrofit space include actor groups that have traditionally been involved with making alterations to homes in one way or another, but they also involve new intermediary actors. The discussion above has shown that these diverse intermediary groups are related to one another through functional linkages defined by particular areas of expertise, routine information sharing, and perceptions of credibility and trust where knowledge about home energy retrofits is concerned.

6.4 Retrofit practice dynamics

The practice of retrofit can be thought of as the widely accepted way of configuring, assembling and installing materials to effect efficient use of energy in buildings. It arises out of the fusion of interests carried by public policy, technologies, materials, and workforce training, know-how and skills. The fusion of these interests is the result of active and daily negotiation and vision building by members of the retrofit socio-technical system. This conceptualization suggests that members of the retrofit sector perform double-duty; they engage (either directly or indirectly) in retrofit practice performances (e.g. insulating, air-sealing, advocacy, information dissemination, etc.), and they also shape the meanings, values and norms (i.e.

processes of intermediation), that give life-sustaining force to the practice, via their daily performances of same. In this way the relation between the practice of retrofit and intermediaries is mutually reinforcing and reciprocal.

Element management

From a retrofit practice perspective, interpreting meanings, values and imageries can support the persistence and transfer of related practices, but it can also reconfigure practice element organization and lead to altered or possibly new practices (Killip et al., 2013; Shove et al., 2012). If practices depend on repeated, identifiable performances for their persistence, and intermediaries are capable of materially altering the relations between the triad of elements that underpin these, what does this mean for the stability of the practice of retrofit? Does intermediation contribute to the mutating or breaking of practice elements, or the creation of new practices (good or bad), and what are the implications for sustainable housing transitions when intermediaries operate in contested spaces while pursuing their own interests, be they political, social, commercial, or organizational? Van Lente et al. (2011), Guy and Shove (2000) and Moss et al. (2009) are interested in these questions and suggest that intermediaries, by virtue of their middle position, have the potential to co-construct ideas, meanings, understandings, and relations that materially influence things like building practices.

Knowledgeable grasping, assembly and deployment of elements is essential for a retrofit practice to emerge. Without skilled intermediary carriers to configure retrofit elements in recognizable ways, they remain unlinked and meaningless. The installation of on-demand boilers is an example of replacing two practice elements, the hot water tank as a relatively inexpensive material element, with another, more expensive technological assembly, and an old idea of a boiler's appearance and economics with a new logic based on saving money and space. In reconfiguring the material elements of the practice, the plumber must redefine the financial logic and motivations embedded in boiler replacement so that long-term financial gains can win out over short-term savings. When asked about his opinions regarding on-demand boilers, one interviewee replies,

You know, we haven't stuck a traditional forced air furnace or a traditional boiler unit in probably six or seven years, it's all on-demand. Radiant heat, all on-demands, 97.5 percent efficiency. Compared to a stand-alone boiler that was running, you know, running its own system [...] Had a separate hot water tank with it, you know, those would be 65-70 percent [efficient]. Everybody goes and spends the money on the higher efficiency. [...] That's an easy sell. They're 97 percent efficient. So, basically, the energy that boiler is burning, 97 percent of it is going into heating your hot water or heating your radiant heat (Builder D, 2 July 2015).

In this way, plumber and mechanical performance intermediaries are decoding and reconfiguring elements to create a new form of an existing practice (i.e. boiler replacement).

Draught-proofing provides another example where we can see elemental reconfigurations by in-situ intermediaries. The triad of elements involved in this discrete practice includes some form of insulative material, an ability to fill building envelope cracks and voids with this material without packing it too densely and creating a thermal bridge, and a belief that deploying this material and skills will serve to prevent unwanted airflow and occupant discomfort. Although this practice appears to be quite straightforward, the relations between its constituent elements and hence its essential nature, can vary substantially. From a materials perspective, I have observed while working as a junior carpenter, strips of newspaper, sprayed foam, silicone caulking, and fibreglass insulation used to draught-proof homes. And depending on the material used, installers will employ metal spatulas, flathead screwdrivers, caulking guns, or their own fingers to fill cracks and gaps. The choice of material, the human actor involved, and the technique used, will depend on temporal and spatial factors. A handyman employed to curtail airflow around some of a home's windows and doors may well choose to use a tube of generic caulking and his moistened fingers to complete the task within two hours, whereas a carpenter or builder engaged in a multi-month, whole-home gut and re-build project, where walls, floors, and ceilings have been opened up, could choose insulating foam spray applied to all exterior openings via specially adapted nozzles, and augmented by diligently applied air barrier tapes and sealants. The former has a much smaller spatial and temporal footprint and involves arguably simpler materials and skills than the latter, however both constitute the draught-proofing

practice and similar space-filling materials. Equally variable is the internal logic or reason behind draught-proofing, a factor that is particularly relevant to the rationale underlying on energy retrofit policy.

The configuration of elements within the practice of draught-proofing can be further altered by other actors engaged in related practices. Energy advisors operating in Vancouver perform home energy audits to assess energy performance and make recommendations for energy retrofits based on those audits. Central to the energy audit is the blower door test which provides a measure of a home's air tightness. A home's air tightness is measured by the number of times the volume of the air in the home is exchanged per hour, and what is the homes effective leakage area. The effective leakage area sums the areas of all cracks and gaps in the buildings envelope and represents this as a single opening with an equivalent area. The lower the effective leakage area and the number of air changes per hour, the more energy-efficient the home is. These metrics are integral to the energy audit practice performed by energy advisors, but they also serve to reconfigure relations between the elements in the practice of draught-proofing. Cracks around windows, doors and vents are seen not simply as sources of unwanted airflow, but rather as contributors to what amounts to a gaping and permanently open hole in the side home's envelope, and materially implicated in the overall energy and environmental performance of the home.

Commitment, influence, reward and connectedness

The emergence and stability of a practice depend on the relative commitment levels of its carriers, the relative influence of practitioners on interpretations of the practice, the internal rewards sensed by carriers, and its connectedness with other practices (Shove et al., 2012).

Retrofits can involve the same product and service providers that work on new homes, or indeed other building-related sectors which has material bearings on the stability of a particular energy retrofit practice. Using wood-framed wall construction as an example, the relative commitment to the practice of energy efficient wall assembly will vary from framer to framer, depending on their

perceived internal reward from reducing unwanted heat transfer from the interior to the exterior (i.e. minimizing continuous material connections across the wall profile via thermal bridging), and the degree of connectedness between the practice of building a wall with lower stud density and other practices like drywall installation that has a material interest in the distribution of studs (i.e. potential fastening points) in a wall.

Again, health of the home right. So when we talk about needing a thermal break. Needing a thermal break. It's not an option anymore. It has to be in every home we build, [...] You're going to see the same sort of critical fluctuation and contraction and expansion in the home if we don't have a thermal break between inside and outside. So if the sun's bombarding your house at 40 degree heat all day, wouldn't you like to stop that heat from coming into your home (Builder G, 17 June 2015).

This builder's commitment to the notion of thermal breaks in walls and the benefits they produce are key to the practice of careful wall assembly, but it also links one practice (i.e. wall construction) to other practices like indoor heat management, which gives it greater connectivity.

Practice stability is also impeded in cases where carriers do not sense an internal reward when performing the practice, or it fails to connect to any other practices.

[F]or some other complex building techniques that are further out there in terms of lack of education, you just don't worry about those sorts of things. [...] some of the framing techniques that they're talking about, that's a little scary from my side of things because we are contractor now, we're not framers. [...] but if I was to approach my framer, even if I talk to him for five seconds, he panics because he just wants to build something. They're just so energized and just want to go you know. And so to start educating them and bringing them on board with this, [...] even though it might not be more difficult, it's different than what they normally do. And what they're all about is perfecting their system and efficiency, and so even if it's no more complicated, but because it's different they're gonna want more [money] because it's gonna slow them down (Builder F, 30 October 2015).

The in-situ intermediaries encountered during the current project reflect a notable air of frustration and confusion when it comes to acting on climate change and improving the energy efficiency of their clients' homes. This, despite the fact that questionnaire responses indicate that the majority see links between climate change and home energy consumption, and report feeling comfortable arguing in

favour of energy efficiency with their customers. This type of cognitive incongruence is commonplace among many in-situ intermediaries.

I mean, that [climate change] doesn't come into the conversation, generally. I mean, the efficiency of all these things does. But specifically climate . . . no, it doesn't really. To be honest, I don't think I've had a customer say, you know, if I use this boiler, is it better for the environment? No, they haven't said that, it [climate change] doesn't come into the conversation. It's efficiency, it's about how much money they're spending (Builder E, 2 July 2015)

Regarding the City of Vancouver's new energy efficiency requirements, the same interviewee states, "*I would say, it's going to cost you money, and I think a lot of it is overkill.*" (Builder E, 2 July 2015). One interviewee reported doing his own home energy retrofit wherein he installed geothermal energy, spray foam insulation, a grey water recovery system, and solar-ready cases, only to find that his bank would not recognize any increase in market value streaming from these energy performance improvements. The conclusion, according to this mechanical contractor is, "*I don't have the data, but maybe it's 10 percent of the market that values green. I think the issue is very unclear at the moment and it will depend on the market that you're looking at*" (Trades Person B, 29 April 2015).

6.5 Intermediation as practice

In this part of the chapter I show how in-situ and ex-situ intermediaries shift values/visions/values (concerning the logic of home energy efficiency and climate change) within the socio-technical system through the performance of intermediation practices of interpretation, translation and information management (i.e. practice-as-entity), and their professional and trade-related skills. I have already argued in Chapter 5 that the retrofit system of provision in Vancouver, like most if not all other Canadian cities, is host to a number of debates and contestations regarding the logic of energy efficiency improvements and the fundamental causes of dangerous climate change. While the materials implicated in retrofit practices are changing, and some new skills and techniques are indeed needed to manipulate these new materials, it should be noted that what is perhaps most vulnerable and unstable with respect to a new retrofit practice or practice bundle, are the set of understandings and principles that complete the practice

triad. Traditional intermediaries as conceptualized in innovation and science and technology studies have a rather administrative and efficiency-based modus operandi as they work to convene parties and reduce transaction costs to accelerate innovations. However, the intermediaries working in Vancouver's retrofit system of provision display more fluid perspectives toward the interests they negotiate between than those early intermediaries.

Maneschi (2013) tracks the variability of intermediary functions, depending on the context within which they operate. In financial, economic and business contexts, intermediaries often articulate needs, link parties and information, identify options, conduct foresight and diagnostics, and help bridge interests and arrive at optimal solutions. As verbal expressions these descriptors are relatively neutral. That is, they suggest the work of intermediaries to be largely impartial to the matter at hand. However, in the context of wastewater governance (Beveridge and Guy, 2009), energy efficiency programs (Heiskanen et al., 2009), improving energy performance of buildings (Janda and Parag, 2013), and social learning (Stewart and Hyysalo, 2008b), the verbs used to describe what intermediaries actually do, focus more on configuring, mediating, coercing, persuading, brokering and negotiating. Moss et al. (2009) break down intermediaries into four categories according to their primary activities: 1) bridge-builders, go-betweeners, partnership builders, conflict resolvers; 2) information disseminators, training and technical support providers; 3) lobbyists, advocate, image makers, campaigners; and 4) innovators, commercial pioneers, eco-preneurs. Both Moss et al.'s categories and Maneschi's analysis reinforce what this research argues; the work of intermediaries varies from dispassionate to values-based, and appears more subjective and interpretive as their operating context becomes more controversial and fluid. At the far end of this spectrum one can expect to find what Fischer and Guy (2011, p. 2588) refer to as the 'interpretive' intermediary that is often situated "*between the textual and representative challenges*" of fuzzy energy efficiency policy goals. In the Vancouver retrofit space, which is replete with new materials, technologies, know-how, understandings and motivations, intermediaries not only stand in-between interests, but as Meyer and Kearnes (2013, p. 426) suggest, "*their work, practices,*

roles, effects and identities also make them in themselves, relevant actors to analyse."

Translation and interpretation

The research suggests that the intermediaries operating between policy and homeowners in Vancouver facilitate knowledge transfer within the system, and that these transfers can follow either Doganova's (2013) 'transfer' or 'exploration' models. In the more linear transfer model, the concepts and ideas transferred are deemed stable as they move from sender (policy circles) to target (homeowner). In a similar way, the intermediary organizations and individuals themselves doing the transfers, also remain unchanged. In a world that follows the transfer model, there is not much room for uncertainty; truisms travel through linear networks to achieve simple and objective goals. An example of this dynamic is the case of the environmental NGO that promotes home energy retrofits by disseminating the technical details and requirements of retrofit incentive programs to local homeowners. In the exploration model however, intermediaries engaged in the movement of information and knowledge can, through their own creativity and inventiveness "*transform not only the knowledge that they put in motion, but also the spaces between which such movements take place, and the entities that are poised to emit or receive*" (Doganova, 2013, p. 444). In the counter world represented by the exploration model, the collective work and identities of a diverse set of intermediaries, who themselves are trying out new ways of doing things and putting new ideas to the test, lead to far greater uncertainty in terms of policy outcomes. The practice of translation by exploration can be seen in the Vancouver retrofit space, as reflected in observations made of supplier practices, builder/contractor attitudes, and utility discourses.

An interviewee who works as a showroom consultant for a major supplier of plumbing materials and heating systems provides some insight as to the nature of these explorations by intermediaries. The employee owned company she works for is a 120-year-old family led business with locations across the province. The subject occupies a unique space between government policy on energy and water efficiency and the homeowner. Unique, because of the close relations she

maintains with plumbers, contractors and builders. Her physical location means that she has regular contact with both the parties that install toilets (i.e. plumbers), and the parties that purchase toilets (i.e. homeowners). Her job involves selling plumbing fixtures like faucets, toilets and shower heads to plumbers, and in recent times, an ever-increasing number of individual homeowners. The principal tools which she uses to sell to her customers include a variety of physical artifacts located in her showroom, her knowledge of the technical specifications of same, and her ability to assist her customers make sense of the plumbing options on offer. Over the past 10 years the subject has gained considerable experience and knowledge regarding toilets, a fact that supports her self-proclaimed title as 'toilet ambassador'.

"I'm the ambassador of toilets, let's face it. [Clients say] my friend, Gail, told me I had to come and see you or one of the plumbers will recommend us personally. When you go to the showroom ask for [Supplier A]" (Supplier A, 9 July 2015).

The water closet as a material object in the home represents a nexus point where issues of resource conservation, technological innovation, environmental degradation, personal hygiene practices, and individual lifestyle converge. As the environmental and energy costs depend on the type of water closet chosen in the course of a home energy retrofit, an intermediary's capacity to promote water efficient toilets is key. The City of Vancouver, through its building by-law and its myriad public information bulletins on water conservation and energy efficiency, require all new homes install water closets (tank type) with maximum flush cycles of 4.8 L (City of Vancouver, 2014b). The by-law notes that dual flush water closets with dual flush cycles of 4.1 L or less and 6.0 L comply with this requirement. In the case of home renovations or retrofit situations, the City has no requirements for the type of water closet installed, only guidance that encourages the installation of water efficient units. The use of water to flush water closets drives considerable energy consumption, thus the move from traditional 13 L single flush toilets (dominant in the Vancouver market through much of the previous century) to the much lower 4.8 L flush models, represents a significant reduction in energy consumption.

The language and ideas used by the Supplier A during her interview are assumed to be the same as those used in her daily work in the showroom, thus examining the vocabulary and imagery she deploys to recount her experiences while selling toilets provides us with a valuable lens through which we can see processes of translation. Very few intermediaries in the retrofit system of provision in Vancouver have access to a copy of the City's building and plumbing codes, including the plumbing showroom representative I interviewed.¹³ This is likely one reason why she never refers to a toilet by its more technical name (i.e. water closet), or mentions a specific flush cycle volume during our conversation. Instead, she speaks of dual flush toilets with half and full flushes. It also explains why the interviewee does not indicate any familiarity with the City's technical flush volume requirements or how these are linked to the City's climate and energy efficiency goals. In contrast, the showroom representative displays a high level of awareness regarding the dollar amount available via toilet rebates offered by municipalities, which municipalities offer rebates, and reasons why some municipalities have stopped offering the rebate.

Because I think once people are looking at new appliances, new faucets, new things, they are almost being led that way through things like the government's Energy Star programme for your washer and your dryer. So you get a rebate if you come and buy this. If you buy a low flow toilet the city of whatever will give you money back. You know, some [rebate programs] have gone. Coquitlam is done, Burnaby is done, New Westminster is done. They've given away all the money they want to give. North Vancouver and Richmond are still giving out money. So you get \$50 back and, you know, we're kind of couponed up. You know, we're into all that, oh I'll buy that and I'll get to save 10 percent. Well, you're spending 90 buck but, yes, it's great you saved the ten. So I think people are geared up to that, to getting, you know, more efficient things through that (Supplier A, 9 July 2015).

Her principal explanation for the arrival of water efficient toilets in Vancouver makes no reference to local building regulations or broader government policy aims. In her view, low-flow toilets on the market are the result of California water laws and strategic decisions made by fixture manufacturers to secure important markets.

¹³ The Vancouver Building By-law is not freely available. Print copies that include the plumbing code cost CDN\$320, while one year online subscriptions for the same materials cost CDN\$200.

No, I think [industry has] almost been leading [...] You have to look at a place like Las Vegas. Okay, you're going to build that many hotel rooms with that many bathrooms and that many people coming to relax and enjoy and have, you know, a shower to end all showers and all those sorts of things. Well, [Nevada] is putting in requirements that say it must be low flow. So if you're going to be Delta faucets and you want to sell to those markets, then you are going to make low-flow faucets. Now why are you going to make low-flow faucets on Mondays, Tuesday and Wednesdays, but on Thursdays and Fridays make the old stuff. You can't run a factory like that. Oh, they have driven it completely. California water laws are insane. They're pushing and pushing and pushing. Again, if you're going to make product for that many people with that requirement, you might as well just let everybody else buy it too (Supplier A, 9 July 2015).

This is evidence that demonstrates how one intermediary, a supplier, acting through its supply chains and relations with major industry manufacturers, (which themselves are responding to water efficiency regulations in the State of California and water supply and demand issues in the State of Nevada), help determine what a normal water closet assembly looks like in Vancouver.

The interviewee, in the course of a normal workday, engages in conversations with clients that often traverse what many consider to be sensitive personal boundaries. As she says, *"it's amazing how close I get with my customers"* (Supplier A, 9 July 2015). Her job and her company's future depends on her ability to understand a customer's material needs and wants, and ultimately her ability to retain their trust. Therefore, a customer who is not happy with the ability of their new low-flow water closet to make waste 'go away' materially threatens this trust relation. As a consequence, my interviewee engages in a constant battle against unrealistic water efficiency regulations and impractical home interior fashion trends. The former is evidenced her commentary on the mismatch between the daily lives of her clients and water efficient toilets.

Well you have to remember that most people will wake up in the morning, have a cup of coffee, have their porridge, then go to the bathroom. The water line [in the bowl] is super low. The pottery is dry. First thing that happens is flush and the second thing that happens is flush. Oh, Lord didn't get it all, flush. Maybe even go get a brush, flush (Supplier A, 9 July 2015).

When asked if the idea of low-flow had gone too far, especially in the dual flush models with the lower of the two flushes requiring only 3 L of water, she responds,

I think we went too far. I think we kind of went so super, super low, . . . that we just went too low on it and so most of us in the industry don't sell dual flush toilets to homeowners. We sell the single flush 4.8 L. It's actually more water efficient over the long run (Supplier A, 9 July 2015).

In response to a question aimed at her level of comfort espousing the benefits of water efficient fixtures to customers, the showroom representative responds,

I am, I am, I think up to some point. I will say to somebody, okay this is the super greenest choice, this is flowing at one gallon per minute. I honestly think you're going to be taking a longer shower [...] and usually a longer shower which doesn't really help anybody because you're heating more water, you're in the bathroom longer with more electricity for the lights running, for the fans running, all those compound issues. Whereas if you bought something that was a 2.0 gallons per minute, yes better than 2.5, it's going to reduce what you need but still you'd be able to use it (Supplier A, 9 July 2015).

As the subject says on more than one occasion, she understands people because she spends her days, virtually at least, inside the private lives and home living spaces of her customers. She feels that conserving water, hence energy, is a moral issue and that to drive uptake of efficient technologies requires compelling narratives and relatable logics, rather than a simple plea to go green at all cost.

The showroom representative also expresses a personal dislike of a new, trendy square-shaped toilet, and her frustration dissuading her valued customers from buying what they understand to be a must-have bathroom amenity, yet what she knows to be a truly flawed product.

Yes, you sit on it and tell me how flat your butt is. Like it's horrible. I feel like I'm going right in because it's a huge square opening and I don't know whether I just have a North American bum, like I'm just used to the oval. It's Italian. It's Duravit. I mean it's big in the market right now. People say, 'oh, my God, did you see the Duravit toilet' and I'll constantly say, please sit on it. Please just sit on it once. Like you'd buy a car and not sit in it. You know, we're talking about something you're going to sit on twice a day maybe, maybe more, maybe less. I don't know, but for a long time. You can change the sheets on the bed if they're rough (Supplier A, 9 July 2015).

In an attempt to steer her customer away from what she believes to be a poorly designed toilet shape, and avoid creating a disappointed customer, the showroom representative is practising a form of information gate keeping or at least information filtering. She points out that she regularly has to manage customer

expectations that have been distorted by popular media including home design magazines and DIY renovation television programs.

[People] watch all that every day, every show, every CTV morning news [show] has a little segment, you know, on how to wash your dog better, how to do this better, how to do that better, how to have a better bathroom (Supplier A, 9 July 2015).

The TV morning news segments are only two or three minutes long, focus on household stuff, and are designed to keep the messages short, simple and glamorous. The showroom representative herself admits that she has done about 20 of these segments, all of which can be seen, she assures me, using a simple Google search.

Well, yes, sometimes I've gone to the studio and done quite a few there and that's when I really have to find something to hit for like two and a half minutes. Boom, boom, boom, boom, boom, get all of the points, show the pretty, show the glam, you know. And, you know, I even brought a toilet down one time, yes (Supplier A, 9 July 2015).

I am struck by how unperturbed the participant is while recounting her own frustration with media outlets distorting her customers' expectations and beliefs, given her own habit of adding her opinions to the same stream of media-based messaging. She does add however that her opinions are just that, hers, and at least not necessarily shared by all of her colleagues. For the subject, promoting and selling plumbing products are part of her normal daily job activities and responsibilities. The materials, skills and understandings that she deploys while carrying out these activities are well defined and structured, and thus unlikely to be questioned. Simply, these are her daily practices.

The experiences of the showroom representative with television suggest the daily practices of morning TV news show producers, which focus on delivering bite-sized, understandable, and highly consumable messages about topics of interest to their viewing audience, help construct collective ideas of what is normal, useful and desirable in terms of household systems and artifacts. This dynamic also creates a direct connection between material suppliers in the Vancouver area, who are

deeply implicated in the retrofit space, and television media content creators who are rarely if ever considered to be involved in home energy retrofits.

What is striking about the testimony of the supplier is how much interpreting and translating she engages in. The personal flavouring, sincere values and beliefs, and contingent nature of the sales people's perspectives advice, supports Doganova's (2013) conceptualization of the exploration model wherein intermediaries themselves are experimenting and creating as they go about transferring knowledge from one actor group to another, with uncertainty being the result. In addition, it provides insights as to what happens when a normal daily practice in one sphere (i.e. product sales) is a form of translation within another sphere (i.e. communicating about energy efficiency and climate action).

6.6 The elusive retrofit practice

Numerous actor groups engaged in either constructing or modifying existing built structures help sustain a generalized construction practice complex, and this complex comprises numerous discrete practices bound up by tight and co-evolved relations of interdependence (Shove et al. 2012). The practice of altering the physical configuration of a residential dwelling to improve its overall energy performance, while overlapping to a limited degree with a construction practice, implicates a novel set of both practices and intermediaries that have not historically been associated with the construction practice complex. The emergence of an energy retrofit practice in Vancouver might therefore be framed as a budding process whereby the much larger construction practice complex produces an outgrowth, that while connected to the parent organism, is ultimately discharged when it is mature enough to stand-alone as a smaller retrofit practice. Therefore, to conceptualize retrofits praxeologically requires attention be paid, not only to new ways of configuring relations between practice elements, but also to the ways in which related practices can connect to each other to form a more stable practice complex.

The configuration of elements constituted by draught-proofing for example can be further altered by other actors engaged in related activities. The work of energy

advisors provides an example. Policy in Vancouver requires in some cases (depending on the scope of renovation or alteration) energy advisors perform home energy audits to assess a home's energy performance and make recommendations for energy retrofits based on those audits. A blower door test, providing a measure of a home's air tightness, is part of the audit, (Globe Advisors, 2013a). A home's air tightness is measured by two metrics: the number of times the volume of the air in the home is exchanged per hour; and the home's effective leakage area (i.e. sum of the areas of all cracks and gaps in the buildings envelope) registered as an equivalently sized hole in the building's envelope (ibid.). The lower the effective leakage area and the number of air changes per hour, the more energy-efficient the home is (ibid.).

The performance of a blower door test is integral to an energy audit, but it also serves to redefine other construction practices. Measuring a home's air tightness causes a reconfiguration of the elements implicated in wall construction techniques and air barrier installation (i.e. skills in detecting air leakage, understanding air movement dynamics, special adhesive tape). It also serves to reconfigure other practices that these elements might co-constitute. As it does, it imposes new meanings on these practices, and most importantly, it forms a connection between the two. Thus, a City policy requiring blower door tests to improve dwelling air tightness is helping to build connections between existing practices, and changing the relations of their elements. Moreover, the blower door test alters the way that physical attributes of a home are commonly understood. This means that cracks around windows, doors and vents are seen not simply as sources of unwanted airflow, but rather as contributors to what amounts to a permanently open hole in a home's envelope, and matters materially implicated in the overall energy and environmental performance of the home. Thus, we can see how the performance of energy audits, performed by a critically positioned intermediary in the retrofit space, is fostering new understandings of draught-proofing, new ways of linking draught-proofing to still other practices, and ultimately contributing to a new retrofit practice.

There are other examples in the retrofit space STSP where old and new practice elements and practices bump into each other to create a modified construction practice or novel retrofit practice. Boiler and furnace replacements, electrical upgrades, window replacements, and larger home renovation projects all constitute situations where this bumping takes place, and where the retrofit practice is emerging.

Upgrading a dwelling's windows is a common practice in Vancouver (Guy et al., 2015). The popularity of replacing windows is confirmed by several studies on energy retrofit programs, yet it is interesting to note that among all energy retrofit interventions, window replacements make the least sense from energy, financial and environmental perspectives (Globe Advisors, 2013a; Wilson et al., 2015). That window replacement is so common among Vancouverites means that window sizing, fabrication, sales and installation comprise stable assemblages of practice elements, even before energy efficiency and climate policies enter the discussion. Retrofitting a dwelling's windows is therefore inextricably connected with existing window sales related performances, but policies requiring specific window performance, shift the relations between these existing actions and require new ways of understanding fenestration principles.

[I]t's key to have knowledgeable tradesmen. With the windows, having a good window salesman that can explain the difference between a low E and a window that wasn't low E, having a window that is charged with argon gas, knowing what the difference between different our values is, knowing the difference between triple painted single pane windows, this is important (Energy Advisor C, 23 June 2015).

Window sales people must now interpret retrofit policy for clients no matter how they feel about energy efficiency and climate goals. Sales, fabrication and installation practices too change. To match the appropriate window coatings with the home's physical orientation, sales personnel may require building drawings. Finely manufactured high-performance windows also require greater care be taken when builders frame window openings to ensure the window's proper performance. By doing so, wall framing, and the materials implicated in this practice performance, can be shifted. Demand for high-performance windows is

thus altering window installation practices, but it is also reconfiguring the relations between elements housed within the practice, as well as some of the elements themselves. One energy advisor notes,

We are told [by the Government] to inform the builders, only purchase the windows [...] from a reputable company. Make sure of course that they know that this is for Vancouver and they know the requirement [...] And that the windows must be delivered with the energy labels on them. If energy labels are not there, they're to refuse the shipment (Energy Advisor B, 13 May 2015).

High-performance windows embody meanings related to issues such as thermal energy management and healthy acoustics, instead of simply providing openings for natural light. Improved windows also impact on space heating loads and understandings regarding the sizing of equipment. Window upgrades are also reconfiguring human-environment relations by highlighting the links between a home's north-facing windows and the energy costs associated with their thermal losses. The goals embedded in policy that encourage energy efficient windows now mix with desires for improved acoustic and indoor thermal comfort and curb appeal. In the process, this mixing action has served to alter the configuration and relations between practice the elements involved in window installation, and made connections between formerly unrelated activities like window sales, building envelope construction, and space heating. These praxeological dynamics point to the changing rules concerning fenestration, brought about via the formation of cross-linkages between multiple window-related elements and actions. It must be said however, that the act of window replacement benefits greatly from strong normative ideas of energy efficiency associated with the EnergyStar efficiency rating system. A system which Canadians regularly encounter when purchasing other household appliances like washing machines and clothes dryers.

These are two examples where a retrofit practice can be seen to be taking form, but there are others where practices are forming associations between themselves to create an identifiable, yet still forming retrofit practice. Wall construction methods that can include either pre-fabricated insulated panels, or 'built-on-site' walls that require strategically crafted corners to minimize thermal bridging, are changing relations between materials and building and even inspection practices.

They've gone beyond the 2x6 wall, This is significant because one needs to understand that the Provincial government has decided that there should not be the need for a significant number of engineer consultants to build a home. [...] which means that single and your two unit dwellings can't be too complicated. [...] But construction is quite complicated, and now they're keeping that 2x6 wall [...] but adding exterior insulation. This is hard for your typical builder because there's a change of ordering of trades. Window rough-in openings are different because you have an added layer of insulation (Energy Advisor B, 13 May 2015).

This example demonstrates how existing building practices are having their elements reconfigured as they are being fused with innovative retrofit techniques. Installing solar hot water conduits (from the mechanical room in the basement up to the attic) during new construction in anticipation of system installation at a later date is another example, as is the mid-construction visit by energy advisors to check air barrier integrity, conduct blower door tests, and verify windows are up to code with labels on.

[T]hat mid-construction visit, besides what I talked about air barrier checking, blower door testing...We're to check the windows and the labels on them to ensure that they meet the 1.4 [U-value] (Energy Advisor B, 13 May 2015).

Examples like these point to the emergence of a clearer retrofit logic among some, but not all of those interviewed, and although the examples here focus only on in-situ intermediaries, ex-situ intermediaries are equally implicated in processes of practice formation and stabilization. From a praxeological perspective, the ability of these related performances to come together to form a stable retrofit practice depends on their coordinated repetition, and the degree of influence the actors who perform them maintain within the system.

6.7 Conclusion

In this chapter, I have shown how notions of trust and authority, coupled with accepted models of collaboration and partnership, provide the glue that hold inter-intermediary relations together, and allow for collective retrofit understandings, principles and norms to form and persist. The analysis revealed distinct and separate communities of intermediaries, whose delineation follow neither spatial, ideological or professional lines. In-situ and ex-situ intermediaries tend to circulate along separate network circuits, with only a few exceptions to this rule, thus

impeding common visions from forming. The ways in which intermediaries are able to re-assemble existing practice elements to form new retrofit practices was explored in the section on practice dynamics. Concepts of practice stability, change, and transfer were employed to analyze what intermediaries in Vancouver experience in their daily work lives. In the section on practice dynamics I have revealed some of the linkages between the routine, taken-for-granted activities (e.g. wall construction), values and motivations (e.g. providing expert services) of retrofit intermediaries and the possible beginnings of a number of retrofit practice bundles related to wall insulation, home energy audits, and high-performance windows. The discussion also revealed how existing professional and trade-related activities of translation, interpretation and gate keeping, though not building-related, nonetheless influence practice element relations. Through the narratives of my subjects, I have demonstrated how intermediaries passively interpret and negotiate retrofit policy goals as they go about physically altering dwellings, often unwittingly.

What becomes clear from my analysis is that technical issues of energy efficiency and climate change are generally obscured from view by most in-situ intermediaries as they go about their daily routines. Despite the majority of those interviewed stating they understand the linkages between home energy efficiency and dangerous climate change, these challenges and the policies enacted in their favour, are often silenced by more pragmatic concerns regarding homeowner satisfaction and meeting minimum building safety requirements. Where intermediaries do explicitly engage with energy efficiency issues, it is largely at the bequest of homeowners concerned about comfort, energy bills, and rarely if ever, the environment.

Chapter 7 Conclusion

It quite often happens that a phenomenon is insignificant only because one fails to take it into account (Bachelard, 1985, p. 104).

The threat of dangerous global warming is requiring cities quickly find ways to significantly reduce local GHG emissions, including making improvements to the energy efficiency of their existing housing stocks. The problem is, this task is easier said than done, and most homes that were energy inefficient 50 years ago are still that way today. Home energy retrofits thus remain a blurry urban phenomenon despite significant political will to the contrary. The aim of this research was to make a contribution to this socio-ecological challenge by understanding some of the reasons behind policy failure. The project was designed to pursue three key objectives: to better understand the broader climate and energy efficiency policy contexts and socio-technical system conditions within which the home energy retrofit practice is expected to emerge; to explore an existing retrofit socio-technical system to learn the form, function, and relations of the intermediary actors implicated in its operation; and, to challenge the way retrofit policy is framed by demonstrating how intermediary actors contribute meaningfully to the establishment and persistence of the practice of energy retrofit through visible and invisible processes of intermediation.

In this thesis, I've provided an in-depth analysis of the home energy retrofit socio-technical system of provision in Vancouver, but in an attempt to find a fruitful way forward for the city's retrofit project, I have wandered off the well trodden path followed by previous writers interested in the techno-behavioural aspects of energy consumption, choosing instead to shed a light on the intermediaries circulating in the unexplored corners of the city's coalescing retrofit system. In retrospect, I was inspired by Bachelard (1985), and went looking for significance in the insignificant. In the course of exploring the less traveled corners of the retrofit system of provision, I learned about the more obscured actors that inhabit these darker recesses and the unremarkable sayings and doings that go on there every day. Having returned from my travels, I have been able to share with the reader what I discovered. I heard stories of hope and inspiration alongside complaints of

confusion, frustration and impotence. I saw the potential of principled creativity to change old trajectories, and the power of norms and traditions to outweigh good intentions. I was presented with emotional and technical contradictions, and listened to exhortations of both pride and prejudice. I discovered several key ideas: improving the energy efficiency of a dwelling is not an engineering or techno-challenge; human behaviour is more quantum than objective in nature; and, there is a whole community of skilled and powerful intermediary actors, sitting between well intentioned policies and homeowners, who together have the potential to make the much awaited retrofit revolution a reality. I have tried to show the value of moving away from a binary policy model, comprising homeowners and policy makers, toward a three-way scheme where intermediary actors are placed in the frame.

I believe this research illuminates the ambiguities embodied by retrofit policies and the various, and popular responses to same. As Schipper says, "*[we] energy analysts have made a mistake [...] we have analyzed energy. We should have analyzed human behaviour*" (Schipper, cited in Cherfas, 1991, p. 156). In this final chapter, I summarize research findings, reflect on the contributions that my theoretical and methodological approach make to the retrofit, intermediary and practice literatures, and present policy recommendations and my assessment of the state of the practice of retrofit in Vancouver. I also offer some suggestions for the design of future policy aimed at making home energy efficiency normal, and finish off by reflecting on the limitations of the work, and pointing out possible future research directions.

7.1 Retro-shifting paradigms

Entering into the home energy retrofit literature, I was immediately struck by an uncomfortable tension. A tension created by the incongruity of policies framing them as rational and technical undertakings, in the face of contingent homeowner behaviours, market failures and associated environmental debates. As I surveyed cities in OECD countries I encountered contested perspectives on retrofits. They were often being presented as relatively linear and rational processes based on engineering definitions of energy efficiency, and various technical interventions

such as insulating walls, installing high-performance windows or upgrading to more efficient boilers. But debates about shallow or deep retrofits, payback metrics, emission intensities, and the reliability of energy efficiency models, blurred this framing. Contributing to these tensions are ongoing debates about climate science and mitigation strategies, increasingly complex issues related to rapidly advancing technological options, and moral and ethical questions regarding who pays and who benefits from climate-induced energy efficiency investments. I found that Vancouver and other cities like it, were busy preparing visions for renewable energy, strategic climate action plans, and enacting energy and climate-related laws and regulations, yet these efforts to govern have largely failed to engage with the essentially social nature of home energy retrofits.

While I did encounter some research into non-technical factors that affect decisions to retrofit such as broader societal and environmental concerns, competing homeowner priorities, or financing concerns, most of the discourse appeared positivist and technocratic. I discovered that whereas energy retrofits in the latter decades of the twentieth century were largely motivated by issues related to home comfort, material replacement and reduced energy expenditures, the motivations for energy retrofits in the early twenty-first century are now much less clear. The observed inertia of routine and taken for granted ways of building and altering homes and configuring their energy performance profiles, highlights the utility of deploying theories of practice, with their notable concern for the 'mundane', to better understand this phenomenon. Neither the influence of broad-scale context on what humans routinely do, nor the source or site of predisposing and pre-conditioning forces, are accounted for by practice theories. To fill this gap, the literature on socio-technical systems thinking was deployed to help examine retrofits more comprehensively. In an STS framing, home energy upgrades are conceptualized as the result of a multi-scalar, and multi-actor system of provision comprising co-evolved human actors, infrastructures, institutional arrangements, and technological artefacts. The nested nature of the retrofit socio-technical system was something that struck me as relevant due to the fact that the components of the retrofit STSP share space and domain with other, larger socio-technical systems

like those related to the provision of general construction services, energy and manufacturing.

From the outset, my personal experience and reading of the literature on retrofits inclined me to engage with energy retrofits on their own terms. That is, as messy, nonlinear, emotional and ideological acts. Prior to entering the field as researcher I suspected I would find a disconnect between retrofit theory and practice, and I was right. I learned from my many conversations in the field that improving the energy efficiency of a dwelling requires engaging with both energy conservation measures, and the actors for whom these constitute a normal part of their everyday lives.

The blurred connections between political aspirations, climate change forecasts and residential energy consumption, combined with shifting governance models, provide a convoluted backdrop to retrofit policies and very likely impede their uptake. The epistemological frame, informed by theories of practice and socio-technical systems thinking, reflects a desire to highlight two dynamics: one, that what people do is co-constituted by the socio-technical system within which they operate; and two, that in a reciprocal manner, the same socio-technical system is co-constituted by the daily sayings and doings of the people within it. It urged me to explore more thoroughly the practices of actor groups who circulate in Vancouver's construction and energy supply socio-technical systems. I believed that there I would locate those actors most deeply implicated in upgrading homes for improved energy efficiency. This meant engaging with both the usual actors contemplated in existing retrofit policy, as well as some other less familiar actor groups. Members of the former group include builders, architects and utilities, while the latter includes green building NGOs and consultants, installers, trades people, designers, energy advisors and auditors, and building trade associations.

7.2 Policy and place-inscribed contexts

The research set out to characterize the influence that misalignments between local retrofit policies and homeowner motivations, values and beliefs regarding energy efficiency and climate change, might be having on the emergence of a normative home retrofit practice. What the research shows in Chapter 4 is that deeply

contested socio-ecological debates surrounding topics like dangerous climate change are presenting cities like Vancouver with profoundly wicked problems. So while the city's environmental roots, greenest city ambitions, bold climate goals and home energy efficiency ambitions are congruent with its desire to tackle climate change and other overlapping challenges, the sheer complexity of the issues and the need to act in numerous policy domains simultaneously, threaten its ability to do so. In addition, there are lingering tensions arising from conflicts between green policies and the city's traditional development ethos, and its feelings of resource abundance. These tensions are exacerbating the City's challenge by confusing the message carried in retrofit policy and leading many to doubt the City's overall vision.

Despite sometimes incompatible policy signals from other non-governmental policy actors operating across all geographical scales, the City has assembled an impressive retrofit policy arsenal. The local policy context is both assisted, and at times impeded, by the interests and administrative functions of organizations both near and far. A review of the numerous external policy bodies with an interest in climate or energy efficiency, and the roles they play in the context of Vancouver, suggests that 'outside' interests do indeed impact local retrofit policy design and implementation. The City's emphasis on technical solutions and its limited jurisdictional reach (despite its special powers under the Vancouver Charter) also confuse both homeowners and industry actors alike. This confusion contributes to a blurring of the retrofit message and impairs its broad uptake in the community. I also explored the role of place in shaping retrofit policy design and implementation and conclude that Vancouver's close proximity to nature gives local residents both strong feelings of environmental protection, and an equally strong sense of resource (i.e. water, energy, space) entitlement. This collective psychological schism overshadows both the form of retrofit policy, and its appropriation by intermediaries.

Based on the research, I am able to conclude that jurisdictional miscues and misalignments, ideological contestations, and deeply embedded place-based values, are all helping to ensure that the logic for undertaking home energy retrofits

remains in question. The research contributes to the literature on intermediaries by implicating these actors in processes that translate and interpret local imageries and values about place, and that are able to infuse these into the logics underpinning practices like energy retrofit.

7.3 Intermediary form and function

Chapter 5 explored the forms and essential nature of the intermediary actor groups operating in Vancouver's retrofit STSP. It did so to better understand who are considered intermediaries in the retrofit system of provision, what the nature of the relations between these actors is, and where each actor is situated within the system. What is striking about the research is that counter the 'ideal type' intermediary description discussed in Chapter 2, I discovered a network of more and less interconnected actors negotiating a broad array of construction skills, know-how and materials to alter existing homes and satisfy a raft of building-related policies. And as they do, these intermediaries mediate among highly contested meanings of energy efficiency and climate change, with varying degrees of what appears to be, intentionality. While some intermediaries do reflect their rosy characterization as purposeful, neutral brokers, wheel-greasers, and as process facilitators, not all intermediaries are created equal, especially those emerging in contested ideological spaces located between environmental protection and market liberalization.

By unpacking the elements that constitute retrofits I conclude that the group of intermediary actors that ought to be considered more strategically is far larger than current policy contemplates. Retrofit intermediaries of interest in Vancouver include those ranging from sole proprietors to supra-national NGOs employing hundreds, from organizations that focus primarily on construction to environmental NGOs, and from actors that spend all their time working in homes to those that never, or rarely do. Each of these intermediaries sits somewhere between the discourse poles constituted by homeowners and policy circles, although some lie closer to these poles than others. Each contributes, even in small ways, to collective understandings, norms and values related to home energy efficiency upgrades, via

processes of intermediation and by just doing what they normally do in their everyday work.

I delineated between in-situ and ex-situ intermediaries to distinguish between those that actually perform in or proximate to homes, and those that contribute more vicariously to these acts, but which nonetheless play a vital role in structuring meaning and breathing life into the retrofit practice. Some of these actors were recognizable as intermediaries, having the characteristics of information broker or advocate, but others either did not see themselves as intermediating between any interests, or if they did see themselves as intermediaries, they assumed the role involuntarily. What I conclude about both intermediary types is that they can exhibit varying degrees of intentionality, capacity, or indeed sympathy, where energy efficiency retrofits are concerned. This is due to the fact that they are not 'purpose-built' for interpreting and translating between the homeowner-policy poles. Instead, they are in a kind of 'superposition', similar to quantum particles, "*neither here nor there but, until pinned down, both here and there at same time*" (The Economist, 2017), as they oscillate between active and inactive intermediary. By revealing the fluidity of intermediary function, the research contributes to literatures on intermediaries by supporting a broader definition of which actors can be considered an intermediary within contested arenas. It highlights how socio-technical-ecological debates like climate change are rendering traditional modes of governance impotent, and necessitating new intermediaries either be created or take up shop in the bodies of existing actors with varying levels of sympathy for public policy goals.

By virtue of being participants in the system, I have described how new kinds of intermediaries engage in both active and passive practices of intermediation. The latter being what can simply be thought of as their trade or professional activities. A routine task like estimating on a window replacement job is an example. In the normal course of their work, some of these intermediaries may also perform active intermediation functions between policy circles and homeowners, or between themselves and other intermediaries. I used the example of the BC Community Energy Association created intentionally to serve as neutral (but purposeful) green

building advocate, educator and capacity builder to make this point. Other examples were found in the work of the Canadian Home Builders Association, and their local counterpart, the Vancouver Home Builders Associations, who actively and purposefully advocate within the retrofit system for incremental enhancements to local building standards over time. Conversations with representatives from both of these organizations confirm their explicit commitment to the role of broker or facilitator. Interestingly, I found that their respective spheres of influence can often traverse traditional boundaries lying between several different socio-technical systems (e.g. retrofits, construction, education). In line with their brokering roles, I discovered that a large share of their activities involve traditional intermediation practices like interpreting building codes and government policy, aggregating and disseminating information on technologies and techniques, and convening workshops and training opportunities for their members. What the research suggests is that there are meaningful linkages between the professional activities of intermediaries (e.g. installing insulation or airtight drywall), their routine acts of intermediation (e.g. promoting one product over another, interpreting public policy on climate action to clients), and the emergence and form of the practice of retrofit.

The research suggests that intermediaries in Vancouver's retrofit space are playing a key role in sustaining and enculturating norms and common sense rules, that materially shape the relations between retrofit practice elements. Retrofit intermediaries in Vancouver are doing so through the modification of their own skills, know-how and materialities, as is the case with builders experimenting with new wall profiles that minimize thermal bridging. In addition, they are also intermediating as they interpret and re-imagine new City retrofit policies and programme incentives, recently added energy-related requirements in building codes, and the technical results contained in new energy audit reports.

7.4 Intermediaries and practice stabilization

In Chapter 6 I presented evidence showing the emergence of an expanding set of teleologically linked in-situ actions supporting improved home energy efficiency. These constitute the retrofit practice-as-performance when considered as singular

events, and when contemplated as actions performed repeatedly across space and time, constitute the retrofit practice-as-entity. Arguably, some energy efficiency measures are stable and well defined. For instance, energy audits are near universal performances with clear connections between the know-how required, the equipment needed, and the reasons for their deployment. In many cases, these new energy efficiency interventions are nudging existing construction techniques and materials, and reconfiguring the relations between these elements to create a new, stand alone practice of retrofit. I showed this using boiler replacements as an example. The research shows that there are many other retrofit-related activities (e.g. providing loans for upgrades, envelope air-sealing, installing solar panels, selling insulation, etc.) which continue to suffer from fuzzy or changing meanings and non-standardized techniques. This is because there is still a relatively small group of intermediaries for whom the merits of promoting energy efficiency in existing homes is understandable, and thus readily adoptable. This group of actors is small compared to a larger group of actors for whom energy efficiency upgrades do not offer much in the way of internal reward. As a result, the elements constituting the practice of retrofit, (e.g. window installation or green building training) will hang together loosely as the relations and values that connect these types of activities continue to circulate in relatively small circles. What I found was a general lack of consistency among retrofit intermediaries regarding the motivations behind home energy efficiency. Often, the skills, know-how and physical artefacts were recognizable and commonly understood, but the meanings and motivations behind their union still varied, resulting in an unstable '*teleoaffective structure*' in the overall practice (Schatzki, 2012, p. 16). Schatzki (2012) reminds us that for a practice to be recognizable, a particular end must be teleoaffective. That is, understood to be successfully accomplished through the performance of the practice's constituting actions. So while we can see a retrofit practice-as-performance taking form across the retrofit landscape, such incidents are not always universally recognizable, by either intermediaries or outside observers, as either a retrofit practice, or as part of even a loosely connected group of energy efficiency measures.

I showed how established relations of trust and collaboration between both in- and ex-situ intermediaries structure the channels through which influence, ideas, and values travel in the retrofit STSP. Maps visualizing these relations (Figures 6-1, 6-2, 6-4) revealed distinctive clusterings of three groups, with information flowing strongly within the groups, yet less intensively between them. The three groups were broken down roughly into those whose routine work is proximal to the dwelling site, another group made up of utilities, energy advisors and provincial government officials who are spatially dispersed, and a third group that includes local designers, architects, NGOs and the City of Vancouver. Similar kinds of groupings were evident when it came to considering issues of trust between the actor groups, and regular collaboration partnerships. These analyses revealed circuits of communication, trust and influence that contribute to the maintenance of normative ways of engaging with issues related to energy home energy performance. I conclude that there are connectivity problems in the system; in-situ intermediaries tend to talk among themselves while ex-situ intermediaries are doing the same, with only energy advisors and utilities bridging between the two. While there are some instances where their boundaries overlap (i.e. principally via the activities of energy advisors and utilities), the two groups remain largely distinct and segregated. My analyses also revealed that the strength of the connecting relations within distinct intermediary groupings is not particularly high. This leads me to conclude that the channels within existing intermediary groups, through which practices can be decoded, reconfigured and transferred, are underdeveloped. The experiences of a utility representative and a sole proprietor builder in section 6.2 shed light on why connectivity between intermediaries is often impaired. These observations also reveal some of the negative feedbacks impacting the stabilization and persistence of the practice of retrofit. On the other hand, those intermediaries that do communicate, are more likely to exchange theoretical ideas which are so vital for practice adoption (Figure 6-4). The example of suppliers and plumbers using their existing network relations to foster a collective, normalizing attitude toward on-demand boilers was presented to demonstrate this dynamic.

I also showed how some intermediaries facilitate the prefiguring of practices by materials and places. Energy advisors, and the blower door tests they perform, have changed the meaning of both the act of caulking, and the caulking material itself. Material supply stores offer another example discussed in Chapter 5, where a retail sales location takes on a new meaning (e.g. site of learning) when they set up material and technology displays. The roles that commitment to a practice, and the internal reward a practice confers on a carrier, was presented, revealing how variable these can be, especially in the context of the construction sector where traditional ways of doing things are all quite well defined.

This part of the research has made further contributions to literatures on practices and intermediation by showing how one practice (e.g. intermediation via interpretation, translation and sense making) contributes to the making or breaking of another (e.g. energy retrofit). Perhaps most importantly, the research contributes to the literature on home energy retrofits by framing them as an essentially praxeological challenge. One that will remain unmet if no attempts are made to engage with the interpretation and translation practices of retrofit intermediaries, and how these materially impact the emergence and form of any new retrofit practice. In other words, it is not enough for policy makers to simply state that a technology or technique will yield energy (or financial) savings, or reduce harmful GHG emissions, they are encouraged to recognize that the motivation for acting in a certain way is one small element of a stable practice. Processes of intermediation materially filter these types of psycho-rational messages to reflect the daily interests of the intermediary, in addition to an intermediary's own unique understanding of locally contextual ideas of place, environmental health, economic and aesthetic norms, and resource availability. As a result of these highly subjective intermediation processes, stable and recognizable practice configurations can struggle to take shape. I have been able to show that a retrofit practice is taking form. There is evidence of relations forming between groupings of teleologically related activities. The home energy audit was used as an example to demonstrate how one activity (e.g. the blower door test) is redefining the relations between other activities related window installation, heating system

sizing and installing, and air sealing. Prior to the arrival of energy advisors, these practices existed largely independent of each other.

7.5 Reflections on policy

The research highlights several opportunities for re-orienting policy through an engagement with intermediaries, their quotidian, and praxeological principles. Vancouver's Greenest City aspirations, and retrofit policies specifically, represent positive steps, but they do put ideological breaks on some parts of the construction socio-technical system's principles and norms, as well as normative consumer values. Policies thus require fundamental shifts, not only among construction sector norms, standards and principles, but also among societal understandings and imagery regarding the environment, the home, and lifestyles. These understandings are wrapped up in practices, rather than being part of human cognitions. Framing the issue of missed retrofit targets in this way allows an opportunity to exonerate the individual and indict practices.

Given the uncertainty and confusion about the rationale and political motivations behind home energy retrofits, there is evidence suggesting that intermediaries are clarifying a retrofit vision, and in the process are depoliticizing retrofits. Intermediaries, displaying varying levels of policy alignment and strategic-ness, can play a vital role in creating a new retrofit practice via processes of intermediation that foster collective visions of what 'makes sense' with respect to home energy improvements. By being so strategically placed between policy makers and their homeowner targets, intermediaries effectively control the processes and means needed to create a new retrofit practice, so it is important to recognize this and engage with these actor groups wherever possible.

Creating a retrofit practice to facilitate wide scale upgrades of Vancouver's housing stock requires, not just deploying new technologies, but a fundamental rewiring of the linkages between technical skills and conceptualizations of things like climate change, wise energy use, and the meaning of home. It is intermediaries who play leading roles in shaping these linkages. It is also important to remember that intermediaries are often active participants in the very systems they mediate.

Retrofit practices are swirling around amidst numerous existing renovation and maintenance practices, which are all quite well established. Therefore, to fashion a new practice specifically for energy efficiency retrofits, requires some new skills and materials, but mostly it requires new ways of understanding and imagining the home and the component relations and systems within them.

7.6 Policy implications

Although the aim was not to provide policy advice or recommendations, there are significant implications for retrofit policy at the City of Vancouver. Re-orienting the City of Vancouver's retrofit policy approach to align with research findings has implications for the City, and will require new strategies be adopted. As shown in Table 7-1, these might include:

- expanding the policy tent to include more stakeholders in policy analysis, design and implementation;
- promoting the formalization of the overall construction sector by supporting enhanced construction trades training and new information exchange channels within the overall construction sector;
- shifting attention away from individual homeowner choices and attitudes toward the daily performances of the people that actually do retrofits;
- recognizing that spatially dispersed actors are able to shape local understandings and norms concerning climate action and energy efficiency; and,
- directing greater resources to making energy consumption in the home more visible, and engaging with the construction sector to build a shared understanding of the relations between home energy use and the global climate crisis.

Casting the stakeholder net further to engage more meaningfully with the harder to get at intermediary actors that make retrofits happen is vital. While builders and utilities certainly influence home energy efficiency improvements and feature prominently in traditional policy design, other lower profile intermediary groups (e.g. material suppliers, specialized construction trades, NGOs, etc.) also help

determine (sometimes unwittingly) whether home energy upgrades occur. Connecting with the less formal among these actors might be facilitated by engaging with the more identifiable network of building material supply companies, as the sales outlets of the latter are often necessarily frequented by the former. By connecting with these more invisible groups, policy makers will be better able to understand how and where they learn, and with whom they exchange ideas, values and normal ways of acting. Being able to locate and intervene in these spaces and processes holds promise for strengthening existing, or forming new retrofit practice relations, as these are paths through which practices are constituted.

The construction sector in the Vancouver area is dominated by rather informal operators who often lack standardized certification or training. It is estimated that approximately 20 percent of the actors in the sector currently engage with formal institutional arrangements like training centres and licensing/certification bodies. Encouraging industry formalization and more standardized training will provide fora through which new logics regarding energy efficiency strategies and technologies may be transmitted to the intermediaries working in the home renovation space. It will also make it easier for policy makers to identify and connect with greater numbers of intermediary actors. Co-benefits of this strategy include improving public opinion for a sector that often operates in the underground economy, improving the overall quality of the industry's products and services, and enhancing recruitment efforts which are seen as a concern for the future of the industry.

Re-framing the retrofit challenge from a practice-based perspective is recommended. Fundamental to such a policy approach is the need to focus more on the practices that enable improved home energy performance, rather than on homeowner education, regulation and incentives. These practices can include relatively unique profession-specific techniques and services, or more mundane and seemingly unrelated intermediation performances by intermediary actors. Identifying the elements that constitute discrete retrofit practices, or the relations that can help knit together practices into bundles, are key objectives in this regard. It is equally important to understand the role that intermediation practices of

interpretation and translation play in making a practice recognizable for new carriers.

Policy in support of home energy efficiency is made particularly challenging because of the relative invisibility of energy in our homes, and the fact that policy of this sort is necessarily linked to relatively complex human-ecological system feedbacks related to climate change. While upgrading the energy performance of a dwelling can be beneficial from a purely financial perspective, doing so to mitigate climate change requires more rigorous engagement with ideological issues related to energy resilience, intergenerational equity, and sustainable resource management. The lack of consensus among intermediaries operating in Vancouver's retrofit socio-technical system regarding the links between climate change and home energy efficiency requires a policy response. Efforts to engage with retrofit intermediaries to make energy consumption in the home more visible, and to clarify the individual, collective, near- and long-term benefits of energy efficient homes can help reduce the circulation of conflicting messages among these actors and more firmly establish the logic and common sense supporting energy efficient homes.

Retrofit policies have 'idea' tendrils connecting them to parties well beyond city boundaries, thus numerous policy bodies, located near and far, have a hand in shaping local retrofit policy narratives by way of a wide ranging suite of policies, programmes, guidelines and standards. Further, unfounded construction and home-related memes circulating in popular media and the internet can sometimes be unwisely validated by informal, yet highly trusted intermediary actors in the retrofit system (e.g. TV channels dedicated to home improvement projects). Therefore, it is particularly useful to recognize this and find opportunities to work with these 'validators' and thought leaders. There appear to be three intermediary groups that act as kinds of communication echo chambers within the retrofit STSP. The City of Vancouver is reasonably well connected to ex-situ intermediaries (e.g. NGOs, associations, designers, consultants), but is quite distanced from both the community comprised primarily of in-situ intermediaries, and the community made up primarily of senior levels of government and utilities. This dynamic clearly has

implications for communication flow, and for the development and implementation of new policies, and should be mitigated by enhancing communication frequency.

Table 7-1 Policy recommendations for the City of Vancouver

Theme	Specific Recommendations
Intermediaries	<ul style="list-style-type: none"> • expand tent to more explicitly include the highly skilled and impactful middle actors in the retrofit space: take a closer look, not at homeowners or those that develop climate policy, but rather at those agents that sit between these opposing interests. • partner with material suppliers as these have 'contact' with all intermediaries that deal with homeowners • the city has an established community of actors within the middle space of the retrofit system with which it collaborates, yet the value of this community although important is diminished by not including members from the further reaches of the retrofit STS • With respect to the network of intermediaries, who talks to whom, who trusts whom, and who works with whom within the retrofit STS are important factors to track, as this is how ideas are transferred, altered, and sustained.
Intermediaries - trades	<ul style="list-style-type: none"> • facilitate training and higher level learning among intermediaries • partner with associations and educational institutions to develop relevant and accessible training for 'on-site' workers especially • enhance the building trades and other related sectors by celebrating their valuable contributions to the state of the housing stock, and formalizing their role in the retrofit agenda, as these folks are generally well intentioned and want to be a part of the solution rather than part of the problem
Practice-approach	<ul style="list-style-type: none"> • permits a re-orienting of the problem, away from homeowner attitudes and obsessions with technology diffusion, and toward a focus on the ways in which practice elements and practices come together via processes of intermediation to form new practices and new relations between practices. • Focus on the situatedness of practices and the roles that intermediaries play in shaping new practices (via the creation of common understandings, either as purposeful acts or as part of their regular daily practices)
Energy efficiency and Climate Change	<ul style="list-style-type: none"> • don't underestimate how 'invisible' energy and energy efficiency are to the consumer nor how abstract and distant the effects of climate change are from people's daily lives • emphasize clear linkages between residential dwellings and the global collective problem of climate change, and focus this awareness raising on the intermediaries that contribute daily to the energy performance of the housing stock • a lack of certainty and confusion about what energy efficiency is and how it relates to climate change are impeding the formation of a unified understanding and vision regarding home energy retrofits

7.7 Limitations of the research

The research contained in this thesis is the result of an in-depth examination of one city's retrofit socio-technical system of provision. As all cities have different political, environmental and cultural contexts, the findings and policy recommendations herein have limited generalizability to other urban centres. However, as a globally renown 'green' city, Vancouver's learnings may well end up providing inspiration, or at least a launch-pad, for another city to examine the status of their own retrofit socio-technical system.

To access the richly textured lives of the intermediaries operating in Vancouver's retrofit STSP, semi-structured interviews were employed alongside several other

methods. Interviewees were selected carefully to ensure that the most important system perspectives were represented in the research. Given the number and diversity of retrofit intermediaries operating in Vancouver, the views of any one interviewee cannot fairly claim to represent the views of the entire sector or profession to which they belong. The relaxed and honest spirit with which interviews unfolded did however provide richly textured and thick descriptions of interviewees' worlds, and provided me with high quality data to analyze.

Examining home energy retrofit practices logically requires researchers study these directly. I was not able to practically undertake an ethnographic study of the retrofit practice, given resource constraints, so a decision was made early on to instead study the sayings and doings of intermediaries via these actors' personal interpretations of their daily realities. This methodological decision means that my accounts of subjects' representations of social interactions within the retrofit STSP, are in a sense, representations of representations. To help overcome this limitation, I played the role of loyal reporter when transcribing transcripts.

7.8 Core contributions and future research directions

This thesis makes important contributions to theories of practice and literatures on intermediation by conceptualizing intermediation as a practice involved in creating a new retrofit practice through processes of vision building and sense making. Of particular note is the usefulness of de-centering the individual and focusing on the practice as the unit of study and policy target. This can serve to neutralize the polarizing effect inherent in any police-policed policy dynamic. The employment of intermediaries and place lenses have addressed some of the shortcomings of practice theories. For instance, fusing intermediary concepts with social practices and exploring retrofit practices as the result of practices of intermediation usefully elaborates on the teleoaffective nature of practices.

The research also reconceptualizes the retrofit practice as being like an embedded niche practice operating within the more dominant construction practice. It also contributes to the literature on practices by linking intermediation practices with the discrete practice of retrofit. It also adds a voice to a handful of researchers who

recognize the critical role that intermediary actors play in the retrofit challenge including Owen et al. (2014), Judson et al. (2015) and Grandclément et al. (2015). By conceptualizing intermediation as a discrete practice (i.e. comprising materials, skills and understandings), that itself shapes other practices (e.g. home energy retrofit) by fostering consensus and creating collective visions in contested spaces, the research expands greatly on the intermediation literature. Accordingly, there are potential implications for how intermediaries are created, mandated or regulated, and for how systems of governance and sustainability transitions are managed. This view of intermediation also fills a blind spot left by STS and Innovation studies by shedding light on how, mechanistically, intermediary power may be exerted in socio-technical systems. The literature on intermediaries is enhanced through the a broader definition of what constitutes an intermediary, and an elaboration of the differentiated types of intermediary which depend on the particular site or sites at which these actors conduct their normal work. In addition, the research reveals areas of overlap between the literatures on intermediaries and socio-technical systems, by implicating intermediaries in new processes of vision building and governance within contested public domains.

Several findings are transferable to other contexts. For example, by analyzing the spatially dispersed networks that retrofit intermediaries are linked to, and how meanings and know-how are transferred and appropriated by these same actors, the research opens up for analysis the routes through which practices travel, and the ways in which they morph and coalesce through space. Further, identifying intermediation as one mechanism through which meanings emerge in contested arenas, offers opportunities for other researchers to explore this same dynamic in other contexts.

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