Understanding Pro-Environmental Behaviour as Process: Assessing the Importance of Program Structure and Advice-Giving in a Residential Home Energy Evaluation Program

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Despite recognition that reductions in fossil-fuel usage are necessary to reduce environmental harm, energy consumption continues to rise globally. There is a growing need to understand how to effectively influence individuals to reduce their energy consumption, particularly of fossil-fuels. Pro-environmental behaviour is the subset of consumer behaviour that is oriented towards reducing environmental impact compared to other options. It is widely agreed that due to a multiplicity of influencers, pro-environmental behaviour is best analysed using an integrated approach that allows the inclusion of different disciplinary perspectives, and seeks to identify the most important influences in the system under study. This dissertation sought to address the broader challenge of how to better design programs and policies that result in behaviour that is more sustainable.

The objective of this dissertation was to assess the importance and effects of program structure and advice-giving on the pro-environmental behaviour of participating in a home energy evaluation program that encouraged homeowners to implement energy efficiency retrofits. Program structure was defined as the combination of the price of the evaluation, the financial reward structure, the level of government support, and the focus on influencing eight specific decisions within a specified timeframe. Advice-giving occurred during the initial evaluation with a home energy advisor and with the delivery of the report that contained a set of recommendations. A convergent mixed methods research design was employed to assess the relative importance of the two factors on participation and advice-following, where advice-following was considered as the matching of decisions to recommendations. The quantitative dataset was made up of files that detailed the 13,429 initial and the 6,123 follow-up evaluations conducted by advisors of the Residential Energy Efficiency Project (REEP) in the Region of Waterloo between 1999 and 2011. The qualitative data were gathered through 12 interviews with home energy advisors, eight of whom had worked for REEP and had conducted more than half of the home energy evaluations contained in the quantitative dataset. A natural quasi-experimental intervention that measured self-selection in response to varying program structure was employed to examine for variations in participation, material characteristics of houses, recommendations, and advice-following. To extend our understanding of the process of participation and decision making patterns, other analyses focused on relationships between the number of recommendations, the time between initial and follow-up evaluations, the number and types of decisions made, and the prioritization of decisions. The interviews assessed for differences in styles

of advice-giving, and for their impact through comparison with the quantitative data that detailed the recommendations and decisions taken by the homeowners. The results of the effects of both factors were interpreted jointly and compared to previous studies about REEP or the EnerGuide for Houses and program as it was delivered nationally.

This dissertation confirmed that an integrated approach to examining pro-environmental behaviour is supported as a useful framework for analysis. The findings support a process-based definition of pro-environmental behaviour as a useful model and form of integration. A convergent mixed methods research design is supported as a valuable and rigorous approach to examine the impact of various influences simultaneously. The delineation of multiple stages in the decision making process greatly enhanced the quality of analyses and findings. The two main factors of program structure and advice-giving affected advice-following. One factor influenced the other, as the program structure affected the receptiveness of homeowners as perceived by advisors, which affected advice-giving. The findings support the importance of both behaviourist and social learning approaches in influencing pro-environmental behaviour, and that their importance varies depending on the stage of the decision process. The findings show that behaviourist interventions, such as the program structure, were associated with variations in participation, and that different subsets of the population of houses from the Region of Waterloo were attracted to the different program structures. Indeed, in each program structure, the decision to return was influenced by different decisions.

A critical finding of this study was that these programs were not sufficient to alter the path dependence of energy consumption or of energy systems as the program participants usually did not implement the most effective retrofits, and if they did, the retrofits did not achieve adequate depth of reductions to energy consumption in a timely manner. According to the home energy advisors, many homeowners had pre-conceived ideas upon entering the program of replacing their heating systems and windows. The interpretation of the qualitative and quantitative data showed that these intentions were often not altered, particularly in the case of windows, the decision that advisors believed to be the least effective of energy decisions.

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ABC	Attitude, behaviour, context theory
CEM	Community Energy Management
CEP	Community Energy Planning
DSM	Demand Side Management
ELM	Elaboration Likelihood Model
HRV	Heat recovery ventilator
IEA	International Energy Agency
IRP	Integrated Resource Planning
LCUP	Least-Cost-Utility Planning
NRCan	Natural Resources Canada
OECD	Organization of Economic Cooperation and Development
OEE	Office of Energy Efficiency (operated by NRCan)
REEP	Residential Energy Efficiency Project or REEP Green Solutions
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
VBN	Value-belief-norm theory

Chapter 1
First Chapter

1.1 The Problem of Energy Sustainability and Energy Consumption

Current energy systems are responsible for pollution such as acid rain, smog and climate change (e.g., Goldemberg et al. 2004), that result in social and environmental impacts (e.g., Stirling 1997). A typical solution to these problems is to decarbonise economies by reducing fossil fuel dependence, encouraging low-emissions technologies, and reducing energy consumption. However, how to address the decarbonisation of economies is strongly debated between the environmental economics and ecological economics communities in two ways. The first debate focuses on whether technological development can overcome resource constraints affordably (e.g., Neumayer 2003; Parker and Gliedt 2012). The second debate focuses on whether there is such a thing as critical natural capital, defined as the ecosystem services that are considered necessary and irreplaceable[1]. (e.g., Turner 2000). Climatic stability, stratospheric ozone, and topsoil or species diversity are all considered critical natural capital for which there are no known or foreseeable technological substitutes (Turner 2000).

The idea of decarbonisation of economies provokes heated debate which can affect the timeframe of implementation of solutions. There are many reasons to reduce fossil-fuel dependent energy consumption as rapidly as possible. Many argue that not planning for decarbonisation results in negative outcomes (e.g., Jaccard 2005; Parker and Gliedt 2012). There are three commonly debated negative outcomes that have the potential to create profound societal impacts. These are: increasing prices and energy price volatility due to fuel scarcity; increasing costs due to delaying mitigation of climate change (Jaccard 2005; Parker and Gliedt 2012); and the physical effects of climate change (Bernstein et al. 2008). According to the Intergovernmental Panel on Climate Change (IPCC) (Bernstein et al. 2008), increases in greenhouse gas emissions are related to increases in global temperatures, that are related to different rates of negative impacts (e.g., sea level rise). Therefore, the faster that emission abatement can occur, the smaller the projected temperature rise, and the smaller the projected negative consequences (Bernstein et al. 2008). To avoid any of the three negative

[1] Turner (2000) notes that irreversible damage to critical natural capital may occur at thresholds that are not known.

consequences requires a reduction of fossil fuel consumption; time is a critical factor for the avoidance or minimization of each impact mentioned.

According to the analysis provided by the IPCC, energy efficiency in buildings[2] is the least expensive sector to address, and can achieve significant reductions at the lowest cost (Barker et al. 2007; Barker et al. 2007). In the majority of regions of the world, buildings can achieve significant savings to greenhouse gas emissions, up to about 25%, at a net negative cost (Levine et al. 2007). From the perspective of economic decisions for a national economy, improving the energy efficiency of residences is one of the first actions a government might select to promote.

In the case of Canada, in order to achieve recommendations for industrialized countries made by the IPCC to avoid more than a 2^oC increase in temperature, Canada should target a reduction in greenhouse gas emissions of 50% from 1990 levels by the year 2020 (The Pembina Institute and The David Suzuki Foundation 2009). Canadian residences account for 17% of consumed energy in Canada (Natural Resources Canada 2010). In 2008, Canadian residences accounted for 10% of Canada's total greenhouse gas emissions (Environment Canada 2010; Office of Energy Efficiency 2010), having emitted 74.2 mega tonnes (Mt) of carbon dioxide equivalent[3] (CO_2-eq) (Office of Energy Efficiency 2010).

There is clear evidence both of rising patterns of energy consumption globally and of change in the structure of demand for energy services. For example, energy consumption rose in every sector in every region of the world (except Russia) between 1990 and 2005, as shown in Figure 1.1 (IEA 2008). Further, according to the International Energy Agency (IEA),

> Global energy use in the household sector increased between 1990 and 2005 by 19% to reach 82 [exajoules] EJ. Households are the only major end-use sector where the increase in energy consumption since 1990 has been greater in [Organization of Economic Cooperation and Development] OECD countries (+22%) than in non-OECD countries (+18%). (IEA 2008: 44)

This situation is in part due to trends in the OECD that counteract energy efficiency and conservation efforts despite improvements in the efficiency of most energy tasks. One prevalent trend is that the pursuit of comfort has led to increased demands for energy services. This trend has offset

[2] Houses and commercial buildings are analysed jointly in IPCC reports.
[3] Including emissions associated with electricity, excluding transportation and commodities purchase.

the savings in energy that otherwise would have occurred due to improvements in energy efficiency (Anable 2010; Eyre 2010). For example, in the United Kingdom, average internal home temperatures increased from 13.8°C to 18.2 °C between 1970 and 2004 (Healy 2008 and Martiskainen 2008 cited in Maréchal and Lazaric 2010). In the United States, since the 1950s, the average size of a purchased house increased as the number of occupants per household decreased, and as a result, average individual floor space tripled (Harris et al. 2007). Both of these changes in comfort have offset the potential savings in energy for heating. A second related trend is the increase in the variety of services sought. In the United Kingdom, it has been found that the average number of types of appliances and devices in a home increased approximately three-fold between 1970 and 2006 (Energy Saving Trust 2006 as cited in Eyre 2010), from an average of 17 electric appliances in 1970 to an average of 47 electric appliances in 2004 (Healy 2008 and Martiskainen 2008 cited in Maréchal and Lazaric 2010).

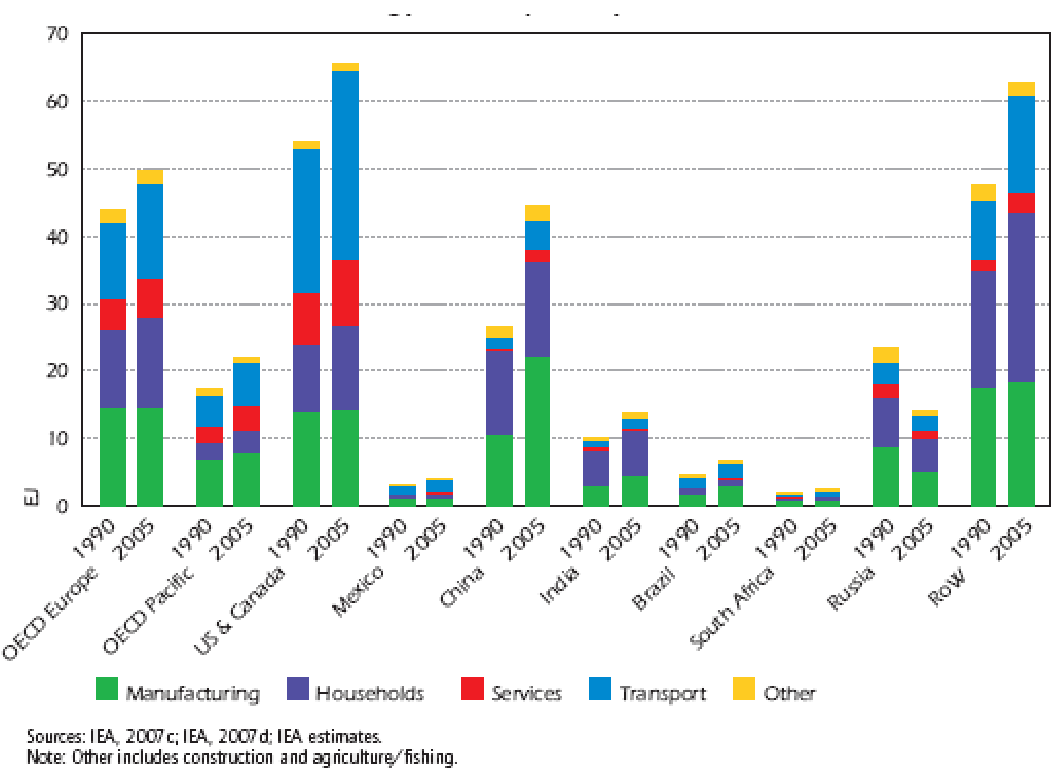

Figure 1.1 Total Final Energy Consumption by Sector, 1990 and 2005 (IEA 2008: 17)

These trends are also present in Canada. For example, the average floor space per house grew 10% between 1990 and 2008 (Office of Energy Efficiency 2010), which demonstrates growth in demand for energy services. During that timeframe, greenhouse gas emissions that are associated with heating and cooling grew by 8% and 113% respectively (Office of Energy Efficiency 2010). Even though the efficiency of space heating improved, total energy for space heating still grew slowly. In the same timeframe, there was an increase in the variety of services sought, demonstrated by a 144% increase in household use of Other Appliances (Office of Energy Efficiency 2010). In addition to these trends, Canadian (and American) per capita household greenhouse gas emissions have been consistently higher than those of other OECD countries (as shown in Figure 1.2). The citizens of some of these OECD countries enjoy a similar climate and quality of life as Canadians (e.g., Goldemberg et al. 2004).

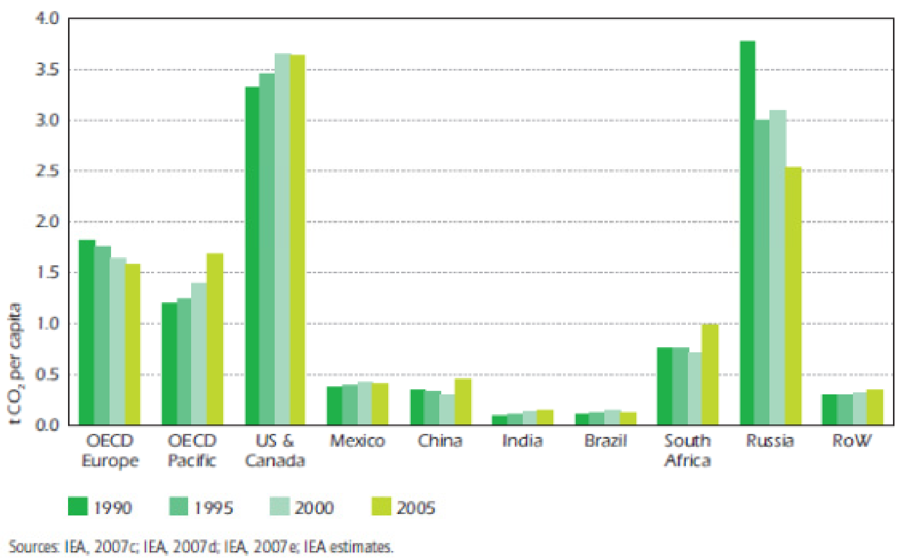

Figure 1.2 Household CO_2-eq Emissions per Capita (source IEA 2008: 45)

The growth trends in energy consumption are symptoms of changing lifestyles and the current system of energy production and consumption. Changing lifestyles are understood to affect preferences for services in the pursuit of comfort, cleanliness and convenience (e.g., Shove 2003). Energy systems are widely thought of as being path dependent (e.g., Owens 1986; Jaccard et al. 1997; Elzen et al. 2004; Jaccard 2005). Furthermore, energy systems and the built environment are acknowledged to reinforce the path dependence of consumptive behaviours. These path dependent consumptive behaviours in turn reinforce the inertia of the energy system. Owens (1986) describes energy consumption as permitting factor to a variety of spatial development patterns, lifestyle, economic and social processes related to quality of life and culture. However, once established, settlement patterns made up of particular characteristics of location, size, shape, and population density are significant determinants of energy consumption (particularly transportation, space heating and cooling) (Owens 1986). These determinants impose temporal constraints on energy system change as they are slow to change (Owens 1986). This also occurs at the personal and household level. Shove (2003) has shown that existing technologies and socio-technical practices structure future developments, and many of these contribute to irreversibility to practice and to the system. The outcome is that all of the aforementioned factors prolong existing patterns of energy consumption (Slob and van Lieshout 2002). Furthermore, reliability is increasingly upheld as an important outcome of energy systems (e.g., Yeager 2004; Yeager et al. 2005; IEA 2009) and this implicitly relates to the pursuit of comfort and convenience by increasing numbers of people. To summarize, a systemic perspective regards energy systems as socio-technical systems and understands that energy consumption is influenced by and influences a variety of factors that occur or operate at various spatial, economic, social, political, and technical scales. The transitions of energy systems have long been studied (e.g., Leach 1992; Smil 2010), and multilevel transitions is one conceptual framework that applies complex systems thinking to better understand long term energy transitions and sustainability (e.g., Geels and Schot 2010; Verbong and Geels 2010).

Given this understanding of energy consumption, some of the broader research questions that energy and sustainability researchers are trying to address are:

1. What factors can lead to a relatively rapid systemic change and deep reductions in energy consumption?
2. How can this reduction happen so as to minimize negative social and environmental impacts associated with fuel scarcity and climate change?

1.2 Pro-Environmental Behaviour as Area of Focus

This study examined the decision to participate in a home energy evaluation program that encouraged homeowners to reduce energy consumption through investment in energy efficiency. A home energy evaluation has the potential to influence significant change in personal energy consumption. The actions taken by homeowners as a result of these programs could significantly reduce personal greenhouse gas emissions as well as vulnerability to fuel scarcity. A household energy evaluation may be one of the few interactions homeowners have with an energy expert regarding their house, and the report is likely the only document detailing their house's energy performance. The home energy evaluation can be considered significant both in terms of learning and identifying large reductions to personal energy use. It is therefore an important site of investigation of pro-environmental decisions concerning energy.

Researchers understand consumer behaviour as a variety of decisions or behaviours that can be influenced by many different factors. Jackson (2005) points out that consumption is part of the pursuit of personal and cultural meaning. Therefore, a particular consumptive behaviour might be influenced by the recognition of a want or a need, personal and group norms, price, availability, product attributes, as well as a variety of other factors. In this study, pro-environmental behaviour is the sub-set of consumer behaviour that is oriented towards environmental sustainability, and more specifically, towards reducing environmental impact compared to other options. It is widely agreed that, due to a multiplicity of influencers, pro-environmental behaviour lends itself to examination using an integrated approach that allows the inclusion of different disciplinary findings and perspectives. Integration means to focus only on the key variables and relationships that account for most of the variation in the behaviour of the system and that are amenable to intervention. (Mitchell 2008). Jackson (2005) describes the basis of integration in pro-environmental behaviour as informed by structuration theory through the recognition that it is influenced both by internal (psychological) and contextual (situational) factors. While this is a common basis for integration of pro-environmental behaviour, this definition is not shared by all. For example, Wilson and Dowlatabadi (2007) appeal for integration as decision models that are nested within each other, ordered by timeframes of decisions. Resource consumption and the implications of more sustainable consumption are embedded in systems of production and consumption (e.g., Lebel and Lorek 2008; Peattie 2010). Thus it is also widely agreed that the factors that influence and hinder pro-environmental behaviour operate at multiple scales that can be internal (e.g., Jackson 2005), spatial (e.g., Owens 1986; Jaccard et al. 1997), social (e.g., Lutzenhiser 1992), political (e.g., Parker and Rowlands 2007) and economic (e.g., Geels and Schot 2010).

It is for the above mentioned reasons that our understanding of pro-environmental behaviour is informed by multiple disciplines. These typically include engineering, ecological economics and industrial ecology, behavioural economics, environmental economics, planning, social psychology, marketing, geography, sociology and history. So far, most research can be considered multidisciplinary as findings from various disciplines are considered complementary, but studies are typically informed by a singular discipline and compared to findings from studies informed by other singular disciplines (Peattie 2010). The engineering and economic traditions are considered to be the dominant tradition of studies about energy consumption behaviour (Wilson and Dowlatabadi 2007). Multidisciplinarity does not produce a “clear picture” of behaviour (Peattie 2010) and many researchers note that it is desirable to employ interdisciplinarity to better understand pro-environmental behaviour. Interdisciplinary research seeks to achieve integration and synthesis from the outset (Mitchell 2008).

1.3 Integrated Approach

Researchers face three broad challenges associated with improving our understanding of pro-environmental behaviour. One challenge is to identify or clarify appropriate forms of integration to examine pro-environmental behaviour. An integrated approach is now widely favoured in examinations of how to influence energy consumption from an impact-oriented perspective and provide indications on how to better design interventions. Another challenge is to find and use cross- and interdisciplinary approaches to better examine pro-environmental behaviour. A third challenge is to identify and use methodologies which correspond with the identified forms of integration and cross- or interdisciplinarity.

In a broad review of the literature on factors which influence pro-environmental behaviour, Peattie (2010) explains that much literature has focused on environmental concerns. Many studies have examined whether a behaviour change occurred, but not the extent to which it changed. Peattie (2010) suggests that pro-environmental behaviour should be understood and examined within the process of consumption, which he describes in six stages. These stages are:

(1) Recognition of a want or a need → (2) Information search → (3) Evaluation of alternatives → (4) Purchase → (5) Use → (6) Post-use

Peattie (2010) points out that many researchers isolate a stage of the process and examine it independently so that knowledge about how the stages fit together holistically is unclear. Due to a focus on the rational choice model, government interventions tend to focus on giving information and influencing private costs (Jackson 2005). As a result, much research has focused on rational decision making as well as pro-environmental intentions (Peattie 2010). Sometimes researchers discuss the lack of a common definition of behaviours in research (e.g., Stephenson et al. 2010), but this could be a result of not defining a behaviour within the context of the six-stage process. When pro-environmental behaviour is viewed as a process, it is easily understood that the decision pathway can be influenced at each stage. Peattie (2010) appeals for integration that acknowledges this six-stage process and research that focuses on understanding the relative importance of different types of influence. Peattie (2010) argues that researchers need to move beyond a reductionist tradition of research that isolates cause-and-effect relationships, and instead examine a broader range of variables through the use of modeling. In Peattie's words: "environmental motivations and outcomes, and the ultimate sustainability of a behavior depends on understanding the entire process of consumption and how individual acts of consumption combine to form a lifestyle." (Peattie 2010: 219). This perspective should impact selection of methodology by researchers.

This research project focused on one pro-environmental behaviour, that being participation in a home energy evaluation program. This research project included relevant data for two programs that were developed by the federal Government of Canada that were delivered by the Residential Energy Efficiency Project (REEP) between 1999 and 2011. Participation in each of the EnerGuide for Houses (1998 to 2006) and ecoEnergy (2007 to 2012) programs consisted of several steps. The first was to arrange for an evaluation of the house by a certified home energy advisor who arrived in person, took measurements and used a computer program to model upgrades that would improve the house's energy performance. The homeowner was either immediately given, or later mailed, a report detailing the selected upgrades. The homeowner decided whether to invest in improvements. The homeowner may have scheduled a follow-up evaluation to verify the improvements made. This participation was made up of several stages that are parallel to the first four stages in Peattie's six-stage process[4]. This comparison is made more clearly in Figure 1.3.

[4] Parker et al. (2005) have examined stage (5) use in the context of REEP's delivery of programs.

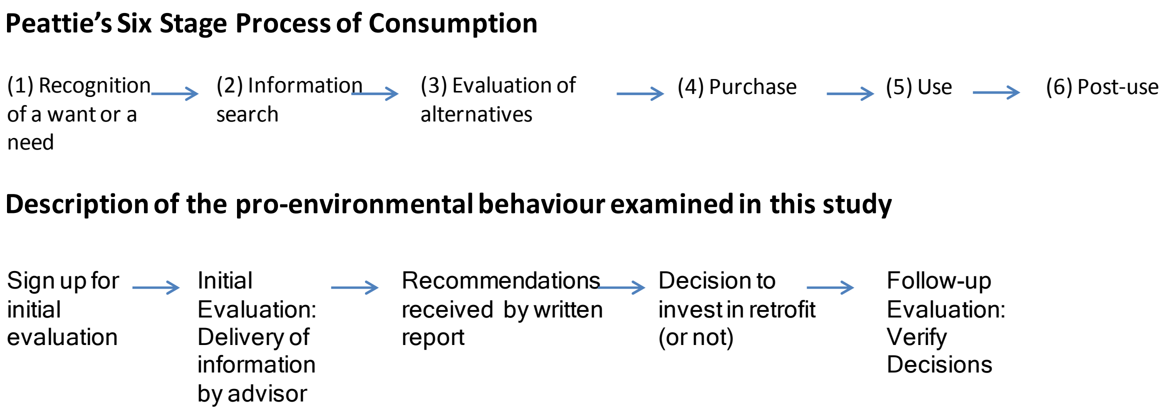

Figure 1.3 Comparison of the Research Topic to Peattie's Six-Stage Consumption Process

The examination of a home energy evaluation program is framed here in terms of participation, the process of advice-giving, and advice-following. Participation was measured for both the initial and follow-up evaluations. Advice-giving occurred during the initial evaluation and with the delivery of the report that contained a set of recommendations. Advice-following was assessed by how well homeowner decisions matched the advice given to them and over what timeframe. Over the 12 years that the programs were delivered by REEP, two factors varied and were examined for the responses of participation and advice-following. The first was the program structure that was defined as the combination of the price of the evaluation, the financial reward structure, the level of government support, and the focus on influencing eight specific decisions within a specified timeframe. The second factor that varied was advice-giving, as the different advisors employed different strategies of selecting and communicating advice during the home energy evaluation and the recommendations included in the report. The EnerGuide for Houses and the ecoEnergy programs were based on the same set of eight retrofit decisions that could have been recommended or achieved[5]. Hence, another variation between this program and other programs was the ability to analyse for prioritization or trade-offs between the eight competing decisions. Additionally, advice-giving by a single advisor may have varied within program structures.

[5] These are: (1) reduce air leakage, (2) insulation to basement, (3) insulation to ceiling or attic, (4) insulation to walls, (5) replace windows and doors, (6) replace heating system, (7) replace hot water system, (8) add a heat recovery ventilator. The ecoEnergy program offered more options under decisions (6) and (7) that are discussed in more detail in Chapter 3.

The conceptual framework for this research is shown in Figure 1.4 and is based on the description of the participation process in Figure 1.3. The conceptual framework conveys the form of integration as process and adds information about the contextual factors operating at scales higher than the pro-environmental behaviour. The rationale for the inclusion of some factors at higher scales is that energy consumption is embedded within a path dependent system and many argue that a systemic perspective on pro-environmental behaviour is required to better understand impact-oriented behaviours. Stephenson et al. (2010) point out that consumer behaviours are difficult to examine as they are embedded within system change, but can be examined in light of systemic change. Although the focus of this study was on pro-environmental behaviour as the process of participating in a home energy evaluation, the conceptual framework reflects that in this dissertation, these decisions were examined in light of systemic change operating at higher scales. This perspective fits with human and economic geography approaches, and this is described in more detail in Section 2.9.

Some of the factors presented in the conceptual framework have already been examined or defined by previous research on the same method of program delivery. For example, this dissertation focused on the impact that program structure had on pro-environmental behaviour. It can be recognized that the program structure and the method of delivery were shaped by factors operating at other scales. This was shown in the analysis by Parker and Rowlands (2007), who described the relationships between local and federal forms of government in the delivery of the EnerGuide for Houses program. In another example, one dependent variable measured in this study was the distribution of participating housing stock in the Region of Waterloo. It is important to recognize that the housing stock and its energy consuming characteristics have been shaped by the interaction of social, spatial, political and economic factors operating over time (e.g. Owens 1986). Further, it is shown in the literature that the outcomes of this intervention on a community scale may have broader effects inside and outside the community. For example, Gliedt and Parker (2007) described the development of new services in response to the cancellation of the EnerGuide for Houses program. It is for all of these reasons that the pro-environmental behaviour examined by this research is described in the conceptual framework as embedded within processes operating at higher scales. It can be noted that the arrow of time is included in this conceptual framework. Time is included because process-based research is necessarily referenced against the dimension of time (Arrow et al. 2004), which is a critical factor in the wider process of decarbonisation of energy systems and addressing climate change.

Finally, it is worth noting that environmental problems exist in part due to resource use and that pro-environmental behaviour may lessen the damage inflicted on the environment. However, this thesis constrains its analysis to a socio-technical context governed by human decisions and interactions. The conceptual framework does not take into account the influence of factors from the natural environment, or how the consumption process directly influences the natural environment. Furthermore, the conceptual framework recognizes reasonable spheres of influence as defined by Stern (2000). For example, it would be difficult for an individual to alter the spatial scale, so the program was designed to influence eight decisions to retrofit a house. The conceptual framework is discussed in more detail in Chapter 2.

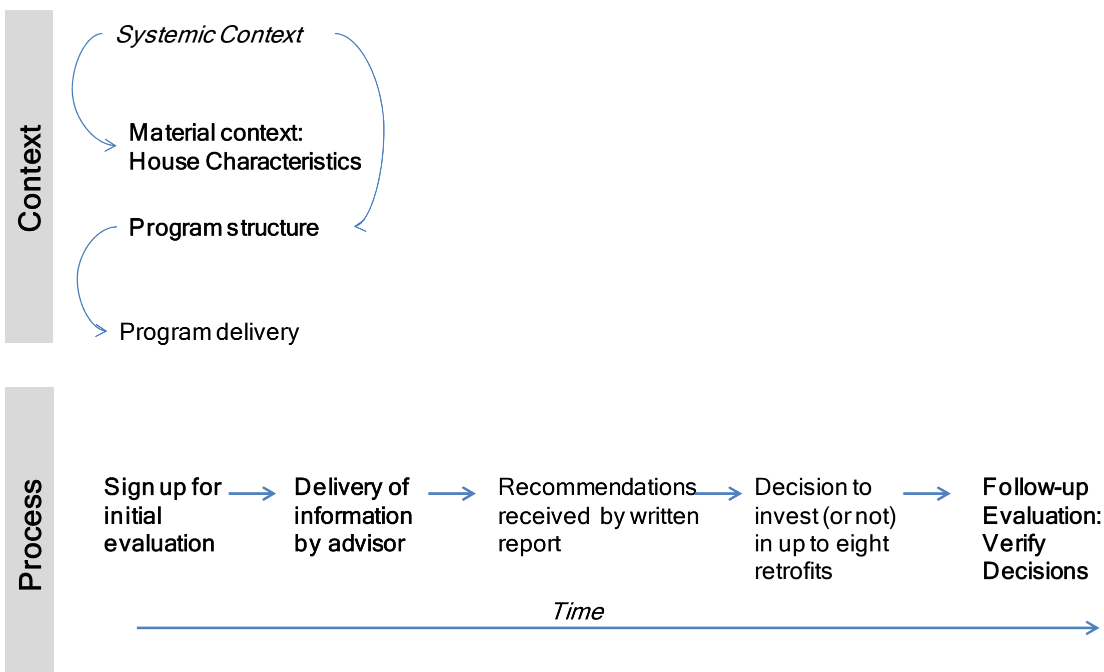

Figure 1.4 Conceptual Framework of the Dissertation

Using an integrated approach allowed the study to be informed by many debates about pro-environmental behaviour. Behaviourists seek to create conditions for behaviour change by altering context, such as making financial rewards available. Social learning approaches stand in contrast to behaviourist approaches by focusing on learning due to exposure to information and experience. Debates in social psychology and evolutionary economics address how information is framed: whether messages are more influential to the outcome if they are loss framed, gain framed, or vivid (salient). Another emerging debate over information is about the effectiveness of the message; whether economic, environmental, or normative messages are more persuasive in affecting pro-environmental decisions. Persuasion theory recognizes the importance of the credibility of the information deliverer, and trust on the part of the information receiver. These are all useful debates to draw from in order to explore the impacts of program structure and advice-giving.

1.4 Area of Research Focus

This research project focused on understanding the impact of program structure on participation, advice-giving and advice-following, and the impact of advice-giving on advice-following. There are many ways to examine the impact of program structure and advice-giving on advice-following. For example, program delivery could be altered by experimental design and include information about the factors of interest (number of options, cost, and financial reward structure). A broad survey could assess a random sample of participants in the EnerGuide for Houses and ecoEnergy programs to examine for reporting on the effects of the number of options, cost, and the financial reward structure, as well as differences in advice-giving strategies. In order to learn more about the advice-giving process, home energy advisors across Canada could be surveyed to examine for variations in how they perform a home energy evaluation and select and communicate recommendations. Advice-following could be measured either through self-reporting by homeowners in surveys, or by using the national dataset for EnerGuide for Houses and the ecoEnergy programs. However, there are limitations associated with all of these research designs. For example, altering program delivery by experimental design is not pragmatically possible, and stated preference experiments may not hold up in reality. A survey of participants of the programs relies on historical recall and self-reporting of recommendations and decisions; both will diminish in accuracy due to time and perceptions of self. Further, it would be difficult to combine surveys with a national dataset to compare and corroborate results. A survey on home energy advisors may not offer enough depth to understand the issues.

Program Period	Description	Price of initial evaluation ($)	Price of follow-up evaluation ($)	Financial reward structure
EnerGuide for Houses	Home energy evaluation. Report delivered to homeowner at evaluation.	25 to 80	Free (min 3 point improvement)	No reward
EnerGuide for Houses with financial reward	Home energy evaluation. Report mailed/emailed to homeowner following evaluation. Maximum financial reward $5,000	75 to 250	0 to 205	Performance based on energy rating scale (>40 - >60 points)
Local support	Home energy evaluation. Report mailed/emailed to homeowner following evaluation.	100 to 260	150	No reward
ecoEnergy	Home energy evaluation. Report mailed/emailed to homeowner following evaluation. Maximum financial reward $10,000	100 to 325	50 to 195	List based

Table 1.1 Differences in Program Structure

Using the national dataset for decision analysis would yield more specificity, and therefore would be useful. The Residential Energy Efficiency Project (REEP) has its own dataset that contains documentation of initial and follow-up home energy evaluations beginning in 1999. The documentation includes the dates of these evaluations and the home energy advisor identification. Between 1999 and 2011, REEP delivered four program variations. These program variations are described in Table 1.1. By contrast, a national data set may not classify evaluations by date, or allow the release of home energy advisor identification, and only had three program structures. Further, a relationship between the University of Waterloo and REEP increased credibility and facilitated access to the home energy advisors who delivered the evaluations; therefore, interviews about their advice-giving strategies could be directly compared to the information contained in the dataset about the decisions taken by participants in the program.

The dissertation presents an analysis of the data collected by REEP that describes the initial and follow-up home energy evaluations combined with an analysis of in-depth interviews conducted with eight REEP advisors. The data analysed for this study were collected over 12 years and during this timeframe there were four program periods. Each program period had a different price of evaluation as well as a different financial reward structure. The interviews with REEP advisors were complemented by interviews with four advisors with the same training. The interviews with the home energy advisors might also suffer from the issue of recall. However, the strength of this research design was that it allowed for increased specificity, corroboration, triangulation, and elaboration by maximizing the available data as well as expertise and resources developed through REEP. Inclusion in the dataset of the time at which the evaluations took place allowed for a further contribution to a process-based view. Previous research on REEP established that through a community based social marketing approach and REEP's association with a university and municipal partners, REEP was regarded as a credible organization, and it consistently had a higher rate of program participation than occurred in other communities (Parker et al. 2003). Therefore the selected topic of examination was a program that had already been studied and recognized for best practices (e.g., Berry 2010). This allowed for triangulation and elaboration by comparing the decisions measured in the dataset to an understanding of how advice was given to REEP participants, and this was also compared to surveys that were designed to understand the motivations and decisions of previous REEP participants. It can be noted, however, that these results cannot be universally compared to all settings for program delivery. For example, REEP did not provide retrofit services, so this research could not examine a combined evaluation and retrofit services provision. However, undertaking an in depth case study can allow for future comparison and contrast with other service delivery methods.

The findings of this dissertation contribute empirical results to several areas of study. The findings presented here demonstrate the benefit of an integrated approach to examine the pro-environmental behaviour of participating in a home energy evaluation, and provide examples of how a mixed methods research approach can be used.

- This study contributes to knowledge about heterogeneity in responses to interventions from subsets of populations. Although they frame integration as nested models, Wilson and Dowlatabadi (2007) appeal for an integrated approach that includes better methods of characterizing and addressing heterogeneity in preferences, contexts, behaviours and decision makers in a targeted population. That is, different subsets of populations respond differently to interventions. One of the reasons for this gap in knowledge is that analysis of pro-environmental behaviour lacks specificity of retrofit decisions. For example, many studies select monetary investment or energy savings as the dependent variable, instead of the types of retrofits decisions taken. This analysis measured the material context, such as the construction period and energy performance of the housing stock under study, and eight specific retrofit decisions. The increased specificity of measurement of decisions allowed for a better measurement of heterogeneity in the target population.

- Abrahamse et al. (2005) have stressed that many studies fail to produce information on statistically significant effects due to very small sample sizes. The dataset of home energy evaluations that is used in this study is sufficiently large that differences can be found within subsets, whether the subsets are by policy period or by individual advisor.

- The inclusion of increased specificity in decisions and of timing of decisions also allowed for analyses that enhance knowledge on the process-based view that is not well documented or elaborated on. As for advice-giving, while many of the factors that form advice-giving have been studied, few studies have examined the role and perspective of home energy advisors and their employed strategies of advice. The findings presented here contribute to a better understanding of how home energy advisors engage with homeowners and offer advice on home energy retrofits.

- Considering both the responses to program structure and to advice-giving, this dissertation therefore enhances our understanding of the usefulness of integrated approaches by examining for interactions between these two independent variables.

- Following the integrated approach, the findings contribute to many different fields of study. This dissertation contributes to discussions in social psychology and economics by facilitating our understanding of the effects of program design in terms of program price and financial reward structure. It contributes to the areas of social psychology and social learning about the effects of the number and prioritization of the eight improvement options by advisors and by homeowners. The findings contribute to a social learning and process-based perspective by elaborating both on the advice-giving process and on advice-following as a process that occurs in time. The study also considers persuasion theory, message framing and content in practice.

1.5 Research Objectives and Questions

The objective of this research was to identify and evaluate the importance of factors that affect pro-environmental behaviour. The findings of this study address the broader challenge of how to design programs and policies that motivate behaviour that is more environmentally sustainable. More specifically, this research was an examination of how program structure and strategies of advice-giving affect advice-following and participation in a 12-year home energy retrofit program. Advice-following was considered as the matching of decisions to recommendations in terms of type and depth.

1.5.1 Research Questions

This research examined two broad research questions which were derived in consideration of the desired research contributions, objectives, and the available data. The research questions were:

1. Where program structure was defined as the combination of the price of the evaluation, the financial reward structure, the level of government support, and the focus on influencing eight specific decisions within a specified timeframe, how did program structure affect participation, advice-giving, and advice-following?
2. Where advice-giving was considered to be the selection and communication of advice during the home energy evaluation and the recommendations included in the report, how did advice-giving affect advice-following? More specifically, what were the strategies of advice-giving employed and did these affect advice-following?

1.5.2 Research Objectives

The general objective related to the first research question was to examine the variations in participation rates, material characteristics, and advice-following in response to variations in program structure. In this research, the material characteristics were considered to be the characteristics of the specific technologies involved in the eight decisions, and characteristics such as the house's floor area, and modeled energy performance, energy consumption, and greenhouse gas emissions. There were five sub-objectives related to this research question.

- The first sub-objective was to identify the differences in program structure between the four program periods in order to articulate the context of a natural quasi-experimental intervention. This included a description of the price of the evaluation, the structure and level of the financial reward, and the level of government support. This facilitated the second sub-objective.

- The second sub-objective was to examine for heterogeneity of preferences in the Region of Waterloo. More specifically, different subsets of the populations that had different material characteristics might have been attracted to participate in the initial evaluation of the program. The houses that exhibited the preference of returning for a follow-up evaluation under each program period might also have had different material characteristics and a different set of recommendations than the population of initial evaluations from which they originated. The research seeks to understand whether and how the different program structures appealed to different material concerns of participants by employing a natural quasi-experimental intervention. This sub-objective is concerned with why some households came for an initial evaluation and then returned for a follow-up and some did not.
- The third sub-objective was to understand how the recommendations varied under each program structure. This sub-objective required the description of recommendations for each type of decision under each program structure.
- The fourth sub-objective was to describe variations in advice-following under each program structure; the matching of decisions to recommendations in terms of type and depth of the houses that returned for a follow-up evaluation.
- The fifth sub-objective was to better understand the multi-stage process of the pro-environmental behaviour under study. There were three components in this sub-objective. The first was to examine for relationships between elapsed time between evaluations and number and type of improvements made. The second was to examine for effects of the number of recommendations on decision making patterns. The third was to analyse for outcomes of households depending on whether their decisions were congruent with the advice given to them.

The stages of the research to answer this question were posited as a series of questions in Table 1.2.

- What were the differences between the program structures of the periods?
- What was the rate of participation in an initial and follow-up evaluation over time? What are the key dates involved in these periods?
- Were there differences between rates of participation (in initial and follow-up evaluations) between periods?
- In which municipalities or utility areas did participation occur?
- Across periods, were there differences between the populations which had an initial evaluation?
- Was the variation in price of an initial evaluation associated with differences in energy use characteristics of participating houses?
- Within periods, were there differences in the initial characteristics of those who came for an initial evaluation, and those who returned?
- What were the recommendations made over the various periods?
- What was the depth of recommendations across periods?
- What was the median/mean number of recommendations made amongst periods?
- What was the relationship between number of recommendations made and the number of changes made?
- What is the relationship of number of changes made and improvement in energy performance?
- What was the relationship between the decision type and number of changes made?
- What was the relationship between the timeframe between the initial and follow-up evaluations and number of changes made?
- What was the relationship between the timeframe between the initial and follow-up evaluations and type of changes?
- What was the relationship between the timeframe between the initial and follow-up evaluations and the type of decision?
- For the homeowners who only changed (1, 3, 4, 5, 6, 7, 8) thing(s), what is the count of each type of change made?

Table 1.2 Sub-Questions That Guided the Research on the Impact of Program Structure

The main objective in answering the second research question was to understand the importance of advice-giving on advice-following. Advice-giving was considered to be the selection and communication of advice during the home energy evaluation and the recommendations included in the report. There were four sub-objectives of the second research question.

- The first sub-objective was to interview a purposive sample of home energy advisors from REEP in order to understand the differences in the strategies or styles of advice-giving of each advisor. The advisors were initially selected by the number of home energy evaluations that resulted in a follow-up evaluation.
- The second sub-objective was to understand the rationale of each advisor for the selection and prioritization of advice that was given to homeowners. This included the selection and prioritization of the eight specific decisions.

- The third sub-objective was to analyse REEP's quantitative data set for the recommendations by advisors and to compare these to decisions taken by homeowners.
- The fourth sub-objective was to compare the qualitative and quantitative results in order to better understand the importance of advice-giving as it affected advice-following.

The stages of the research to answer this question were posited as a series of questions in Table 1.3.

- What were the advisor's professional background and personal or professional motivations/ philosophies to deliver home energy evaluations?
- What were the advisor's perceptions of homeowners' level of knowledge, motivations and decisions?
- What was the importance and prioritization of each type of improvement with respect to the improvement of the home's energy performance?
- How did advisors select recommendations and what was the rationale for prioritization?
- What was the advisors pattern of communication and engagement with the homeowner, such as, the level of homeowner participation encouraged, their style of communicating problems and solutions to homeowners, and how they overcame communication barriers?
- What were some of the perceived barriers associated with the program's structure in impacting energy usage in homes?
- By advisor, what were the number, type and depth of changes recommended?
- By advisor, what were the number, type and depth of changes made?

Table 1.3 Sub-Questions That Guided the Research about Advice and its Impacts

1.6 Outline of the Dissertation

The dissertation is written in seven chapters. Chapter 2 describes and assesses the literature relevant to understanding pro-environmental decisions, and to clarify the current state of research. This chapter elaborates further on the integrated approach as it identifies and evaluates the importance of different factors which affect pro-environmental behaviour. Chapter 3 presents the chosen methodology for this research. A convergent mixed methods research design was used. A different mixed methods research design was used to address each research question, with different emphases on the qualitative interviews with home energy advisors and the quantitative analyses using the dataset. The research questions were analysed separately and divided into two results chapters. Chapter 4, the first results chapter, addresses the first research question and the identified sub-objectives and sub-research questions. Chapter 5, the second results chapter, addresses the second research question and the identified sub-objectives and sub-research questions. Chapter 6 presents an integrated discussion of results. The discussion summarizes, compares and synthesizes major findings from the two results chapters, and these results of this interpretation are compared to other research about REEP and to broader research areas for elaboration and triangulation. The discussion summarizes the findings, contributions and contradictions of the research with findings from other studies. Chapter 7, the conclusion, presents a summary of the major research findings, the potential for application of these findings, and summarizes areas of future research.

Chapter 2

Literature Review

Our understanding of pro-environmental behaviour, the subset of consumer behaviour that is oriented towards reducing environmental impact compared to other options, has evolved over time in response to an accumulation of knowledge about the barriers it faces. Currently, a wide variety of disciplines analyse how to influence pro-environmental consumption decisions. The purpose of this literature review is to assess many of the literatures that address such decisions, and then to identify those that are most relevant to the conceptual framework that was presented in Chapter 1. This chapter is therefore organized around the exploration of literature that describes the different factors that have been demonstrated to influence or inhibit pro-environmental behaviour, particularly as they explain the five-stage process and context presented in the conceptual framework.

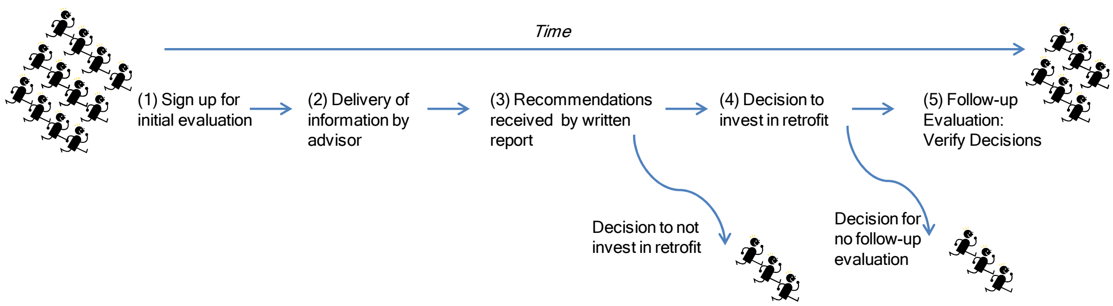

Figure 2.1 Process of Participation in a Home Energy Retrofit Program

As this dissertation focuses on one particular pro-environmental behaviour, that being to participate in a home energy evaluation program, the decision set examined in this research involved the five-step process that is described in Figure 2.1. First was the decision to have an initial home energy evaluation. Second was the exposure to information and learning which occurred through interaction with the home energy advisor. Third was the exposure to information and learning which occurred as a result of receiving the report. Fourth was the decision to invest in home energy improvement. Fifth was the decision to have a follow-up home energy evaluation to document the improvement. However, there is also a growing consensus that an integrated approach is critical to understanding how to influence pro-environmental behaviour. There is agreement that there are factors which operate at various social, political, technological or spatial scales and affect resource consumption decisions (Owens 1986; Jaccard et al. 1997; Stern 2000; Wilhite et al. 2000; Parker et al. 2003; Shove 2003; Abrahamse et al. 2005; Wilson and Dowlatabadi 2007; Stephenson et al. 2010). Furthermore, consumption decisions in turn affect the related system of production and consumption (e.g., Owens 1986; Stern 2000; Wilhite et al. 2000; Slob and van Lieshout 2002; Shove 2003; Wilson and Dowlatabadi 2007).

In the case of energy efficiency retrofit decisions, the pro-environmental behaviour is typically first understood as the purchase and use of a technology that improves the efficiency of resource use. The efficiency gap is defined as the gap between possible technical improvements and the current state of technology (e.g., Parker et al. 2003), and many barriers have been identified that prevent bridging this gap. The variety of types of identified barriers is discussed in this literature review, and is demonstrative of the multiplicity of disciplines that investigate decisions that impact resource use. The literature review is therefore based on identifying and examining the various approaches to understanding the multiple factors that influence pro-environmental behaviour that operate at a variety of scales.

2.1 Key Concepts

There are four key concepts related to pro-environmental behaviour that both influence and appear throughout this literature review. These are whether the behaviour is impact or intent-oriented, the notion that habits govern all types of behaviour and decisions, the argument that the influence of learning through social learning is more important than creating the conditions for change through incentives and disincentives, and the rebound effect. These are explained prior to the main discussion of the literature review.

2.1.1 Impact-Oriented versus Intent-Oriented

Critical to understanding pro-environmental decisions is the material aspect of the decision itself, that is, whether it is pro-environmental or detrimental in impact. Stern (2000) carefully distinguishes between impact- and intent-oriented behaviour. Intent-oriented behaviours stem from an intention of environmental significance, usually to reduce environmental harm. Impact-oriented behaviours are environmentally significant in that they have an impact on environmental outcomes. One example of an impact-oriented decision is a reduction of fossil-fuel use. The associated environmental benefit is the reduction of greenhouse gas emissions that effect climate change. The critical insight made by Stern (2000) is that intent-oriented decisions may not have an environmental impact, or the intended environmental impact. Stern (2000) illustrates this with an example of consumers who reported avoiding the use of spray cans because they believed that spray cans emit ozone depleting substances. However, these ozone depleting substances had already been banned for several decades. Meanwhile, impact-oriented decisions may have no associated intent of environmental impact. For example, individuals may reduce their consumption in order to save money. However, this decision may benefit the environment. The potential for asymmetry between intent and impact suggests a barrier of visibility or knowledge between the decision and the environmental (or lack of) impact. The impact-oriented decision which has no associated intent reveals asymmetry between attitudes or motivations and impact. In some cases, this may be a result of a lack of visibility or knowledge by the decision maker about the associated environmental benefit. The intent-oriented decision, which does not benefit the environment, similarly points to an asymmetry in knowledge about cause and effect of the action. Peattie (2010) uses the distinction between intent and impact-oriented behaviours as a way to distinguish between empirical studies. Peattie (2010) observes that marketing studies usually focus on intent while industrial ecology and ecological economics studies usually to focus on impact. Whitmarsh (2009) studied climate change behaviours and attitudes in the United Kingdom and found that price was a stronger determinant of impact than of intent. For instance, Whitmarsh's (2009) findings were based on the results that the actions that participants reported to have taken to address climate change diverged from those prescribed by policy makers. Meanwhile, the participants' motivations to save money led to behaviours that had an environmental impact.

The definition of pro-environmental behaviour used in the conceptual framework of this thesis relies on Peattie's (2010) impact-oriented definition, where the process of pro-environmental behaviour consists of the following six stages:

(1) Recognition of a want or a need → (2) Information search → (3) Evaluation of alternatives → (4) Purchase → (5) Use → (6) Post-use

Peattie (2010) demonstrates how to organize various empirical studies that investigate numerous types of pro-environmental behaviours as they inform the different stages of the process. Studies that focus on a purchase decision tend to focus on stages 1 to 4. These could be, for example, studies that examine purchasing patterns of organic, socially or environmentally sustainable goods. Some purchase decisions, particularly those aimed at increasing the efficiency of the resource use, focus on substitution of an existing technology for a new one. Some examples of these decisions are the purchase and installation of low-flow faucets and shower-heads, the purchase of energy efficient light bulbs, heating and cooling systems, or the improvement of the building envelope to reduce heat loss. An example of a stage 5 use decision is the curtailment or management of a service or a piece of equipment. Examples of curtailment or management behaviours include temperature settings, light settings, and maintenance of equipment. Many studies that focus on the use stage analyse the frequency of use of services derived from resources, such as from energy and water. These researchers clarify that the use of a service is affected by habits and personal practices related to comfort, cleanliness and convenience. For example, Lin and Deng (2006) related preferences of temperature settings to air conditioner usage in high rise buildings in Hong Kong. Shove (2003) describes the frequency and method of washing and drying laundry, and the length and frequency of showers. Shove's (2003) analysis of the interviews explored the rationale behind these practices. Studies which focus on stage 6 usually examine the pro-environmental behaviours of waste reduction and recycling.

2.1.2 Habits

Researchers have learned that influencing all types of decisions and behaviours involves the influence of habits. It has been discussed in the first chapter that Peattie's (2010) definition of a six-stage process illustrates that the process of consumption can be influenced at each stage. An influence at each stage requires the influence of habits, whether they are habits of activity or of how information is processed in making a decision. Maréchal and Lazaric (2010) describe habits as the path dependency of behaviour; habits are the well-practiced actions that are triggered by contextual cues with the purpose of reducing mental load. Habits may develop to avoid trade-off decisions and the typically associated negative emotions (Schwartz 2005). Maréchal and Lazaric (2010) explain that habits must accord with the socio-technical context. This explains in part how the path dependency of consumption relates to both technology and the user. According to behavioural economists and psychologists, habits affect decision making and have been studied for their effect on purchase decisions (Schwartz 2005; Wilson and Dowlatabadi 2007). The role of habits as they affect purchase decisions and technological use is discussed throughout this literature review.

2.1.3 Social Learning

Social learning theory examines the influence of information in its various forms, but is very different from the "behaviourist" perspective. The behaviourist perspective is that behaviour will change based on reward and penalties. Social learning theory states that people learn from the trial and error of life (Darby 2006), whether through imitation of attractive or influential models or learning by counter-example (Jackson 2005). These two different approaches form the basis of one debate among scholars who argue for a clear differentiation between what Peattie (2010) considers the marketing approach and a learning approach. According to Takahashi (2009) "The use of incentives and disincentives, as well as a appropriate environment that entices the promoted behaviour, is what differentiates marketing from education." (142). Darby (2003; 2006) criticizes the behaviourist approach and argues that social learning, of which acquiring tacit, or procedural knowledge is a component, serves a critical function in society moving towards a sustainable energy future.

2.1.4 The Rebound Effect

The rebound effect is an important concept of the literature review. It is a phenomenon felt at various scales, which is a common consequence of decisions related to efficiency. The rebound effect is described as an increase in consumption of services following an investment in technical efficiency of those services (Sorrell and Dimitropoulos 2008). The rebound effect can occur at the individual level (Sorrell and Dimitropoulos 2008), or it can be economy wide (Dimitropoulos 2007). Jevons' Paradox is an example of the rebound effect (Alcott 2005). The rebound effect raises the concern for policy advisors and policy makers that the increased consumption could offset savings associated with more efficient technology (Sorrell and Dimitropoulos 2008). Similar concerns exist about the effects of changing lifestyles due to social norms or rising incomes. Similar to the rebound effect, these changing lifestyles can also result in increased resource use due to an increase in the demand for services (Reisch 2001; Slob and van Lieshout 2002; Linderhof et al. 2006; Harris et al. 2007; Webb 2008; Anable 2010; Eyre 2010).

2.2 Barriers to Influencing Energy Decisions

Researchers now generally agree that decisions with environmental impacts are influenced by a variety of factors operating at a variety of social, spatial, and political scales. The following is a broad discussion of many of the approaches that inform our understanding of pro-environmental behaviour, followed by a section summarizing those more relevant to this research.

2.2.1 Technical Gaps and the Engineering Approach

Several oil shocks occurred in the 1970s and led to high and volatile energy prices. This resulted in the wider recognition that energy resources could be used more efficiently (e.g., Lovins and Thorndike 1978; Nader and Beckerman 1978; Brooks 1981; Morrison and Lodwick 1981). The problem of energy efficiency is typically first understood as the efficiency gap: the difference between technology in use and the most efficient technology that could be a substitute (Parker et al. 2003). Policy makers and energy planners were encouraged to focus efforts on energy efficiency and managing the demand side in order to mitigate for the lack of reliability of the supply side (e.g., Lovins and Thorndike 1978; Nader and Beckerman 1978; Brooks 1981; Morrison and Lodwick 1981). The potential for the demand side to alleviate supply-side shortages was explored in energy forecasts and models that typically assessed the economic potential by analysing and influencing private costs. Demand side management (DSM) programs were based on the acknowledgement that available efficient technologies did not have a great enough market share compared to less efficient technologies and that implementing more efficient technologies was less expensive than securing new fuel supply. This form of analysis, called least cost utility programs (LCUP) or integrated resource planning (IRP), supported the development of programs that were designed to influence the uptake of more efficient technologies (e.g., Nadel 1992; Levine et al. 1995; Nadel and Geller 1996; Didden and D'Haeseleer 2003; Gillingham et al. 2006).

However, at the same time that attention turned to the demand side in the 1970s, it was also found that technology selection alone is not predictive of patterns of resource use. Researchers and policy makers learned that technology type may not be a reliable predictor of pro-environmental behaviour. The origins of behaviour research are grounded in observations of the spatial setting, stemming from a series of studies (Socolow 1978, Sonderegger 1978, Diamond 1984 are often cited) that identified that physically identical buildings had ratios of energy consumption that varied from 2 to 1 (townhouses), up to 10 to 1 (apartments) due to the number of occupants and their behaviour (Owens 1986). An understanding developed that built form and technology may define some parameter of energy demand, but that occupant behaviour and situational factors, including number of occupants, income, socioeconomic factors, appliance usage patterns, temperature preferences and even window opening patterns also affect energy consumption (Owens 1986).

2.2.2 Financial Stimulus and the Economics Approach

Many economists, particularly environmental and ecological economists, argue that resources are over- consumed in part due to the lack of appropriate price signals. Environmental and ecological economists have argued that prices are too low and that externalities must be incorporated into price (e.g., Pearce and Barbier 2000; Turner 2000). Economists also consider price as an ideal instrument of intervention as it is decentralized (Lipsey and Lancaster 1956), and has the potential to affect both investment and behaviour (Houthakker 1951). According to Levine et al. (1995), failure to obtain energy services at minimum cost implies market failures for energy efficiency. This tends to be the underlying rationale for DSM programs that use financial incentives to alter payback periods and discount rates for the consumer (e.g., Levine et al. 1995).

However, many studies have shown that consumers do not necessarily behave in an economically rational manner (e.g., Tonn and Berry 1985). Therefore, price may not be sufficient to influence pro-environmental behaviour. For example, Wilson and Dowlatabadi (2007) undertook an examination of consumers' willingness to pay more upfront to save energy costs later. They found that discount rates[6] of consumer energy purchases varied greatly (between 5 and 300%[7]). This analysis demonstrates the difficulty in predicting discount rates selected by consumers, and that wider contextual factors beyond economic factors affect decisions. The findings that consumers do not make decisions that are considered to be economically rational with respect to energy are replicated in other studies. It therefore appears to be a well established fact that price is not sufficient to encourage pro-environmental behaviour.

However, many economists, such as Jaccard (2005), have argued that price has not been sufficiently high for long enough periods of time in order to influence pro-environmental behaviour. Jaccard (2005) estimates that energy prices need to rise by 25 to 50% over the long run in order to

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[6] A discount rate is an economic measure that indicates the time preference for consumption.

[7] "In the case of domestic energy technologies, revealed discount rates were found to be clustered in the 5% to 40% range, but higher rates were applied to refrigerators and water heaters than to heating equipment and weatherization measures. Other studies have found short-term discount rates as high as 300% for air-conditioning technologies." (Wilson and Dowlatabadi 2007: 173)

achieve sustainable levels of energy consumption. The IPCC has estimated that a price of 20 to 100 USD per tonne CO_2equivalent would be required to reduce the use of carbon based fuels enough to appropriately address climate change (Barker et al. 2007). Further, in consumer theory, consumers maximize preferences within their income (Baumol 1977). It has been found that income is not necessarily found to be a barrier to retrofits (Tonn and Berry 1985). It has also been found that lower income groups are more likely to conserve energy (e.g., Herriges and King 1994). Lower income groups have also been associated with more energy efficiency changes than higher income groups (Parker et al. 2005; Ryan 2009). However, price is difficult to control as it is defined by landscape developments, such as markets that operate at an international scale, and by regulatory regimes (Geels 2004). Further, despite calls from many economists and the IPCC to raise prices, this has not proved broadly politically salient[8] (e.g., Stern 1999). Even if price were to rise sufficiently, other criticisms of the economics approach to influencing consumption are that it does not account for heterogeneity in preferences (e.g., Wilson and Dowlatabadi 2007), or how preferences are formed (e.g., Leach 1992). Further, other disciplines question the assumption of consumer sovereignty (Stern 1999). For example, consumers may be willing to purchase a product with particular attributes and discover that this is not possible if it is not available on the market as producers do not supply it (Stern 1999).

2.2.3 Visibility

Related to the issue of economic rationality of decisions is the observation that resource use can be invisible. The quantity of a resource or commodity consumed depends both on the type of technology and habitual behaviour. In the case of energy, major residential energy using appliances are typically hidden from view (Hirst and Brown 1990). Researchers have found that consumers have little to no knowledge of the differences in energy use due to using different types of equipment or employing different habits of use. Consumers are therefore unable to influence their habits of energy use and energy bills due to lack of knowledge of cause-and-effect relationships (e.g., Kempton and Montgomery 1982; Kempton et al. 1985; Attari et al. 2010). Kempton and Montgomery (1982) describe the inability of the energy user to understand cause-and-effect in energy use due to lack of specific information.

[8] Forms of carbon taxes have been implemented in the Canadian provinces of British Columbia and Quebec. In each of these provinces electricity from hydroelectric dams (understood as a low carbon fuel source) is the dominant energy supply in buildings.

> Consumer energy choices are more difficult than other market decisions, partly because multiple residential energy uses are aggregated into one or two utility bills. Imagine a parallel situation for groceries: a store without prices on individual items, which presented only one total bill at the cash register. In such a store, the shopper would have to estimate item price by weight or packaging, by experimenting with different purchasing patterns, or by using consumer bulletins based on average purchases. Although these cost estimation methods seem unbelievably crude for groceries, we show here that such methods are indeed used to estimate household energy use. (Kempton and Montgomery 1982: 817)

Due to this lack of visibility, homeowners focused on dollar savings rather than energy savings, and undertook what the researchers considered to be more obvious, but not necessarily effective, energy management activities. The energy management activities that homeowners commonly discussed included turning off the lights, television, or stove. However, few homeowners discussed the more hidden but more effective activities such as reducing hot water usage. The researchers commented that the household energy saving experiments described by the study participants generally resulted in energy savings that were so small that differences in their energy bills would be difficult to observe. For example, some families reported that they turned off the stove before they finished cooking. Other families' experiments confounded too many variables. For example, some reported trying to save money by reducing energy usage associated with hot water heating. However, the researchers observed that it is affected by temperature setting, price, and water use; accordingly, it would be difficult for participants to isolate the effects of each variable. Their study noted that many families expressed frustration when they did not save money on their energy bills. Some of these conclusions are reflected in a study by Attari et al. (2010) that examined consumer's perceptions of energy use and savings of various energy equipment and behaviours. Participants tended to focus on curtailment activities rather than energy efficiency investment decisions. They also demonstrated difficulty distinguishing the differences in energy use across devices. Frustration with lack of knowledge about appliances' use of energy was found to be a common motivation amongst electric power meter borrowers in a study done in Finland (Liikkanen 2009).

Diffusion of innovations theory states that visibility and demonstrability of technologies are critical to the rate of market penetration[9] of those technologies. This theory describes the conditions under

[9] Market penetration is the concentration of investment decisions within a community.

which technologies diffuse along social networks. Hirst and Brown (1990) point out that "The diffusion effect works best when innovations are visible, as was true for microwave ovens, videocassette recorders, and personal computers, which penetrated the market very rapidly." (275) For this reason, solar technology might be more visible, and therefore have more appeal than energy efficient technologies (Archer et al. 1987 as cited in Wilson and Dowlatabadi 2007).

With the exception of "choice editing" of available products, in which choices are omitted from the consumer, scholars agree that information influences pro-environmental decisions as it reduces invisibility of energy use. In the case of energy consumption, it is thought that the provision of information about energy-saving options may result in energy savings (Abrahamse et al. 2005). One mechanism to improve visibility is energy information feedback. Feedback is a response to the "information-deficit" model that has been expressed as: Increased feedback->Increase in awareness or knowledge-> Changes in energy-use behaviour->Decrease in consumption (Wilhite and Ling,1995 cited in Hargreaves et al. 2010). Darby (2000; 2006a) has carried out reviews of studies to describe types of energy information feedback and their effectiveness[10]. Feedback is understood as a consequence based strategy (Abrahamse et al. 2005), and is classified by the frequency of feedback and the effects of tailoring of information for the user (Darby 2000; Darby 2006a).

Feedback and information techniques have typically been studied in combination with other influences, and are understood as influencing change in energy consumption through varying mechanisms. It is for this reason that information feedback will be explored further in the chapter in relation to various theories.

2.3 Internal and External Factors

Social and environmental psychology researchers have also been active in the study of pro-environmental consumer decisions. They explain how to take into account variables internal to the individual, such as attitudes, norms, mental models, and capabilities. They have examined how to influence the context external to the individual by using tools and interventions which include information feedback, information framing, rewards, penalties, and injunctive norms.

[10] Darby's classification is quite useful, but the estimations of the percent of energy conservation achieved are optimistic compared to findings of many recent studies. For example, the literature review by Kjaerbye et al. (2009) reports as little as 1.5% reduction in electricity consumption from real-time electricity information feedback.

2.3.1 The Impact of Attitudes

The theory of reasoned action (TRA) and the related theory of planned behaviour (TPB) explain the role of attitudes and intentions in decision making. TRA explains behaviour as the result of beliefs about outcomes, evaluation of outcomes, and subjective norms (what other people think), to form an intention leading to behaviour (e.g., Azjen and Fisbein cited in Martiskainen 2007). TPB adds the concept of "perceived behavioural control" to the TRA model, which affects both intention and behaviour. TRA is a commonly used model in analysing and explaining behaviour decisions (Jackson 2005). However, TRA is limited to assumptions of deliberative decision making (Wilson and Dowlatabadi 2007). The TPB model is typically used to measure relationships between attitude, subjective norms, perceived behavioural control, with intentions and the resulting behaviour (see Figure 2.2). In the case of pro-environmental behaviour, these studies generally do not measure the resulting behaviours, but concentrate on the relationships between the precursors to behaviour (Jackson 2005, Kalafatis et al. 1999 cited in Martiskainen 2007). On the other hand, in a meta-analytic review of a broader set of behaviours, Armitage and Conner (2001) report that TPB can account for significant variation in either observed or self-reported behaviours. The subjective norm-intention correlation exhibits the weakest relationship, and is the most weakly theorized component of the theory. However, their study shows strong relationships between perceived behavioural control and intention formation, and also between intentions and behaviours. When intentions were measured as intention, desire, or self-prediction, intentions and self-predicted behaviour more strongly than desires (Armitage and Conner 2001). Overall, TRA and TPB have been tested to explain a broader set of behaviours, but have not been tested or shown a strong link in the case of a pro-environmental behaviour that is intent-oriented. These models may be useful in explaining impact-oriented influence on some stages of the consumption process identified by Peattie (2010).

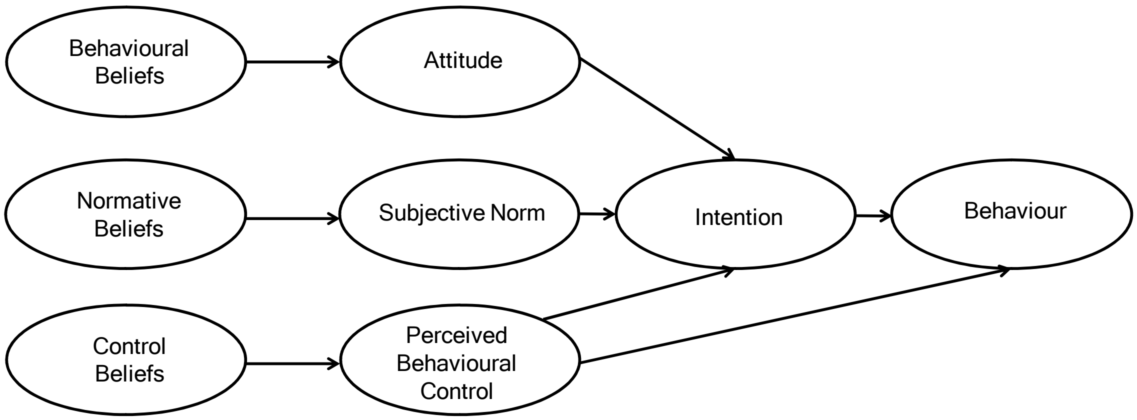

Figure 2.2 Theory of Planned Behaviour (Adapted from Armitage and Conner 2001)

Value-belief-norm (VBN) theory seeks to explain the impact of injunctive social norms (what is morally right), on intent for pro-environmental behaviour. VBN, illustrated in Figure 2.3, seeks to explain how the activation of environmental norms in an individual could lead to pro-environmental behaviour. However, it is acknowledged that pro-environmental intent is not necessarily sufficient to alter behaviour. VBN acknowledges the importance of information as it might influence pro-environmental personal norms and a perceived ability to reduce threats (Martiskainen 2007). However, even when pro-environmental norms are present, studies have found asymmetry between norms and behaviour. For example, Jackson (2005) cites a study (Bickman 1972) in which, of 500 people surveyed, 94% acknowledged responsibility for not littering, but only 2% picked up litter planted at the survey site.

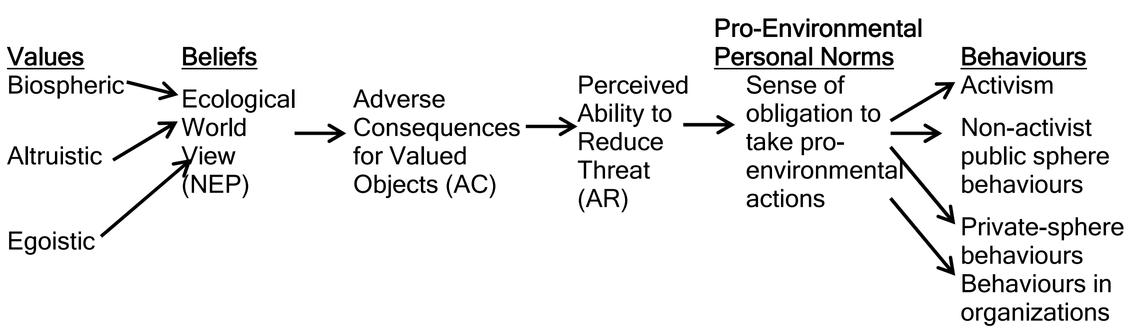

Figure 2.3 Value-Belief-Norm Theory (Stern 2000)

Even when norms are pro-environmental, it has been found that situational factors might impede pro-environmental behaviour. A common observation of researchers is that wealthier people may have pro-environmental norms, but wealth is also associated with higher levels of consumption. Hence, pro-environmental norms and attitudes are understood as not sufficient to produce pro-environmental behaviour (e.g., Gatersleben et al 2002, Jensen 2002 cited in Jackson 2005). This leads to the understanding that other factors must be accounted for in order to better explain pro-environmental behaviour.

Attitude, behaviour and context (ABC) theory addresses the omission of context and situational factors from TRA, TPB and VBN theories. ABC theory links the outcome of behaviour (B) to attitude (A) and context (C) (Stern 2000). It describes that when the attitude towards environmentally significant behaviour exists, contextual forces can either compel or discourage the intended behaviour. More specifically, behaviour (B) is mediated by the relative weighting of factors between attitude (A) and context (C). This theory clarifies that attitudes or context alone may not predict the energy conservation behaviours. ABC theory recognizes the possibility for intervention through the influence of contextual forces, which can be rendered positive or minimized if negative. For example, Stern et al. (1986) observe that it is important to minimizing negative forces, such as the inconvenience of scheduling. They found that home energy evaluation programs that employed a visit by a professional home energy advisors as the main intervention yielded lower participation rates than the programs that employed a take-home shopping-list[11]. These researchers concluded that this was possibly due to ease of delivery and no need for advance scheduling. They also reported that a shopping list-based program that was delivered in Canada in the 1980s, the Canadian Home Insulation Program (CHIP), yielded similar savings to energy evaluations provided in the United States and at a lower cost.

ABC theory highlights the importance of four causal variables. These are: attitude, contextual forces, personal capabilities, and habits and routines. These four causal variables are described in Table 2.1. What is of interest is that ABC theory highlights the usefulness of information, which may affect both attitudinal and personal capabilities (knowledge), and rewards and penalties are recognized as interventions to affect context.

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[11] These are typically a list of pre-decided changes which can be made, and homeowners simply present evidence that these purchases or alterations were made.

Attitudinal	**Personal Capabilities**
General environmental predisposition	Literacy
Behaviour-specific norms and beliefs	Social status
Nonenvironmental attitudes (e.g., about produce attributes)	Financial resources
	Behaviour-specific knowledge and skills
Perceived costs and benefits of action	
Contextual Factors	**Habits and routine**
Material costs and awards	
Laws and regulations	
Available technology	
Social norms and expectations	
Supportive policies	
Advertising	

Table 2.1 Causal Variables in ABC Theory (Stern 2000)

2.3.2 Habits and Routines

Habits and personal routines are widely recognized as potential deterrents to pro-environmental action. The field of evolutionary economics focuses their research on the role of habits in decision making. Habits form because people have limited cognitive capabilities and rely on cognitive frameworks and rules to make sense of the world. According to Maréchal and Lazaric (2009), a habit is a “behavioural predisposition to repeat a well-practiced action that is triggered by a contextual cue” (108). These satisfactory strategies are ways to minimize cognitive elaboration. Maréchal and Lazaric (2009) describe that when habits take over decision making, this causes “the balance of the decision-making process to swing away from cognitive effort and towards automaticity: low degree of involvement, low perceived complexity, and high degree of constraint.” (109). As habits become deeply ingrained, they may run counter to an individual’s intentions. Once formed, habits become a strong predictor of behaviour, regardless of intentions. “To be functional, people’s habits have to be “accordant” with prevailing socio-technical forces that shape consumers’ choices towards more energy-consuming ways of life.” (Maréchal and Lazaric 2010: 110). It is widely acknowledged that daily energy use patterns, whether at home, at work, or in travel, are primarily habitual. Electricity use habits have been observed to be counteracted or altered when groups and individuals devise a systemic plan (Winnett et al. 1978).

Habits and cognitive routines play a role in purchasing patterns by affecting the selection of decision making heuristics. These heuristics are satisficing, recognition, elimination and availability (Wilson and Dowlatabadi 2007). Satisficing is the sequential search for information until a threshold or target is reached. Recognition favours familiar or recognized elements, for instance, stopping on a previously selected choice. Elimination is a form of reducing the range of alternatives. The availability heuristic favours information that is readily available. This can induce anchoring, which is bias towards the first available information to compare alternatives. For example, the availability heuristic can cause a consumer to anchor on vivid (salient), but anecdotal evidence, such as a story of a personal experience, and this can cancel out rationally-derived information (Kahneman and Tversky cited in Schwartz 2005). Anchoring is typically used by stores that introduce a higher priced item or a sale in order to sell a lower priced item; the higher price is an anchor that indicates the consumer is getting a better deal (Schwartz 2005). Anchoring is related to framing, in which consumers respond differently to options depending on the reference used—whether it is a loss, a gain, or similar when compared to the reference (Kahneman and Tversky cited inSchwartz 2005) Emotion can also play a strong role in decision making heuristics as “Emotions can guide behaviour when rules fail to apply and when cognitive resources are not available to support a calculated rational choice.” (Lee and See 2004: 64) Kahneman and Tversky’s prospect theory explains that negative feelings associated with loss typically are stronger and disproportionate to positive feelings associated with gain. Hence, people are typically loss averse in decision making (Schwartz 2005). According to Schwartz’s (2005) review, “[s]ome studies have estimated that losses have more than twice the psychological impact as equivalent gains” (Schwartz 2005: 70). Framing becomes important in understanding feelings of loss aversion, as how the loss or gain is framed depends on the perceived neutral point. For example, although they might be for the same dollar value, people may give disproportionate weighting when faced with a decision to take a “discount” or a “surcharge”.

Kempton and Montgomery (1982) give one example of the role habits have on a decision to purchase an efficiency upgrade. They demonstrate that consumers try to make rational econonomic decisions. However, their chosen methodology for payback calculations is based on past price, rather than energy units. This leads to an underestimation of dollar savings and biases payback periods to appear longer than they actually are. This is contrasted with an energy analyst’s model that would base its estimation on energy units and adjust for rising price to show a shorter payback period. Kempton and Montgomery (1982) call this “bounded rationality”, as the consumer adapts known, habitual, methods to a new problem, even if the method does not does not accurately reflect benefits.

Decisions are also affected by the number of available choices, as made clear in Schwartz’s (2005) summary of decades of research from psychologists, economists and market researchers. More specifically, the summary suggests that when offered a few sampling choices (e.g., six choices), consumers are more likely to be satisfied with the product and make a purchase, but when confronted with many choices (e.g., 30 choices) they are less likely to make a purchase. The number of available choices forces consumers to confront trade-offs between standards (e.g., price and quality). Forced trade-offs in decisions make people unhappy and indecisive. When options increase, so does internal conflict. If the conflict is not easily resolved through an internal standard (e.g., price or quality requirement), then people avoid the decision. Habits and routines are ways of minimizing decisions and avoidance of unhappiness.

2.3.3 Forms of Information Delivery

The information deficit model and VBN and ABC theories all demonstrate how information can influence pro-environmental behaviours. In the case of home energy consumption, the main goal of providing households with information about energy-saving options is that it may result in energy savings (Abrahamse et al. 2005). According to De Young (1993) the role of information is to "increase awareness about an environmental issue or help an individual to gain specific knowledge about such an issue are expected to alter the individual's attitude and beliefs about this issue and, ultimately, cause that individual to take appropriate action" (487) (information deficit model) or to help people identify attitude-consistent behaviours (TRA and TPB) or "gain procedural knowledge needed to successfully carry out the behaviour" (488) (social learning). Scholars have studied many types of information for their impact on pro-environmental behaviour. The types of information described by studies and review papers are listed in Table 2.2.

Types of information	Author of Review/ Study
pamphlets enclosed in utility bills	McDougall et al. (1981)
advertising campaigns	
home energy efficiency evaluations done by professional auditors	
appliance energy- consumption labels	
specific feedback	Dennis and Soderstrom (1988)
interactive hotlines	
demonstration projects	
publication or media efforts	
prompts	De Young (1993)
Education	
modeling and training of conservation behaviour	
self-discovery	
direct experience	
brochures	Winett and Kagel (1984)
booklets	
prompts	
workshops	Abrahamse et al. (2005)
mass media campaigns	
modeling	
feedback	
continuous feedback	
comparative feedback (i.e., information on other people's behaviour)	
program recruitment:	Hirst et al. (1981).
bill enclosures	
workshops	
booklets	
television or other mass media	

Table 2.2 Types of Information Used to Influence Pro-Environmental Behaviour

Information can be categorized in many ways, all of which are examined by researchers for effects on pro-environmental behaviours. Information can be categorized by the frequency with which it is given, as general or tailored, (i.e., specific to the individual or household), as antecedent or consequence (Abrahamse et al. 2005), or as instigating social influence (Katzev and Johnson 1987 as cited in De Young 1993). Antecedent interventions take place prior to the occurrence of the environmentally significant behaviour while consequence based strategies offer a reflection, or outcome as a result of current consumption (Abrahamse et al. 2005). Some antecedent interventions are information, prompts, persuasion, education, and modeling (De Young 1993). Consequence based strategies are mainly reinforcement and feedback in its different forms (De Young 1993).

One of the most thorough reviews of the effects of information delivery is by Abrahamse et al. (2005). The review is based on 38 peer-reviewed studies of field experiments and one in a laboratory setting, dating from 1977 to 2004. The overall finding of the review is that information was a more common intervention than changing contextual forces, and that information tended to raise awareness but did not strongly impact behaviour changes or energy savings. However, another major finding was of flaws in the studies themselves to determine many of these impacts. The literature review provides a strong recommendation for changes with research design and the inclusion of specific types of information in the analysis of results. One finding that Abrahamse et al. (2005) stress throughout the article is that very small sample sizes fail to produce information on statistically significant effects. Another common flaw is that many studies generally relied on self-reported behaviours rather than on a measured change in energy consumption. Further, Abrahamse et al. (2005) present concerns about the generalizability of the studies, as "households who participate in this type of studies tend to be highly motivated, tend to have higher than average incomes, and higher than average education levels" (282). Finally, they write that studies tended to be conducted over relatively short timeframes and this limits the ability to understand any long term impacts.

2.3.4 Persuasion Theory and the Elaboration Likelihood Model

Persuasion theory and the elaboration likelihood model (ELM) are both theories that describe how to bring about change in behaviour through message communication. Persuasion theory was developed by Hovland et al. in 1953 (Jackson 2005), and is based on the three elements: the credibility of the source of the message (speaker), the persuasiveness of the message, and the responsiveness of the recipient. The elaboration likelihood model takes into account that the recipient may process the message either centrally, when they pay mindful attention, or peripherally, when the recipient's engagement is low. Mindful attention is associated with longer term behaviour change. As previously mentioned, the receiver of information and their context can affect how a message is received and how it influences behaviour. Personal characteristics, as well as the social groups and the networks a person moves in can also influence the effectiveness of a message.

Credibility of the source of the information has been found to influence behaviour change. Credibility is related to the amount of trust invoked in the receiver. According to Craig and McCann (1978), "It is a general finding that information, or messages, originating from a high credibility source can influence a greater change in either attitude or behaviour in the recipient than a message from a low credibility source." (82). In energy research, several field experiments have found that different levels of participation in energy efficiency programs can be explained by whether recruitment is perceived to be instigated by the government, a local utility company, a private company, or a community group. Craig and McCann (1978) found that consumers reduced more electricity consumption in the summer (air conditioning) in response to a message from the New York Public Service Commission (high credibility) than the same message from Con Edison (low credibility). Kennedy et al. (2001) found that pamphlets originating from local community based partnerships (local utility companies, environmental non-governmental organization, local government) generated more bookings for a home energy evaluation program than pamphlets that appeared to originate from the federal government. Stern et al. (1986) reported significantly different rates of uptake of weatherization programs depending on whether mailed letter advertising originated from a private company, partnership of private company and the county, or from the county's board of commissioners. Stern et al. (1986) also found that rates of uptakes of these programs were highest when a utility company subcontracted to community groups to deliver home energy audits, lower if subcontracted to private contractors, and lowest when delivered by the utility company. Berry (2010) argues that community organizations are perceived as more trustworthy. Hoffman and High-Pippert (2010) write that "community based" as a label gives value to a project, leading to projects to preferentially label as community based. Sender credibility also typically translates to information received online (Nandhakumar et al. 2004). It can be noted that these findings show that credibility is important, but also show contradictions in terms of the scale at which credibility is generated; in one case a public service commission was higher credibility, and in others, community organizations and partnerships were more credible. This shows that with respect to credibility, context matters, and assumptions cannot necessarily be made about the most credible source.

2.3.5 Rewards

Rewards are a commonly used consequence-based strategy. They are applied to shift the contextual forces for the decision maker. Rewards are considered to be positive contextual forces and have been applied to many behaviours. Table 2.3 describes examples of situations when rewards have been applied in research that the types of rewards researchers have analysed the impacts of. According to De Young (1993), material incentives can influence a rapid change in conservation behaviour, and are understood by researchers as being reliable at changing behaviour. It is generally agreed that rewards usually encourage benefits only while they are applied (De Young 1993; Dwyer et al. 1993). Stern et al. (1986) and Stern (1999) have shown that information and financial rewards affect context positively. For example, financial rewards have been shown to increase participation in programs

(Stern 1986; Stern 1999). There is mixed evidence on the effect of the size of the reward. It is not clear that a larger reward yields strong change (De Young 1993). For example, Winett et al. (1978) found a reduction in energy usage only in response to a higher rebate; a lower rebate yielded little change. Meanwhile, Stern et al. (1986) found that the size of an incentive was not predictive of participation rates in a weatherization program. Stern (1999) describes that larger incentives led to greater success in program participation. However, Stern (1999) also reports large variations in the rates of participation across programs that offered the same large incentive. According to these findings, when an incentive is larger, variations increase and other factors that influence program delivery increase in importance. However, according to Stern et al. (1986), the size of a grant does not affect the level of participation, and in fact, lower grants typically generated higher participation. It is thought that different types of incentives appeal to different types of households. In particular, low-income groups prefer grants to loans, possibly to minimize indebtedness (Stern et al. 1986). There is only one known study that examined the effectiveness of a tax rebate, and it found that rebates had little effect on decisions to add home insulation (Pitts and Wittenbach 1981). In that study, 39% of surveyed respondents were unaware of the rebate, and 62% said it was unimportant in such a decision. The ineffectiveness of tax rebates could have been due to lack of ease of collection. Stern et al. (1986) argue that this effectiveness of a financial reward will in part depend on how well negative contextual influences are minimized, such as the ease with which it is collected, and can be applied.

	Author of Review/ Study
Examples of situations where reward has been applied	Dwyer et al. (1993)
littering	
driving distance	
recycling	
energy conservation	
energy efficiency investment	
Types of rewards	Stern et al. (1986)
competitive lotteries	Dwyer et al. (1993)
tax credits	
rebates	
grant	
low-or no-interest loan	
Examples of non-monetary rewards	Stern (1999)
offering convenience	
free service (e.g., home energy evaluation)	

Table 2.3 Description of Types and Application of Rewards

In the case of home energy retrofits, there is evidence that preference for incentive type (e.g., loan versus rebate) may be somewhat influenced by income. Large grants can be declined if they require large amounts of capital, and this depends on a householder's ability to manage budgets (Stern et al. 1986). Other relevant findings are that in the case of loans, the size of the incentive correlates with the amount of retrofit activity. With similar financial values, partial grants or rebates are associated with higher rate of retrofitting (i.e., participation) than loans. One area of future research suggested by Stern et al. (1986), that has not yet appeared in the literature, is the idea of market segmentation by reward type; that is, offering loans, grants, and retrofits of the same value to see if this instigates a higher rate of participation.

2.3.6 Information Feedback

Information feedback is considered a consequence-based strategy. It is generally thought to be effective in influencing pro-environmental decisions and behaviours. Dwyer et al. (1993) draw from a taxonomy developed by Geller to distinguish between feedback only, such as energy consumption, and feedback signaling consequences, such as projected monetary costs. Feedback has produced varied impacts on consumption and is used to operationalize a variety of types of behavioural interventions. In a summary of studies, Dwyer et al. (1993) report mixed results. For example, in one experiment, the same feedback technique applied in three cities produced a 4 to 5% reduction in two cities and none in the third (Hutton et al. 1986 as cited in Dwyer et al. 1993). In another study, feedback led to reduced electricity consumption of high consuming consumers while raising the consumption levels of low-electricity consumers (Bittle et al. 1979-1980 as cited in Dwyer et al. 1993). Generally, consequence based strategies, including feedback, maintain effects while the consequences are in place but cease with the removal of the consequence (Dwyer et al. 1993). Darby (2006) claims that the effectiveness of feedback increases with increased accuracy, increased frequency, and historical comparison in energy use measurement. Darby (2000) reports savings of up to 20% for continuous feedback. Kjaerbye et al. (2009) report electricity savings of only 1.5% associated with continuous feedback in a Japanese study (Matsukawa 2004 cited in Kjaerbye et al. 2009). One large study (1,452 households) focused on the effects of daily (i.e., lower frequency) email and text messages on reducing energy consumption. It was estimated that a reduction of 2 to 3% was achieved (Kjaerbye et al. 2009). In one study (Winett et al. 1978), feedback was combined with monetary rebates. This study found that the households that received a higher rebate reduced their electricity usage. They reported counteracting their habits by carrying out a systematic plan. Hence, whether feedback is frequent or not, there is wide variation overall on the effectiveness of feedback which may depend on initial levels of consumption, as well as other factors.

2.3.7 Commitment

Commitment is related to the concept of activating internal sources of control of an individual, further enabling a pro-environmental action to occur. Commitment is found to be a strong influence on behaviour. Sometimes commitment is related to a goal and sometimes it is made public. According to Dwyer et al. (1993), early work on commitment was done by Katzev, who hypothesized that internal sources of control would have more influence over the individual than external sources of control. These studies focused on recycling, household electricity, and public transit use. In a review of Katzev's studies, Dwyer et al. (1993) concluded that there is little difference in the effects of a written or verbal commitment. A consistent finding is that commitment encourages behaviour change that can last for several months (Dwyer et al. 1993). Another finding is that behaviour changes are further strengthened when combined with rewards (Dwyer et al. 1993; Abrahamse et al. 2005). Goals are also found to encourage behaviour change and higher goals found to have a stronger influence (Abrahamse et al. 2005).

2.3.8 Persuasiveness of Information Delivery

How information is framed and when it is presented is of great importance in designing interventions to influence pro-environmental behaviour. The effects of a message improve with the application of insights from the aforementioned theories and factors that influence pro-environmental behaviour. The following is a brief review of the effectiveness of different methods of delivering information.

Mass media and verbal pleas have not been found to be particularly effective in promoting pro-environmental behaviour and decisions. Luyben (1982 as cited in Abrahamse et al. 2005) found that a televised plea from President Carter to lower thermostat settings did not convince homeowners to change settings nor did it raise awareness. Residents were contacted by telephone and in person, and no difference in self-reported temperature settings or in knowledge about the effects of lower settings was found between those who heard the plea and those who did not. Further, those visited in person had underreported temperature settings. This calls into question the reliability of self-reported data. Another campaign mailed out advice booklets and shower flow control devices, and found that the receivers had taken more action than non-receivers. However, changes in energy consumption were not tested (Hutton and McNeill 1981 as cited in Abrahamse et al. 2005).

The use of prompts is considered more successful in delivering the message and promoting pro-environmental behaviour. In particular, message success is thought to improve if it is presented when and where the target behaviour or decision occurs (Winett and Kagel 1984). According to Winett and Kagel (1984), prompts are more successful if they are highly specific, stated in non demanding or non threatening language, salient, convenient, proximal to the requested behaviour, and repeated. Prompts have typically been used by placing stickers near lighting, reminding occupants to turn them off. Winett and Kagel (1984) found an improvement of 40% for turning off lights when prompts were placed in a classroom. Hence, prompts are relatively successful in changing behaviour (Winett and Kagel 1984). However, De Young (1993) argues that prompts are relatively unsuccessful, as they lose effectiveness over time. Further, behaviour usually returns to baseline once prompts are removed (De Young 1993). This speaks to Abrahamse et al.'s (2005) criticisms of studies which are too short in timeframe.

Information format is also found to be an important factor in influencing decisions. According to Winett and Kagel (1984), "Messages which appear to be quite similar in their information content have quite different effects depending upon the format and modality of presentation and the context in which the information is presented." (655) Magat et al. (1986) found that simple changes in the format of home energy analysis reports could significantly improve the efficiency of consumer choices. In their experiment, participants were presented with four different formats containing the same information but with key pieces of information ordered differently. Participants made more efficient selections as the format of the information changed. They concluded that the ordering of information may be significant in consumer choices. However, it is important to note that these decisions were taken in an artificial setting.

Communications research in the domain of health promotion and energy conservation also examines the effectiveness of loss-framed or gain-framed messages. It was previously explained that prospect theory describes that negative feelings associated with loss are stronger and disproportionate than those related to gain. Loss-framed messages explain consequences of inaction. Gain framed messages emphasize desirable consequences. Prospect theory predicts that loss-framed messages will be more motivating than gain-framed messages. O'Keefe and Jenson (2008) explain that loss-framed messages are generally thought to induce greater effectiveness, or behaviour change, than gain-framed. The logic is that fear or loss aversion will evoke greater message processing. However, their review failed to find greater message processing in loss-framed than gain-framed messages across studies, which were most representative of the health field.

2.3.9 Normative Appeals, Networks, and Comparative Feedback

As previously mentioned, in persuasion theory, the receiver of information and the context can affect how a message is received and how it influences behaviour. Personal characteristics of people and their social groups and the networks they move in can also influence the effectiveness of a message.

Normative appeals (e.g., neighbours are conserving energy) have been found to exert a stronger influence on pro-environmental behaviour than prompts (Goldstein et al. 2008 cited in Peattie 2010) or than information based on rational economic choice (Nolan et al. 2011). However, experts are not necessarily convinced. Nolan et al. (2011) report that energy experts perceived financial appeals (saving money) to energy conservation as more motivating than normative appeals. When these experts were exposed to evidence that demonstrated that normative messages are more persuasive, they increased their opinion of the motivating influence of normative appeals, but did not decrease that of financial appeals. Pallak and Cummings (1976 as cited in Abrahamse et al. 2005) found that a group giving a public commitment reduced energy use more than a group that gave a private commitment.

Diffusion of innovations theory describes how quickly an innovation can diffuse through a population via its networks. It explains the sequence of adoption in a social network based on the personal characteristics of the adopters and non-adopters with respect to their relationship with risk. In the decision to adopt energy efficiency measures, Darley and Beninger (cited in Wilson and Dowlatabadi 2007) found that peer experience and social feedback were useful in reducing uncertainty about renovation decisions. Scott et al. (2001) also found social networks to be a stronger determinant in a home energy retrofit technology investment than other attitudinal or contextual factors. More recently, Egmond et al. (2006a; 2006b; 2006c) developed market segmentation techniques for policy development to influence mainstream adopters to accelerate the adoption of home energy efficiency improvements.

Experiments have also been conducted to document the impacts of normative (comparative feedback) appeals on resource use. However, whether these appeals result in reduced energy consumption is disputed. Darby (2006) reports that householders are not interested in comparative feedback. According to Darby (2006), most householders would not be interested in being compared to other households and they also raise concerns at not being matched properly to a group for comparison. However, Siero et al. (1996), who are widely acknowledged to have done the only study on comparative feedback in organizations, point out that comparative feedback results in the acknowledgement of being in a group. One outcome is feelings of competition against other groups that potentially results in improved positive relations within the group. Siero et al. (1996) also found that these changes persisted beyond the experiment, and that there were behaviour changes without alterations to attitudes. In light of Abrahamse et al.'s (2005) criticisms, it is important to note that this experiment did not measure change in energy consumption, only self-reported conservation behaviour.

2.4 Social Marketing and Delivery of Programs in Communities

Findings about the persuasiveness of information have been incorporated into various interventions in home energy evaluation programs. For example, Gonzales et al. (1988) trained a group of home energy advisors to provoke the availability heuristic by communicating vividly, personalizing recommendations to the homeowner (increased salience), inducing commitment (perceived behavioural control), and framing recommendations in terms of loss rather than gain (loss aversion). They found that more homeowners in the experimental group applied for financing of retrofits through programs offered by utility companies than homeowners in the control group that was served by advisors without the specialized training. However, when utility data were analysed, no differences in energy consumption were found between the two groups. The authors claimed no rebound effect occurred. However, they did not examine the possibility that the control group either exhibited more behavioural changes such as maintenance or reduced comfort compared to the experimental group, or, that perhaps they made changes without applying for financing. It is notable that the researchers did not examine the level of financing, or the specificity of decisions made. Mckenzie-Mohr (1994) has advocated using the same principles of engaging consumers with information as the basis of social marketing (i.e., marketing of awareness of social issues) programs, and adapted them to training programs for energy auditors. Takahashi (2009) reports a wide variance in how social marketing as a concept is interpreted and applied by programs. Berry (2010) and McKenzie-Mohr (2000) advocate that community based social marketing (social marketing which makes effective use of community networks) for energy efficiency could ultimately achieve greater results than traditional energy efficiency programs. This is reflected in Takahashi's (2009) findings that show that energy programs make up a large proportion of programs which use social marketing. According to Darby (2006) social marketing has a low success rate, of about 5% behaviour change.

2.5 Demographics and Psychographics

It is well established in the literature that situational (demographic) variables (wealth, income, education etc.) are determinants of energy consumption. However, they are not necessarily stable predictors of pro-environmental behaviour. For example, in the case of home energy retrofit programs, a repeated finding is that demographic variables are not strong indicators of investment in retrofits, but sometimes are strong indicators of program participation. Stern et al. (1986) found that income related to a preferred reward type. Hirst et al. (1981) examined a variety of home energy retrofit programs offered under the Residential Conservation Service in the United States. They found that program participants tended to have higher incomes and levels of education, larger homes, and had greater interest and awareness with energy conservation than the general population. Hirst et al. (1981) points out that participation of these groups might make sense as they are more highly correlated with home ownership.

Some researchers say that this is a problem of temporal stability of predicting behaviours, and argue that psychographics are more temporally stable and therefore potentially more predictive than demographics (e.g., Oliver et al. 2011). Psychographics are the measure of people's values, attitudes, interests, opinions, personality, and trends (Weinstein 1986). Psychographics can be used to apply TRA, TPB, and VBN theories to market segmentation techniques in order to target behaviour change in specific populations. Anable (2005) has explored the application of demographics to travelers' inclinations to mode switch. Focus groups and test surveys were used to develop an in-depth survey, incorporating TPB with world views, including ecological world views. A cluster analysis helped identify six distinct types of travelers. Within these distinct types, Anable (2005) discovered clear correlations between these groups and the intention to mode switch. In exploring willingness to pay for green electricity, Oliver et al. (2011) found that previous pro-environmental behaviours correlated with willingness to pay, as did those with a more environmental ethic. In Ontario, Ipsos (2009) has used psychographics to examine the potential for adoption of energy efficiency and conservation behaviour in households.

2.6 Social Learning

Instead of aiming to influence habits of action and decision making, social learning can affect pro-environmental behaviour by allowing people learn by the trial and error of life (Darby 2006). De Young (1993) sees the value of learning procedural knowledge as a solution to help people who are ready to act, and have a pro-environmental attitude, to successfully carry out the behaviour. Darby (2006) defines social learning as acquiring tacit, or procedural knowledge in order to carry out an action. Social learning makes use of similar types of information that are used by the behaviourist approach. Prompts, environmental education, "how to" books and modeling and training of behaviour are considered as possible learning techniques by De Young (1993). Darby (2006) has examined techniques of initial awareness raising, learning through action, and the use of feedback as a method of self-teaching. Darby (2006) categorizes feedback according to whether it is internally (user) or externally (other) directed, that is, whether the user is in control of finding and using information or whether an external party does this. Further, Darby (2006) examined the results of do-it-yourself home energy surveys and the impacts of energy advice sought through hotlines and an energy advice centre. Darby (2006) found a correlation between action practice and the amount of efficiency measures undertaken in the home. In a program that sought to reduce air conditioning use in the summer, Winett et al. (1982) ran an experiment in which an expert technician and extension agents (non-experts trained by the extension agent) gave training and instructions to homes to reduce air-conditioner use. The homes were able to reduce their electricity use by 21 to 24% in the summer (Winett et al. 1982). It was found that the homes with owners who were trained by the expert technician had more savings with more enduring effects than those trained by extension agents. Winett used modeling in several experiments in which participants were shown a video that demonstrated conservation behaviours (Dwyer et al. 1993). These showed results of significant reductions in household energy use compared to a control group. While the results did not last in the long term, Dwyer et al. (1993) consider modeling to be a promising technique as it is both effective and low-cost. With respect to the development of a sustainable production/consumption system, Marchand and Walker (2008) suggest that consumers can advance their environmental ethic of responsible consumption by doing product design of sustainable consumer products, suggesting that designers support responsible consumers in this end to gain knowledge and develop products.

2.6.1 Social Learning as Process-Based Understandings

The social learning approach encourages a process-based understanding of pro-environmental behaviour. While Peattie's (2010) process-based model is based on stages of action, the social learning perspective focuses on the process of developing procedural knowledge. The social learning approach is particularly useful to understand the case of retrofit implementation. Bird (2006) examined specific barriers associated with two individual retrofits in a home energy retrofit program and argued that describing retrofits as one time actions oversimplifies our understanding of the behaviour associated with retrofit decisions. Bird (2006) describes that the decision to implement a home energy retrofit is better viewed as a process of a renovation composed of many smaller decisions. Some scholars therefore argue that a process based perspective provides a more effective understanding of some pro-environmental decisions. A process-focused view requires a temporal perspective in which the research treats a group as a system changing over various time-scales (Arrow et al. 2004).

Curiously, the process-based view is rarely used in studies of pro-environmental consumer decisions. Bird (2006) employed an approach to understand and reduce barriers to home energy retrofits. He conducted a telephone survey and focus group with homeowners who had been recommended furnace and basement insulation retrofits, and concluded that uncertainty is a key barrier. Further, that "retrofit actions still require support, possibly extended over a period of time" (Bird 2006: 46). To summarize Bird's (2006) perspective,

> The EGH [EnerGuide for Houses] incentive program will remain limited in effectiveness because it attempts to address multiple retrofit barriers with a single intervention. This research has shown that each retrofit would best be addressed by an intervention that targets its specific barriers.... It is possible that prior research which has characterized energy investment actions as 'one-time' (Kempton et al, 1992; Poortinga et al, 2003) may have led to oversimplified assumptions about the behaviours associated with some retrofit installations. For example, Geller (2002a) states, "In the case of one-time behaviors, only a single successful application of the (behaviour change intervention) is needed for desirable social change" (p.22). While it is true that the same structures of support are not necessary for furnace replacements as are needed for habitual actions like

> taking shorter showers, this study finds retrofit actions still require support, possibly extended over a period of time. For example, improving foundation insulation involves learning the necessary techniques, determining the related products to purchase, purchasing the products, and applying them successfully. Each of these stages may present its own set of unique barriers. This study has found that many homeowners, particularly those that perform the renovation work themselves, consider the retrofits to be a process rather than a discrete action. (Bird 2006: 45-46)

Darby's (2006) research is focused on social learning in the decision to retrofit a house. Darby (2006) found a correlation between action practice and the number of efficiency measures undertaken in the home. The participants who implemented more renovations had higher numbers of energy efficiency retrofits done in the past and planned for the future than those participants who performed less renovations overall. As a result, Darby (2006) proposes a social learning model whereby the dependent variable of tacit knowledge, associated with ability to plan and carry out renovations, increases over time in relation to the combined independent variables of information, action, and feedback and the ability to learn unaided. Darby (2006) bases the sigmoid learning curve (shown in Figure 2.4) on management studies, and describes that "tacit knowledge about energy expands as the learner accumulates experience." (Darby 2006: 2937) From this perspective, rather than "bombarding" those with lower levels of tacit knowledge with general leaflets, Darby (2006) argues that it makes more sense for "an energy advisor...to interpret explicit knowledge to householders, so that it makes sense in terms of their own experience....As learning progresses, the learner will be able to seek out and use whatever information s/he needs from the appropriate source, with less need of help from others." (Darby 2006: 2937) For these reasons, Darby (2006) views discussion with highly knowledgeable people combined with frequent energy feedback as excellent methods of learning tacit energy knowledge for homeowners.

Overall, a process-based understanding of pro-environmental behaviour encourages an understanding of the various stages and decisions that make up the behaviour. It also encourages the inclusion of time as a dimension of analysis. Finally, it encourages the attention to gathering procedural knowledge over time to address the various decisions and stages in the process. This study is informed by the process-based understanding.

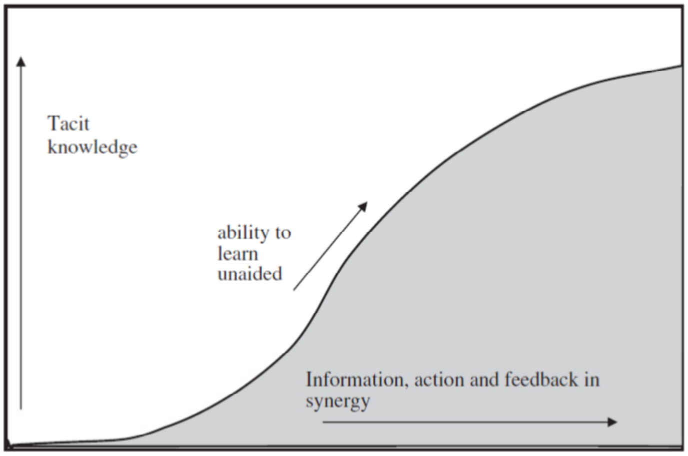


Figure 2.4 Darby's Model for the Development of Tacit Knowledge (Darby 2006)

2.7 Systemic Barriers and Integrated Approaches

The theories and studies presented so far in this literature review described factors that are differentiated as internal (psychological) or external (situational). So far, contextual factors have not been differentiated as they operate in a wider system. However, as described in Chapter 1, it is becoming more widely recognized that energy behaviours impact and constrain change of an energy system, and the energy system impacts and constrains energy behaviours. Hence, both energy behaviours and energy systems are path dependent as they interact. Furthermore, energy systems are also impacted by other factors. Spatial factors, such as land use, interact with energy systems to slow change, as do systems of knowledge and regulation. The systemic perspective explicitly acknowledges that personal consumptive behaviours and technological systems are interconnected and interactive in time and that both are affected by other factors and systems. This section of the literature review presents literatures that describe how social, technical, spatial, temporal and political factors operate at various scales and affect the path dependence of energy behaviours, energy systems, or both. These multiple perspectives are considered here for their inclusion in an integrated approach.

2.7.1 Social Scales, Lifestyles and the Hypermodern Society

Sociologists and socio-technical researchers attribute the rising demand of energy services to lifestyles which are increasingly linked to technology (e.g., Wilhite et al. 2000; Shove 2003). These researchers base their understanding of energy consumption in daily practice which is embedded within a social context. In 1992, Lutzenhiser encouraged the study of energy sub-cultures in order to better understand how changes in society affect energy consumption (Lutzenhiser 1992).These researchers examine how shifting social norms, daily practice, lifestyle, and the pursuit of status impact consumption. According to these researchers, in high income societies there has been a continuous trend of increased demand for energy services in pursuit of comfort, cleanliness and convenience that has diminished gains in energy efficiencies (Wilhite et al. 2000; Shove 2003). The two trends in use of energy services discussed in Chapter 1, the increase in the use or demand of particular services, and the increase to the type of energy services sought, both offset the savings in energy due to improvements in energy efficiency (Anable 2010; Eyre 2010). Examples of increase in demand of particular services are increases to house size, indoor temperature, length of showers, and frequency of laundering. Examples of increases in type of services include introduction of new electronic gadgets, hot tubs, and air-conditioning.

These researchers have used sociological theories of practice to understand how social conventions, shared understandings, and technical know-how have converged and influenced technological development and technological practice. The growth of these uses of services is linked to evolving social norms which lead to acceptance and an increasing technological presence in our lives. These researchers observe that convenience is linked to scheduling and the hypermodern society. Convenience seeking behaviour has caused the development of new needs due to shifts in norms and the introduction of new devices and appliances (Wilhite et al. 2000). Shove (2003) argues that the co-evolution of suites of technologies, social norms, and social practice have caused a socio-technical context that is difficult or impossible to unwind. Slob and van Lieshout (2002) developed a model to analyse the environmental outcome of social interactions with technologies. This model takes into account the behaviour, technology and arrangements (such as regulations), each a point of a triangle, that are mediated by interactions between information or organization, infrastructure and technology behaviour interactions (see Figure 2.5). Shove (2003) argues that it is important to relate key moments when socio-technological change can occur to answer the questions of how to consider both the direction and rate of change of energy consumption as well as why are some routes are taken and not others (Shove 2003).

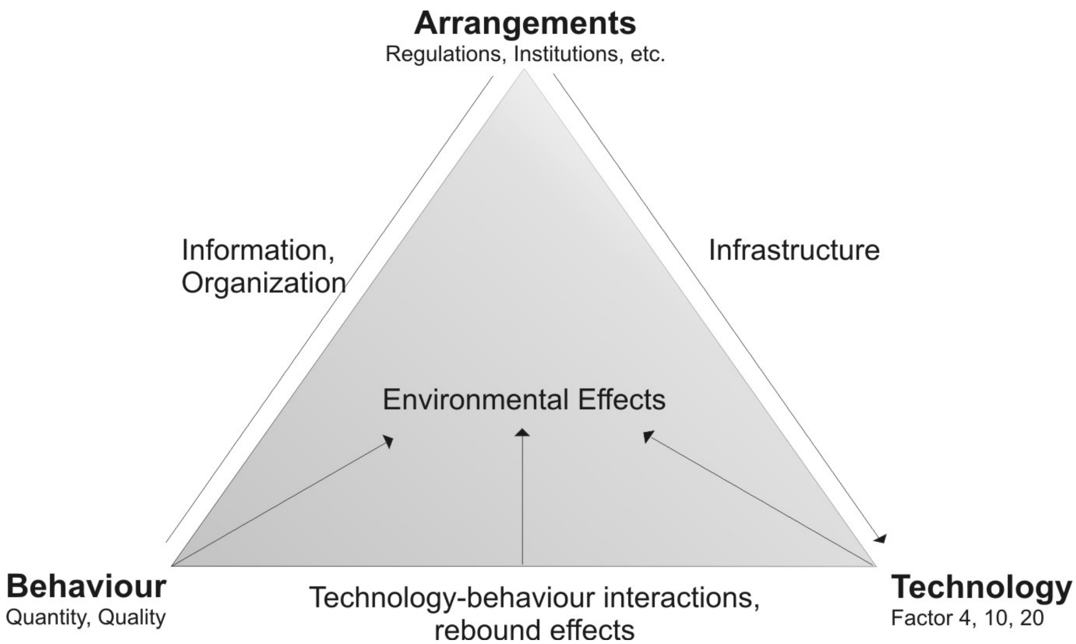


Figure 2.5 Relationships between Behaviour, Technology and Arrangements (Slob and van Lieshout 2002)

2.7.2 Spatial and Temporal Scales

Discussions of energy and urban form have been developed into another body of literature that draws important connections between spatial scales and energy consumption. This literature is sometimes referred to as community energy management or planning (CEM or CEP). This body of literature is sparse, but it is very useful as it explains the context of path dependence of the energy system at the local and regional scales, as well as how it is that consumers are bound by how much and what energy they consume. Owens' (1986) contribution is significant as it clearly explains the technological trade-offs for decisions made in space and time that limit pro-environmental behaviours in the long run. It was described in Chapter 1 that availability of modern fuels is a permitting factor to spatial and social development patterns, and that these patterns are slow to change as they mutually reinforce each other (Owens 1986). Owens (1986) demonstrates with detail why these patterns are necessarily slow to change by using thought experiments and empirical data to link spatial patterns to the heating and cooling of buildings, transportation options, and various forms of energy supply. According to Owens (1986), spatial patterns are a source of inertia as they act as a hierarchy for energy consumption. The trade-offs and tensions to energy sustainability are described as follows. A spatial perspective requires matching supply and demand not only temporally, but as densities (measured in watts/m^2). Dense urban systems tend to distort the natural energy flux as they "borrow" energy in space and time. For example, this is why centralized power generation and higher energy density fuels (such as oil) are generally favoured. Consequently, a desire to rely on distributed generation and to achieve transportation efficiencies might result in environmentally divergent outcomes. Owens' work forms the basis of the seminal work by Jaccard et al. (1997) on CEM/CEP that explores the degree of influence of a spatial-temporal hierarchy on energy efficiency options and outcomes. One outcome of the work of Jaccard et al. is the recognition that the hierarchy governing energy consumption choices, shown in Figure 2.6, is not well understood or currently applied. These spatial analyses explain the hierarchy within which energy consumption decisions are made, contextualizing path dependence and the bounded nature of energy consumption decisions at the local and regional scales.

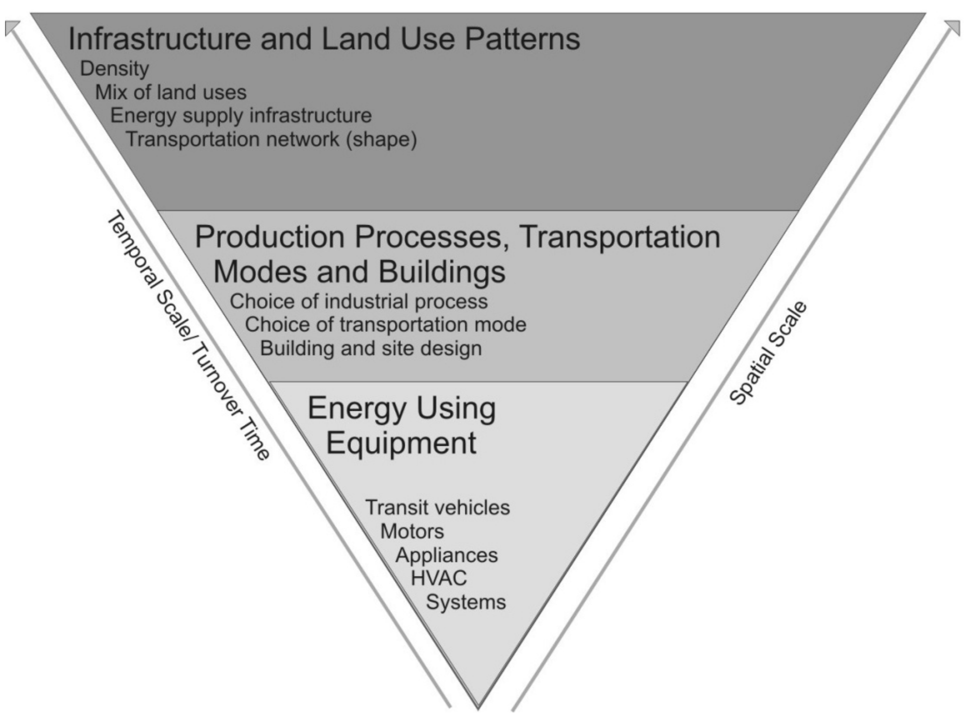


Figure 2.6 Hierarchy of Energy Decisions in Community Energy Planning (Jaccard et al. 1997)

2.7.3 Multilevel Perspective on Transitions

It has been established that energy systems have considerable inertia to change and that contributes to inertia in a reduction in energy consumption. The multilevel transitions perspective is an emerging approach that proposes mechanisms and pathways for long-term socio-technical system change. This perspective recognizes that large socio-technical systems, such as critical infrastructure, are structured as nested hierarchies. This literature explicitly recognizes that the transition of critical infrastructures, such as electricity, transportation, and water systems, requires a non-linear sequence of complex interactions between actors, institutions, and technological development at a variety of scales (Grin et al. 2010). This socio-technical perspective integrates science and technology studies, evolutionary economics, and structuration theory, and employs these epistemologies as a basis to understand interactions of technological innovations between scales (Geels and Schot 2010). The multilevel perspective links the three scales of 'socio-technical niches', the 'socio-technological regime' and the 'socio-technical landscape' (Geels 2010). 'Socio-technical niches' form the network involving new innovations at a local scale. The 'socio-technological regime' is made up of the social network of infrastructures, regulations, markets, established technical knowledge, etc. The 'socio-technical landscape' is the exogenous environment of air quality, resource prices, lifestyles, economic structures, etc. Each scale provides a different type of structuration, and the lower scales are nested within the higher scales. That is, regimes are nested within and structured by landscapes, and niches are nested within and structured by regimes. Further, there is heterogeneity within each scale. It is in this manner that the framework links socio-technical outcomes to technological innovations and decisions as they relate to each other across nests or across scales.

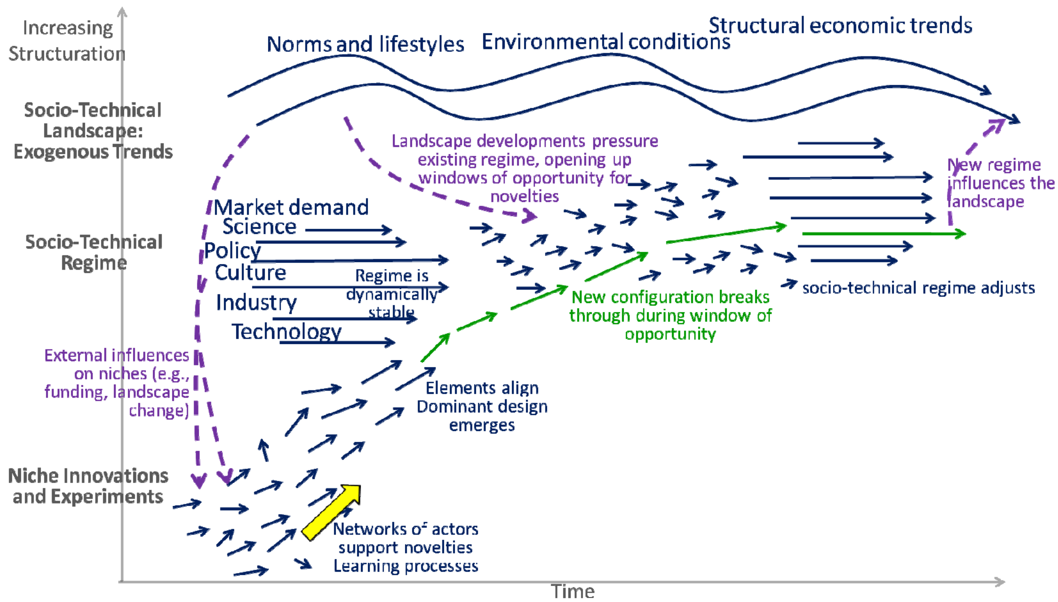


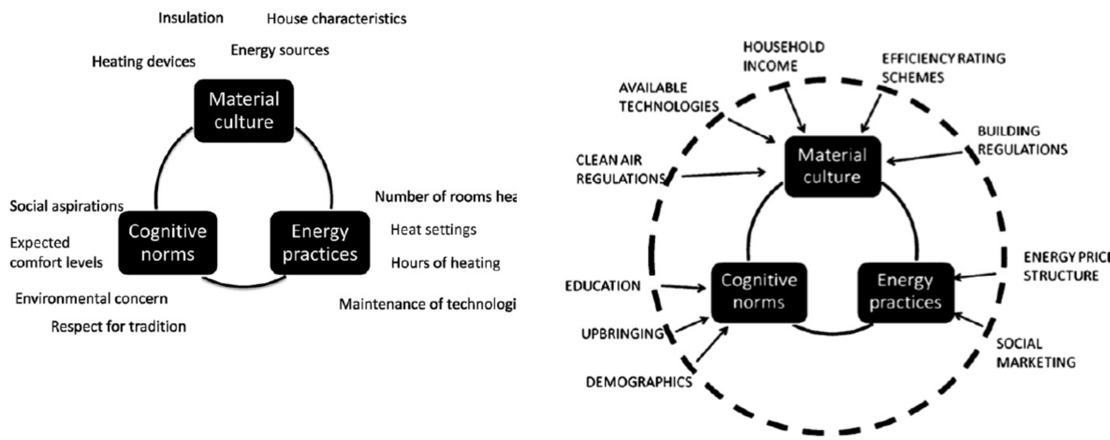
Figure 2.7 Niche "Breakthrough" within a Multilevel Framework (Adapted from Geels)

In this conceptual framework, it is the alignment of these processes that enables the breakthrough of novelties, strategic niches, or innovations into mainstream markets where they compete and potentially transform the existing regime (Geels and Schot 2010). A typology of "transition pathways" includes the transformation, reconfiguration, technological substitution, and de-alignment and re-alignment pathways (Geels and Schot 2007; Geels and Schot 2010). The pathways differ in terms of timing and nature of multi-level interactions, hence, in terms of interactions by the different levels. The multilevel transitions framework provides a conceptual framework to understand the direction that innovations can take in a technological system. The interaction between these scales at specific points in time provides a framework to understand broad socio-technical system change.

Innovations are primarily considered as conducted within the socio-technical regime: such as the interaction of industry, government and the market demand. What is lacking within this conceptual framework is the consumer selection process, that is, how consumers interact with innovations and influence the pathway of the breakthrough. The multilevel transitions framework is not explicitly connected with consumer perceptions and system relations, and has been criticized for this omission (Shove and Walker 2010). However, Stephenson et al. (2010) point out that consumer approaches can still be examined while considering the context of systemic change. Brown and Vergragt (2012) examined new modes of delivering home energy retrofits as niche experimentation. They considered the system to consist of homeowners, technology, professional knowledge and know-how, and the governing regulations and standards. They examined how "multi-stakeholder groups in which different actors with multiple framings collaborate, and in the process learn and change their individual and collective framing of the project." (158). This is how Brown and Vergragt (2012) frame innovation, and take into account grassroots activities that may affect system change. Overall, it seems that while multilevel transitions do not directly incorporate consumers, it is a promising framework to understand the system within which their decisions are bounded and the potential and pathways for change.

2.7.4 Energy Cultures Framework

Stephenson et al. (2010) acknowledge the difficulty in directly accounting for the dynamics that affect changes in the energy system and the dynamics that affect changes in patterns of energy consumption. They propose and explore a model for energy cultures, shown in Figure 2.8, which takes into account changing consumption patterns over time and heterogeneity in preferences in light of systemic changes that occur simultaneously and interconnectedly. Their model is driven by the interaction of the three components of cognitive norms, material culture, and energy practices that are co-constitutive of behavioural outcomes. Their model includes contextual factors by encouraging the labeling of what influences and what is influenced by each interacting component of the model. For example, material culture is made up of house characteristics and specific technologies. Material culture is influenced by available technologies, household income, regulations, and building and technology standards. Energy practices represent interactions between individual, social, and institutional behaviours. Cognitive norms account for personal factors, such as beliefs and injunctive norms. The value of the energy cultures model is its parsimony and simplicity as three interactive components that can be tailored around each decision. The impact in its application is to take into account a multitude of relationships as it provides a framework to label the drivers of, and what is driven by, each component, and their interactions. This model encourages specificity of context as it encourages description of particular technologies and technological systems, particular energy practices, particular cognitive norms, and particular interventions. Some of these features are employed in this study's conceptual framework.



What is Influenced (left), Systemic Influences (right)

Figure 2.8 Energy Cultures Framework (Stephenson et al. 2010)

2.8 Integrated Approaches

As discussed in Chapter 1, a consensus is developing among researchers that due to a multiplicity of influencers on consumption, and the importance of including multiple disciplinary perspectives in research, pro-environmental behaviour lends itself to examination using an integrated approach. Integration means to focus only on the key variables and relationships that account for most of the variation in the behaviour of the system, and that are amenable to intervention (Mitchell 2008). One implication of this is the growing level of acknowledgement that single disciplinary models are not sufficient to explore and analyse how to influence pro-environmental behaviour (Peattie 2010).

In order to select the form of integration and narrow the factors to the most influential, the specific decision should be matched to the appropriate model. The literature described thus far has presented different forms of integration; for example, Jackson (2005) describes the models that acknowledge internal (psychological) and external (situational or contextual) variables are integrated as a structurationist approach. Wilson and Dowlatabadi (2007) reviewed multiple decision making models for pro-environmental behaviour. The literature included discussions of economics, behavioural economics, diffusion of innovations theory, social psychology and sociology. They appeal for nesting decision models within each other according to time-scale and systemic impact or interaction. Peattie

(2010) takes into account internal and external factors, but frames consumption as a process and so the form of integration is as process. In contrast, Stephenson et al. (2010) describe the lack of a common definition of behaviour, and therefore the form of integration they present is co-constitutive between three interacting components. Jaccard et al. (1997), informed by spatial and technological scales, describe the form of integration as a hierarchy. Parker et al. (2003) examine the influences on energy retrofit decisions in response to a program delivered in the context of a community setting. The form of integration employed by Parker et al. (2003) utilizes four dimensions; these are explained as discipline influenced by technical and social factors, stakeholders as partnerships between public and private organizations, scale which incorporates global and local perspectives, and finally, issues which form the debate for conservation or substitution.

The appeal of an integrated approach is that as the form of integration increases the number of scales considered, it increases our understanding of contextual factors. This dissertation employed an integrated approach as the framework of analysis by acknowledging and examining multiple factors related to making improvements in home energy efficiency within the context of local delivery of a national home energy evaluation program. This approach acknowledges the possibility for interaction between two or more factors of influence.

2.9 Human Geography and Integration across Scales

The socio-technical approaches and the inclusion of scale presented are compatible with the analytical approaches taken by human geographers. Human geographers employ scale as a device to shape understanding of a phenomenon, and as a conceptual mechanism to order the world by circumscribing and ordering processes and practices so that these are distinguishable and separable (Herod 2003). Human and economic geographers incorporate structurationist models of agency (Sheppard 2000); for example, human geographers have studied the abilities of people to “act back on” global processes (Castree 2003). Materialists strive to understand how various actors “work” to make themselves local or global, that is, how the local and the global are “produced” (Herod 2003). Economic geographers consider economic systems to be path dependent, as the history of the system predicts the achieved equilibrium (Sheppard 2000). Peck (2000) describes economic geography as a more self-conscious discipline than economics. According to Peck (2000), economic geography can take into account economic habits and conventions, societal expectations, consumption norms and cultural practices. Reid (2010) conceptualises the household as a more important level of pro-environmental behaviour to be addressed by policy makers than individuals. Brown and Vergragt (2012), and Darby (2006) all conceptualise homeowners as members of communities. Indeed, Peck's (2000) definition of economic geography takes into account the habits and practices of individuals and households. The relationships between scales will be discussed more carefully in the explanation of the conceptual framework that was developed for this study.

2.10 Conceptual Framework for Analysis

The conceptual framework for analysis is a representation of the context and process of the pro-environmental behaviour of participation in a home energy evaluation program delivered by REEP. The conceptual framework is shown in Figure 2.9. The objective of this research was to analyse factors that affect pro-environmental behaviour to address the broader challenge of how to design programs and policies that motivate individual behaviour that is more environmentally sustainable. One key variable that this study examined was the program structure. The different program structures that occurred are described in more detail in Chapter 3 in Figure 3.1. The program structure varied over time and was composed of the price of the evaluation, the financial reward structure, the focus on influencing eight specific decisions within a specified timeframe, and the level of support provided by government. The other factor that was examined was advice-giving, defined as the selection and communication of advice during the home energy evaluation and the recommendations included in the report. The factors identified in the literature review as relevant to understanding this particular context and intervention are included in the conceptual framework. The variables that were measured by the study are indicated in bold text in the conceptual framework shown in Figure 2.9. This conceptual framework reflects that the selected form of integration was process based. It also describes that some of the variables, such as program structure and the material context of housing stock, were structured by processes at higher scales.

The conceptual framework describes the process in five stages. The semi-transparent rectangles represent filters that explain the potential for influence of courses of action at each stage. The first step in the evaluation was the decision to call the delivery agency and ask for an evaluation. The literature review explains that there was an initial motivation or intention that caused the homeowner to schedule a home energy evaluation, and this is illustrated by the first filter. The next stage in the process was the initial home energy evaluation that consisted of an interaction between the home energy advisor and the homeowner. The evaluation itself entailed an energy assessment of the house and delivery of information both during the evaluation and after, with the delivery of the report. During the evaluation the homeowner may have learned procedural knowledge from the advisor. The filter that appears between the evaluation and the delivery of the report shows the potential that homeowners influenced the recommendations given to them. Homeowners influenced the recommendations as part of the process during the earliest years of delivery of the program (Parker et al. 2003). Once the homeowner had received their report with recommendations, they were faced with making decisions. Both the evaluation and the report could contribute to the development of procedural knowledge and to influence specific types of decisions. The filter shows that the literature describes that at this decision making stage, homeowners may make decisions by gathering information, gaining procedural knowledge, and making trade-offs between retrofit decisions. Bird (2006) discusses that each decision has its own process and barriers to implementation. From this perspective, as the recommendations increased, the trade-offs faced by the homeowner could multiply. If a homeowner invested the time and money into one or many retrofit decisions, then the filter furthest to the right shows that the motivation for information as feedback or for a financial reward may have caused them to return for a follow-up evaluation when their retrofit decisions were measured. Hence, after some time has elapsed, a sub-set of homeowners returned for a follow-up evaluation within the program time limit, which consisted of an assessment of changes.

The diagram that illustrates the conceptual framework details the relationships to be investigated in bold type. The elements that were examined include (1) material context represented by some of the physical characteristics of the houses that participated in response to the program structure; (2) the in-person delivery of the initial evaluation by various advisors; (3) the recommendations given in the initial evaluation and report; (4) the decisions made, that were verified in a follow-up evaluation; and (5) the time that elapsed between the two evaluations. Advice-following was considered as the matching of decisions to recommendations in terms of type and depth.

The literature review examined many bodies of literature that help to explain pro-environmental behaviour. The stages of the process that were included in the conceptual framework narrowed the selection of literatures deemed useful for the analysis.

One identified purpose of the study was to examine the impact of program structure on participation in a home energy retrofit program. Program structure was defined as the combination of the price of the evaluation, the financial reward structure, the level of government support, and the focus on influencing eight specific decisions within a specified timeframe. The price of an evaluation was considered as a penalty and a financial cost. A financial reward was defined as a reward. The information given was a low-frequency form of information feedback. Hence, ABC theory has value in examining the importance of contextual factors to influence a desired behaviour. Some of the program structures that this research assessed combined feedback with rewards. The increased number of decisions may have caused competition between decisions (trade-offs), and therefore prospect theory was considered important for this study to acknowledge. The measured dependent variables were participation and the measured material characteristics of the participating houses, such as the period of construction or the energy efficiency of the house. The energy cultures framework considers that different material context can be indicative of a different combination of concerns or practices. The inclusion of the time that elapsed between evaluations and the specificity of decisions in the analysis allowed for a process-based understanding of decisions. Therefore, process-based understandings and the social learning model presented by Darby (2006) were determined to provide value in this study.

The second part of the research examined the advice-giving, and considered the selection and communication of advice that was given to the homeowner during the evaluation and in the report. These can be considered the communication and type of message. The bodies of literature that were considered to be valuable to this section of the assessment include persuasion theory, prospect theory and the use of the common decision making heuristics, and studies on message framing. However, as this section of the research depended heavily on qualitative analysis, many other bodies of literature may explain the perceptions that home energy advisors had about the decision making process of home owners. For example, Jackson (2007) observes that most interventions are based on a rational choice model. Nolan et al. (2011) demonstrated that many experts were informed by a rational choice model. Message delivery can also result in learning, and therefore Darby's (2006) process-based model for social learning was considered relevant to this portion of the study. Gonzalez et al. (1988) reported that when advisors provoked the availability heuristic, homeowners were more likely to apply for financing from the utility company, and this was also deemed useful for the study.

The conceptual framework illustrates the program structure and material context as key variables in the analysis. The material context was considered as the physical characteristics of houses that participated. The houses that participated originated from the housing stock in the Region of

Waterloo. The multilevel transitions perspective would describe the program structure as a niche experiment. The program structure could be considered as structured by the socio-technical landscape and regime interactions and developments. The composition of the housing stock and its technical features of the group of houses that participated under each program structure was a dependent variable in this study. However, the composition of the housing stock of the Region of Waterloo was also structured by the socio-technical landscape and regime interactions and developments. The price of energy is another landscape development (Geels et al. 2010). Although this study did not take price into account, it is an example of a landscape development that may have impacted the pro-environmental behaviour. It was considered to be worthwhile to include landscape developments into the conceptual framework as reminder of the influence that they have.

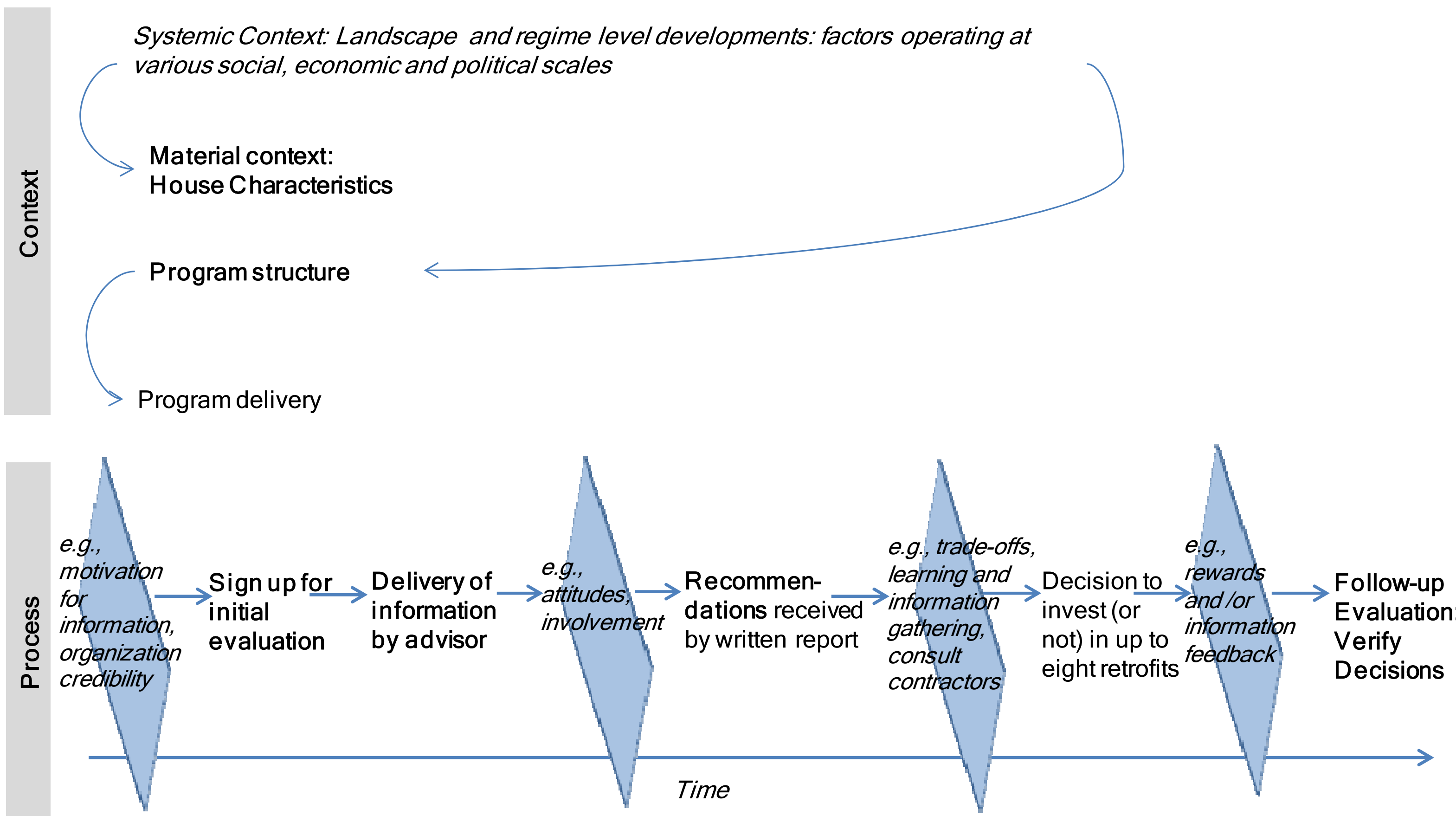


Figure 2.9 Conceptual Framework Informed by the Literature Review

2.11 Previous Findings about REEP Program Delivery and National Level Results

This study is focused within a specific body of literature that was developed in the Region of Waterloo. The federal EnerGuide for Houses program started in 1998. The Residential Energy Efficiency Project (REEP) was founded in 1999 by the University of Waterloo and the Elora Centre for Environmental Excellence with the purpose of delivering the EnerGuide for Houses program to the Region of Waterloo. REEP continued the delivery of the federal EnerGuide for Houses program until its cancellation in 2006. The partnership between REEP and the University of Waterloo has produced many studies about the delivery, uptake, and impact of the EnerGuide for Houses and ecoEnergy programs. Some of these studies examined homeowner motivations. Other studies with relevant findings were conducted at the national level. Several studies utilized the national level dataset owned by Natural Resources Canada. The findings of these studies as they are relevant to the conceptual framework are described.

2.11.1 Findings on Material Context

Parker et al. (2001) estimated the amount of energy savings that were possible in different subsets of the housing stock (material context) to meet Kyoto Protocol requirements in the Region of Waterloo. They projected that to meet a 6% reduction each participating house in the first year (1035 houses) each house would need to reduce greenhouse gas emissions by 20% on average in order to offset economic, population and residential growth.

2.11.2 Findings on Program Delivery

REEP made use of social networks and word of mouth and local media to deliver their programs (Kennedy et al. 2001; Parker et al. 2003). Parker et al. (2003) describe that REEP advertised their program using marketing techniques through social networks[12]. REEP was the only program delivery agent in Canada that was associated with both a university partner and with an environmental not-for-profit organization. REEP stood out in its first year by delivering 9% of the total set of national evaluations. In the first half of the second year, REEP delivered 11% of the total set of national evaluations. However, at the time, the Region of Waterloo accounted for 1.4% of Canada's population. To elaborate on REEPs success in reaching a larger proportion of the population than other program deliverers, Kennedy et al. (2001) conducted an experiment to assess the credibility of a local partnership that included local utility company, an environmental non-governmental organization, and local government compared to that of just the federal government. Kennedy et al. (2001) found that the

[12] Although REEP used community based methods for marketing and recruitment, it is not clear that all of their methods were based on the social marketing techniques used by Gonzales et al. (1988) and advocated by McKenzie-Mohr (1994).

pamphlets that originated from the local community partnership generated more bookings for an initial evaluation than the pamphlets that associated the program with the federal government. This relationship held when the materials were reversed and sent to the same sampling frame of the population.

2.11.3 Findings on Participation

Song (2008) studied the REEP dataset of the evaluations performed by REEP from 1999 to 2006. Song (2008) correlated these data with demographic information collected by the Census of Canada by postal code. Song (2008) tested level of education, average household income, employment rate, home ownership, population aged 65 and over, age of dwelling, and number of eligible dwellings to explain participation rates. None of these demographic determinants predicted participation in the second evaluation, but there were moderate positive relationships between initial participation and each factor. The most important determinant was higher education, followed by home ownership and age of dwellings. Ryan (2009) examined nationwide results from the EnerGuide for Houses program in Canada from 1998 to 2006. Ryan (2009) used the same method as Song (2008) to connect demographic variables to participation, and found weak relationships between demographic variables and participation rates. Ryan (2009) education, income, and the possession of a trade certificate as the three slightly positively correlated values that determined participation in a follow-up evaluation in the EnerGuide for Houses program. The latter is interesting to note from the perspective of social learning and the importance of procedural knowledge.

2.11.4 Surveys on Attitudes and Behaviours

REEP also conducted survey studies of some of the households that participated in an initial evaluation. Scott et al. (2001) examined 339 responses to a questionnaire delivered to participants of the REEP program of 1999 and 2000. The survey included questions regarding situational (demographic) factors, attitudes, behaviours, and decisions to implement retrofits. They found that household income was not a significant influence on technology investment. Curtailment behaviour was strongly associated with personal norms. Technology investments were associated with comfort, economic and situational factors (length of tenure in home, comfort motivations). They found stronger associations between social networks and investment in technology and between social networks and energy management behaviours. The participants in this study reported high levels of implementation of many retrofits. However, less than half had insulated exterior walls or installed heat recovery ventilators. Gilby's (2010) survey built on the survey of Scott et al. (2001). Gilby (2010) delivered a similar survey to REEP participants in 2010. Gilby's (2010) major findings were that the main motivations to participate across both timeframes were cost, comfort and environmental concern. Barriers to participation were initial upfront costs in both periods, lack of financing, time, mess, inconvenience of retrofits. While lack of information was found to be a barrier in 2000, it was not in 2010. Participants in the 2010 study had already implemented minor and major work before the evaluation occurred (Gilby 2010). Overall, Gilby (2010) found that attitudes and behaviours remained the similar in participation groups separated by 10 years. One question about both of these studies is whether the sampling frame was representative of the total population of participants. For example, Gilby's (2010) study distributed 190 surveys during the initial evaluation, and 71 were returned in 2010. However, it is unclear whether it was a sample of convenience or was randomized according to some criteria. The survey by Scott et al. (2001) appears to have been distributed to the entire REEP population (n= 823) and they received a response rate of 64%.

2.11.5 Findings on Economic Rationality

At the national level, two studies analysed the actions taken by approximately 20,000 homeowners under the EnerGuide for Houses program across Canada between 1998 and 2000 (Aydinalp et al. 2001; Fung et al. 2007). This analysis matched decisions taken with modeled cost-benefit analysis data, and found that homeowners did not make the most economically efficient decisions with respect to energy, and rarely achieved the recommended energy savings (Aydinalp et al. 2001; Fung et al. 2007).

As previously described, the home energy evaluations measure the impact of technology on energy efficiency, and give an estimate of energy consumption, but this is based on standard behavioural assumptions in the Hot2000 computer model, and therefore are not indicative of actual consumption. Parker et al. (2005) conducted a study that contextualized the evaluation as an intervention to influence natural gas consumption. Study participants allowed the researchers to analyse their natural gas consumption one year before and one year following the evaluation. Participants provided survey responses on income and attitudes about energy behaviours. Parker et al. (2005) found that lower income groups were associated with making more energy efficiency changes and fuel savings than higher income groups (Parker et al. 2005). Higher income groups were associated with increased natural gas consumption following the evaluation. This is indicative of the rebound effect. 12% of households increased their average consumption by 25%; this increase offset much of the gains achieved by the participants who conserved energy (Parker et al. 2005).

2.11.6 Specificity of Decisions

Gamtessa and Ryan (2007) analysed national level data from the EnerGuide for Houses from 1998 to 2006. Among the eight decisions that could be made, their analysis shows that windows and doors and furnace were changed with the highest frequencies.

2.11.7 Advice-giving

There have not been any studies conducted about advice-giving in the context of the EnerGuide for Houses program in Canada. However, several American studies have examined the role of the home energy advisor. Several studies that examined advice-giving were discussed in Section 2.4. These studies showed that advisors could employ persuasive techniques to address barriers and fit with common decision making heuristics (Gonzales et al. 1988; McKenzie-Mohr 1994; McKenzie-Mohr 2000). Other studies have explored the role of the home energy advisor as modeler or teacher (e.g., Winett et al. 1982). A recent study surveyed 479 home energy advisors in the United States to examine their business size and learn more about investment in home energy retrofits by homeowners (Palmer et al. 2011). However, the only focus on process was related to techniques used for measurement (e.g., blower door, bills, infrared imaging, home energy rating system, or computer modeling) and recommendations typically made to homeowners (Palmer et al. 2011).

2.11.8 Timing

Bird (2006) implemented a telephone survey and focus groups to explore the barriers to furnace and basement retrofits. Besides finding that the barriers were different for the different retrofit decisions, Bird (2006) reports that consumer perspectives support provision of economically rational information (payback, etc.) and information on cost and time estimates. Bird (2006) also found that participants reported uncertainty due to the different advice given by different contractors or from the advice given by the home energy advisor.

Hoicka and Parker (2011) observed that homeowners who participated in the ecoEnergy program had undertaken fewer improvements than homeowners who participated in the EnerGuide for Houses program. The program, however, had been running for just under two years and many who returned had done so in a short period of time.

2.12 Areas for Investigation

There are areas in the literature where further research can improve our understanding of residential energy retrofit decisions. This research contributes to expanding knowledge and understanding of pro-environmental decisions in the context of a home energy evaluation program in several ways. The contributions rest on several aspects of the study that are novel, particularly when examined in combination. The first aspect is that this study viewed the pro-environmental behaviour in question as process and employed an integrated approach as a framework of analysis to reflect this perspective. Second, time was included in the analysis to reflect behaviour as process. Third, as will be discussed more thoroughly in Chapter 3, the study used verified data of decisions. Fourth, these data describe eight specific decisions and the material characteristics of the participating houses. Fifth, the study employed a natural experiment that examined the impact of different program structures on aspects of participation on the same population. Sixth, this study employed interviews with home energy advisors to understand the advice-giving process.

Several factors of the study contribute to its usefulness in the field. Bird (2006), Darby (2006) and Peattie (2010) all consider a process-based view as a promising area of research in order to better understand how to influence pro-environmental behaviour. This study contributes to our understanding of pro-environmental behaviour as a process contextualized in time. It can also comment on the usefulness of process as form of integration and analysis. There are few studies which examine specific retrofit decisions in time. Any expanded understanding of the timing of specific retrofit decisions, as well as the analysis on learning, such as information search patterns, would expand understandings of social learning and the process-based view, as well as impact program design and delivery. By analysing eight specific decisions, and due to the time limit of the program, homeowners wishing to return for a follow-up evaluation will be forced to make trade-offs, or may choose to learn new procedural knowledge to reduce uncertainty and accomplish a retrofit. The nature of these trade-offs and favoured decisions do not appear to have previously been explored in the context of a home energy evaluation program. Few studies have previously examined for indications of exploration for alternate advice outside the home energy evaluation process.

The use of verified data of real decisions is a contribution in itself, and addresses the problems previously discussed with studies that rely on self-reported data, or measurement of intentions or stated preferences. There is evidence that self-reporting of energy related decisions can result in over-reporting of pro-environmental decisions (Abrahamse et al. 2005). The research is not experimental or based on measurements of intentions, but based on observations that were gathered as a process of decision making occurred. Furthermore, as will be discussed more carefully in Chapter 3, the benefit of data resulting from pure experiments is that it minimizes rival hypotheses. However, in the case of research into energy retrofits, this literature review has made it explicitly clear that decisions are affected by contextual factors operating at a variety of scales. Hence, it is hard to apply experimental data to predict a home energy retrofit decision. The capital required for a home energy retrofit is not trivial and decisions compete for attention, time, and capital; a common finding amongst researchers is that real decisions vary from stated preferences from respondents. While this research cannot account for all rival hypotheses, it can address research gaps by examining real decisions in response to combined factors.

There are few studies that examine the effects of varying program structures using the same mode of delivery (i.e., organization and marketing) on the same population. This research examined the variations between program structures based on the number and material characteristics of houses and the associated recommendations. It also examined whether specific initial material characteristics or recommendations were associated with the decision to participate in a follow-up evaluation. Further, this research examined whether types of decisions, the process length associated with the number and types of decisions varied by program structure. This natural quasi-experimental intervention can be considered a niche experiment by the multilevel transitions perspective. It is also an example of experimenting to find heterogeneity of preferences within populations, called for by Wilson and Dowlatabadi (2007). As reported by Stern et al. (1986) and Stern (1999), it is unclear if the size or the structure of a financial reward affects the rate of participation in a program, and De Young says it is unclear how it affects decisions. This research will contribute to clarification of this matter found in psychology literature. The review paper by Abrahamse et al. (2005) expresses concern that studies generally have small sample sizes, this study contained a large enough sample size such that many results are statistically significant.

Overall, there is generally a lack of specificity of the retrofits or the recognition that different actions may be subject to different influences or factors. Studies typically report investment in dollars or changes in energy consumption (e.g., Gonzales et al. 1988) or on one specific recommendation rather than focusing on which decisions were made within a group of possibilities. For example, Gamtessa and Ryan (2007) used data of the eight specific retrofit decisions in the EnerGuide for Houses program, but their analysis combined multiple decisions into a single decision without demonstrating the common set of influences enabling them to be considered together. More specifically, their analysis combined the decision to replace windows and doors with decisions to reduce air leakage, insulate the walls, the basement, or the ceiling, into a holistic category of building envelope. They concluded that investment was in building envelope; it will be seen further in this study why investment in windows and door should be better considered separately. Hence, this research will pursue and encourage understanding specificity of decisions within a larger package.

Few studies exist that examine the role and perspective of home energy advisors. This research will speak to the dearth of studies on the role of the home energy advisor and the rationale for selection, as well as the effectiveness of their chosen techniques. In this study, interviews were conducted with a purposive sample of home energy advisors to probe for an understanding of their methods of selecting and giving advice, and interacting with homeowners. The study examined how these various methods might influence the dependent variable of advice-following. The research examined the responses from the perspective of learning and tacit knowledge emphasized in the process-based view, and information type and message persuasiveness, and therefore contributes to these literatures. Another contribution from this research is the description of the interactions between advisors and homeowners, advisors' perceptions of homeowners’ knowledge and skill level, and the extent to which advisors contribute to the gain of procedural knowledge (planning and executing a home energy renovation). This also contributes to knowledge from the perspective of social learning.

Chapter 3
Methodology

This dissertation explores various factors that affect pro-environmental consumption behaviour in order to address the broader challenge of how to design programs and policies that motivate individual behaviour that is more environmentally sustainable. This study focused on the pro-environmental behaviour of participation in a home energy evaluation program that was designed to encourage investment in energy efficiency retrofits. The program was delivered over 12 years by the Residential Energy Efficiency Project (REEP). In the program, homeowners received advice that they may have followed. This examination of a home energy evaluation program is framed in terms of participation, advice-giving, and advice-following. Participation was measured for both the initial and follow-up evaluations. Advice-giving occurred during the initial evaluation and with the delivery of the report. Advice-following was assessed by how well homeowner decisions matched the advice given to them and over what timeframe they returned to measure these changes. Over the 12 years of the program, two factors varied and were examined for the responses of participation and advice-following. The first was program structure that was defined as the combination of the price of the evaluation, the financial reward structure, the level of government support, and the focus on influencing eight specific decisions within a specified timeframe. The second factor that varied was advice-giving, depending on the advisors' style or strategy. The two main research questions were:

1. Where program structure was defined as the combination of the price of the evaluation, the financial reward structure, the level of government support, and the focus on influencing eight specific decisions within a specified timeframe, how did program structure affect participation, advice-giving, and advice-following?
2. Where advice-giving was considered the selection and communication of advice during the home energy evaluation and the recommendations included in the report, how did advice-giving affect advice-following? More specifically, what were the strategies of advice-giving employed and how did these affect advice-following?

This dissertation employed an integrated approach as it considered multiple disciplinary approaches and the importance of two types of factors. Integration took the form of a multi-stage process, with the recognition that contextual factors that operate at higher scales have structured the program design and the material characteristics of the houses that participated. A challenge to researchers that was identified in Chapter 1 is to identify and use methodologies that correspond with the identified forms of integration while employing cross-disciplinarity or interdisciplinarity. The chosen research methodology was a convergent mixed methods research design. This design made use of qualitative data, quantitative data and the secondary sources identified in Chapter 2. The qualitative data were collected from interviews conducted with 12 home energy advisors. The quantitative dataset was made up of files produced from the home energy evaluations collected by REEP between 1999 and 2011. These files contained the technical characteristics of the house and the associated recommendations for each evaluation. Eight of the interviews were conducted with energy advisors who worked for REEP. These eight advisors had delivered more than half of the home energy evaluations contained in the quantitative dataset. Four additional interviews were conducted with advisors with the same training and similar experience as the REEP advisors. The secondary sources that were analysed mainly consisted of studies that analysed issues related to REEP's delivery of home energy retrofit program conducted between 1999 and 2010. Other secondary studies that were analysed had examined national level data from the EnerGuide for Houses program between 1998 and 2006. These studies were briefly discussed in the literature review in chapter 2.

This chapter summarizes the rationale for and the steps taken to implement the methodology. This chapter presents a brief discussion of the selected mixed methods research design. It presents explanation description of the qualitative data collection and analysis. This chapter also contains a description of how the REEP dataset was prepared and analysed, presented within a discussion of how to analyse and interpret retrospective and observational data. Finally, the chapter explains how findings from the qualitative, quantitative and secondary sources were merged and compared.

3.1 Mixed Methods Research

Mixed methods research derives from the philosophical foundation of pragmatism (Creswell and Clark 2007; Feilzer 2010), combines qualitative and quantitative approaches (known as "strands") and is becoming more widely used and accepted (Creswell and Clark 2007; Johnson et al. 2007; Teddlie and Yu 2007; Feilzer 2010). According to Creswell (2007), the perspective of pragmatism allows a focus on outcomes or consequences of the research, rather than on the antecedents. Pragmatists focus on identifying what occurs, or how things occur, and believe that research occurs in social, political and historical context. Therefore, pragmatists commonly employ mixed methods in order to address their defined problems.

Mixed methods research can offer the benefit of finding convergence and corroboration of results (triangulation), elaboration and clarification of results from one method by another (complementarity), improvement in method development through the combination of methods, the discovery of paradox and contradiction (initiation), and extension of the breadth and range of inquiry by using different methods (expansion) (Creswell and Clark 2007). Mixed methods research designs depend on the combination of four key decisions, that are "(1) the level of interaction between the strands, (2) the relative priority of the strands, (3) the timing of the strands, and (4) the procedures for mixing the strands" (Creswell and Clark, 2007: 64).

A convergent mixed methods approach, one of the four major types of mixed methods designs, puts equal weighting on the qualitative and quantitative strands. This allows the researcher to directly compare the two strands of results for corroboration and validation, or to illustrate the quantitative strand with the qualitative strand, or to synthesize the two strands to more completely understand a phenomenon (Creswell and Clark 2007). Creswell and Clark (2007) point out that it is the simplest and least time consuming design as data are collected simultaneously as opposed to sequentially. A convergent mixed methods research design is illustrated in Figure 3.1.

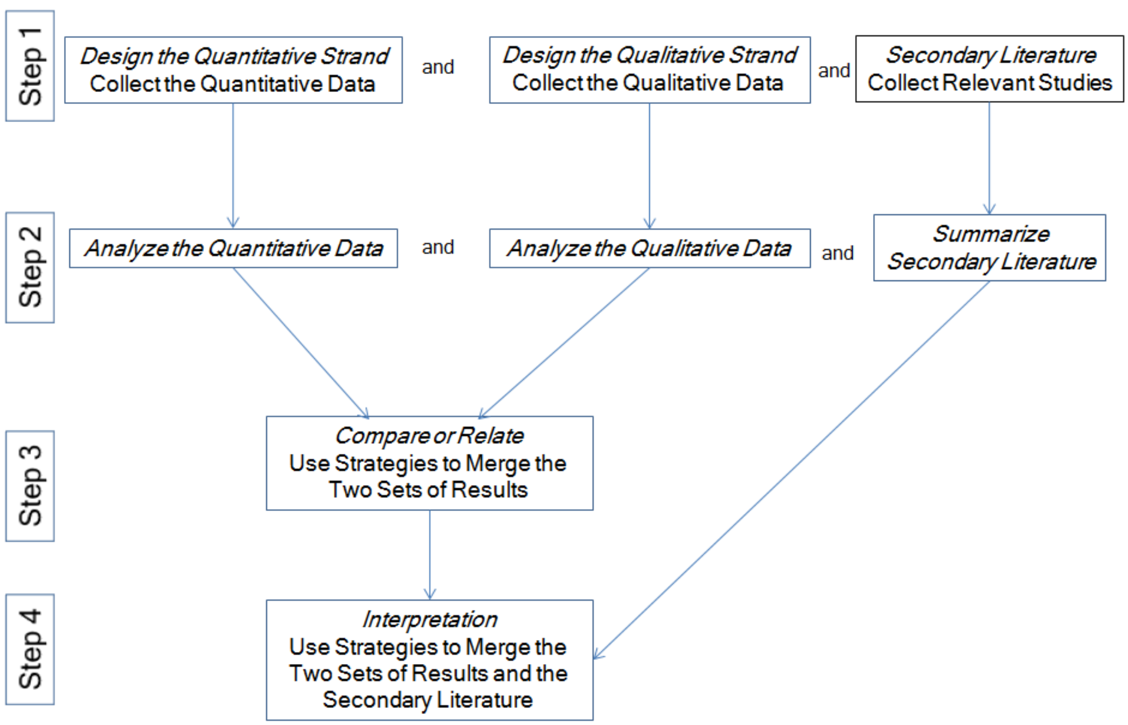


Figure 3.1 Convergent Mixed Methods Research Design (adapted from Creswell and Clark 2007)

A convergent mixed methods approach was chosen as the best design for this research due to timing, the size of the desired group of home energy advisors (18), and the type of available data. In this approach, qualitative and quantitative data are gathered separately and concurrently[13], putting equal

[13] The historical data were collected and managed simultaneous to conducting interviews.

emphasis on each strand. The four key steps of a convergent mixed methods design are design, analysis, compare or relate, and interpretation (Creswell and Clark 2007). These four steps were followed in this study.

This dissertation examined factors that affected advice-following in two parts: the impacts of (1) program structure as well as of (2) advice-giving. The results are presented separately in two results chapters, namely Chapters 4 and 5. The results presented in Chapters 4 and 5 were jointly interpreted in the discussion (Chapter 6). The results were compared to the secondary studies at that stage of interpretation.

Chapter 4 presents the results on the impacts of program structure, as it affected participation and advice-following under various program structures. In this section of the study, a natural quasi-experimental intervention design was used in which location was held constant and time varied. This research design was used to examine for differences in response to the four program structures. The responses examined were participation rates, the distribution of material characteristics, the recommendations given to participating households, and the advice-following and decisions taken. One component of the analysis of advice-giving that is presented in Chapter 5 presents the advisors' observations about homeowner decision making activity within these program structures. This information was obtained from the interviews that were conducted with the home energy advisors. A third strand of data was obtained as observations or findings from the secondary sources. These three strands were combined in an independent level of interaction as they were combined at the interpretation stage, and compared and related in Chapter 6. This research design is described in Figure 3.2.

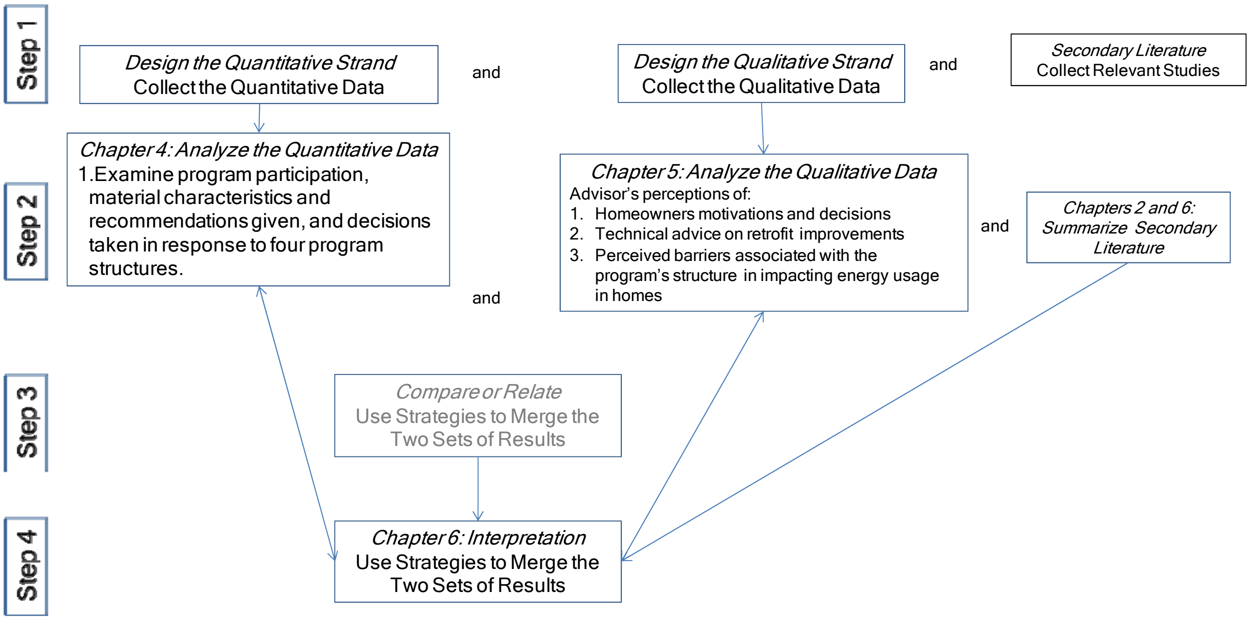


Figure 3.2 Convergent and Independent Mixed Methods Research Design for Research Question 1

Chapter 5 presents an examination of advice-giving strategies and how homeowners followed the advice of various home energy advisors. Three strands of data were used in this section of the study. The first strand came from interviews with home energy advisors. These interviews were transcribed, coded and analysed to understand advice-giving strategies such as prioritization of recommendations, depth of recommendations and delivery of advice. The second strand of data was quantitative, and included an assessment of number, type and depth of recommendations to homeowners by advisors. The dependent variables measured were number, type and depth of decisions taken by homeowners. The third strand was provided by results from other studies. The qualitative and quantitative strands of data were combined interactively in Chapter 5, at the stage of analysis. The results of the analysis were combined with the third strand that consisted of the secondary studies at the interpretation stage in Chapter 6. This research design is described in Figure 3.3.

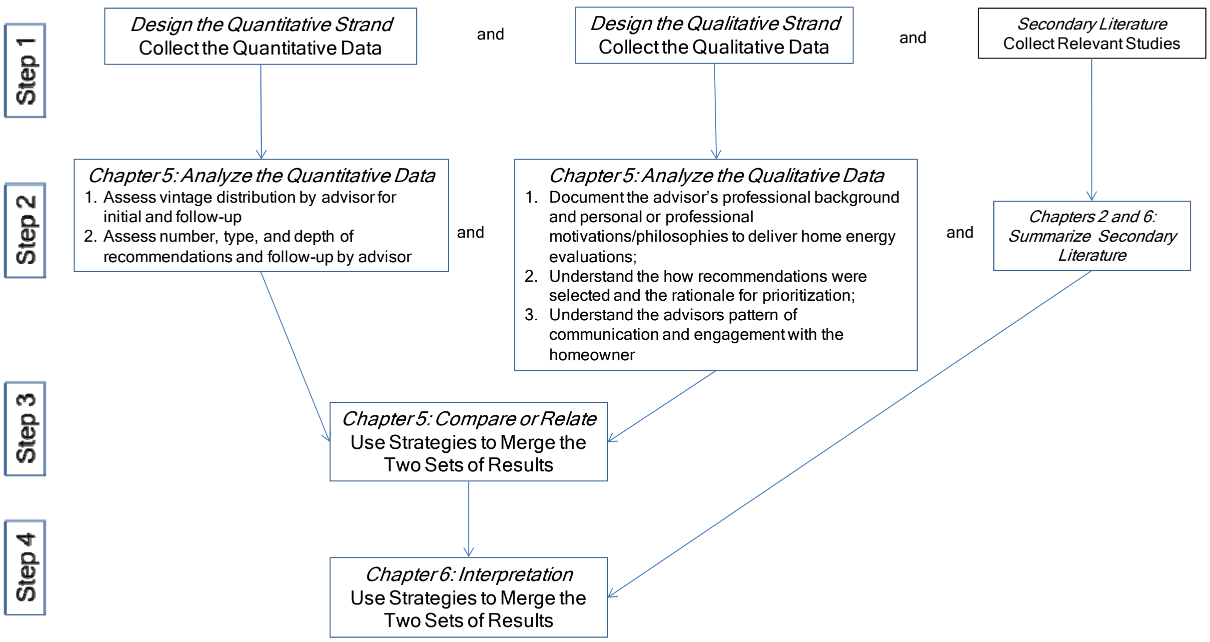


Figure 3.3 Convergent and Interactive Mixed Methods Research Design for Research Question 2

3.2 Using Quantitative Data for Analysis

Depending on the type of data and how it is collected, quantitative data can yield different types of information with differing levels of reliability, predictive power, or inference to a population. The quantitative researcher upholds the controlled experiment as the ideal strategy for the collection of data because careful design and randomized group assignment can minimize rival hypotheses (Campbell and Stanley 1963). An experimental design in which the researcher does not have the control to randomize subjects into treatment groups is called a quasi-experimental design (Feilzer 2010). A natural quasi-experimental intervention compares a naturally occurring treatment and comparison condition, and non-experimental designs, such as correlational design and passive observational design, do not include random assignment and typically lack control groups (Campbell and Stanley 1963). According to De Veaux et al. (2010), the attributes of experimental units that are not being studied and cannot be controlled for may affect the outcome of an experiment. This can partially be controlled for by grouping similar individuals together and randomizing within each of these blocks; variability can be removed or minimized due to the difference of the blocks. Despite the drawbacks of non-purely experimental data, Campbell and Stanley (1963) explain that many forms of data can still be used to search for causal processes. However, this is time-intensive as the following process must be used: "Reliance is placed on measuring alternative explanations individually and then statistically controlling for them. In crosssectional studies in which all the data are gathered on the respondents at one time, the researcher may not even know if the cause precedes the effect." (Campbell and Stanley 1963: 17)

Within observational study design, prospective studies gather data in advance and are typically better understood than that gathered retrospectively. Consequently, prospective studies can be better controlled than retrospective studies (De Veaux et al. 2010). Thus care must be taken in suggesting cause-effect relationships, especially in retrospective studies that involve memory (De Veaux et al. 2010). Campbell and Stanley (1963) explain that "direction of memory bias is to distort the past attitudes into agreement with present ones, or into agreement with what the tenant has come to believe to be socially desirable attitudes." (Campbell and Stanley 1963: 66).

In summary, in order to effectively employ and interpret quantitative data, the researcher must either control experiments for alternate hypotheses or remain aware of sources of invalidity and look for similarities from different sources of research or information. If that is not possible, the researcher must simply examine the data for correlations and treat the results as exploratory. However, carefully controlled experiments also have weaknesses. While they can clarify causal processes, Babbie (1990) points out that, given that they are generally performed in a laboratory setting, their artificiality is a weakness as social processes may not occur in the same way in a natural setting. Chapter 2 clarified that pro-environmental consumption decisions and behaviours are affected by a variety of factors occurring at a variety of human scales, hence, the artificiality of experimental data could be a weakness if it is not conducted in a real-world setting concerning real decisions.

3.3 Description of the Quantitative Data

The quantitative dataset was collected by REEP while delivering various versions of a federal home energy retrofit program. The federal EnerGuide for Houses program started in 1998, and REEP was founded and began delivering it in May 1999 (Parker et al. 2001a). This program ran until the abrupt announcement in April 2006 of its cancellation in May 2006 (Bird 2006a). Despite program cancellation, REEP found support from local municipal government and utility partners and continued to deliver both initial and follow-up home energy evaluations (Parker and Rowlands 2007). In April 2007, the ecoEnergy program was established by the Government of Canada and REEP began to deliver this program. On March 31, 2010 it was announced that the ecoEnergy program would immediately cease acceptance of initial evaluations into the system, and follow-up evaluations would only continue until March 31, 2011(Office of Energy Efficiency 2012). Hence, there were three major time periods - one associated with the EnerGuide for Houses program, one without federal funding, and one associated with the ecoEnergy program.

When the program structure was taken into account in terms of delivering information (1999 to 2003) and financial reward (2003 to 2006 and 2007 to 2010), there were actually four main program delivery periods with different combinations of information and financial rewards, and five different follow-up groups. These program periods are described in Table 3.1.

	Initial Evaluation				Follow-up Evaluation			
Policy period	Period label	n	Dates	Price ($)	Period label	n	Price ($)	Financial Reward
EnerGuide for Houses	1	4261	May 1999 to September 2003	25 to 80	1	67	Free (min 3 points)	No reward
				75 to 250	1.1*	393	0 to 205	Performance-based on energy rating scale (>40 to >60 points) Maximum ($) $5,000
EnerGuide for Houses	2	2947	October 2003 to May 12, 2006		2	1056		
Local Support Only	3	230	May 12, 2006 to March 2007	100 to 260	3	7	150	No reward
ecoEnergy	4	5991	April 2007 to March 31, 2011	100 to 325	4	4600	50 to 195	List-based Maximum ($) 10,000$
Total		13429				6123		

* Period 1.1 is the group of households which had an initial evaluation during period 1, but had a follow-up evaluation after October 1, 2003 when performance-based financial rewards were offered.

Table 3.1 Summary of Initial and Follow-Up Program Periods as Delivered by REEP in the Region of Waterloo

Table 3.1 describes participation, price, and the structure of the financial reward for each program period. Within these program periods, prices varied by date and by location as some utilities and municipalities provided a subsidy for the cost of a home energy evaluation. The EnerGuide for Houses program initially offered no financial rewards for improvements in energy efficiency, and charged a relatively low price (approximately $25 to $80) for an initial evaluation. A follow-up evaluation was free, provided there was a three point improvement in the house's energy performance rating. In October 2003, the program began to offer financial rewards to homeowners. This reward structure rewarded an improvement to the houses overall energy rating score, that is, improvement to energy performance, not for specific measures taken. It should be noted that as the energy rating score of a house increases, the performance increases. An energy rating score of 80 is equivalent to the R-2000 standard for houses. The initial cost of an evaluation ranged from $75 to $250, and a follow-up evaluation, necessary to receive a reward, ranged from $0 to $205. Houses that had an initial home energy evaluation during the initial

EnerGuide for Houses program were able to return for a follow-up evaluation and collect a financial reward after October 2003, when the program began to offer financial rewards (label 1.1). Between programs, from May 2006 to April 2007, despite program cancellation, REEP continued to offer home energy evaluations and the initial evaluation cost ranged from $100 to $260, and a follow-up cost $150. In April 2007, the ecoEnergy program was established by the federal government. This program offered prescriptive, or list-based financial rewards, offering a set monetary value for each specific retrofit measures. The Ontario provincial government further matched these incentives, thereby doubling the reward for most retrofit measures.

3.3.1 Description of Files

While working with local, provincial, and federal partners, REEP established its own internal data management system that contains the initial and follow-up[14] home energy evaluation measurements made by REEP staff since 1999. Each evaluation was made by a certified home energy advisor who employed software (HOT2XP or HOT2000[15]) to prepare an individualized energy model of the house. The initial evaluation produced two sets of data. One set was of the measured and modeled factors related to the house's initial measured home energy performance. The second dataset provided the same types of measurements based on the recommendations made by the home energy advisor to improve energy performance of the home. As a result, the dataset for an initial evaluation contains both the measured and modeled variables related to initial energy performance, but also provides an estimate of the same variables associated with the improvements recommended by the advisor. If a homeowner elected to have a follow-up evaluation, a third set of data were measured and modeled using the same categories. Hence, the REEP database contains a set of multiple factors for each home as shown in Table 3.2. One set for initial performance, one set for recommended performance as specified by the advisor, and, if applicable, one set for follow-up, or achieved, performance. The following eight recommendations for improvements can be counted or quantified in the database: (1) air-sealing; (2) insulation to foundation/basement, (3) insulation to ceiling/attic, (4) insulation to walls, (5) improvement of windows and doors, improvement to (6) heating and (7) hot water systems, (8) improve air quality with a heat recovery ventilator (HRV).

[14] Follow up home energy evaluations were performed at the discretion of the homeowner. As a result, there are less follow-up than initial evaluations.

[15] The EnerGuide for Houses program used HOT2XP a modified version of HOT2000 while the ecoEnergy program used a newer version of the HOT2000 software.

	Information Tracked for Administrative Purposes		Information Used for Model			Information and Advice Presented to Homeowner During or After the Initial Evaluation**			
Measured and Observed Variables	City and Postal Code	File ID	Year built	Housing type	House volume	Advisor	Air changes per hour	RSI for attic, walls***	Hot water heater efficiency
	Date of initial evaluation	Date of follow-up evaluation	Total floor area	Main floor size	Hot water heater type	Furnace efficiency			
			Furnace type	Furnace fuel type					
Modeled variables						Home energy rating score	Space energy	Potential incentive amount	Air changes related to HRV
						Equivalent Size of air leakage 'hole'	Consumption of electricity, gas, oil, propane, and total energy	Energy costs for by fuel	Heat loss air leakage
						Heat loss foundations/ basement	Heat loss attic/ ceiling	Heat loss walls	Heat loss windows/doors

**Required verification

***Foundation insulation (RSI) values for data collected prior to 2007 contained too many extreme values to be considered reliable and was discarded.

Table 3.2 Measured, Observed and Modeled Variables of Each Household Dataset Used for Advice and Information in REEP's Database Collected for Each of Initial, Recommended, and Follow-Up Sets of Data

3.3.2 Data Preparation

Steps in Data Preparation

1. Identify and fix errors
2. Code cases for advisor, date, price, and estimated and received financial rewards
3. Match initial files to follow-up
4. Analyse files according to type, depth and number of recommendations and achievements.
5. Compare energy rating scores by vintage categories.

Prior to analysis, the dataset was prepared and sorted. This included combining the multiple datasets that resulted from the various periods. The first stage was to scan the data to identify and fix potential errors[16]. Fewer than 1% of the initial files were eliminated due to errors or duplicates, and approximately 9% of follow-up files were eliminated due to errors and duplicates[17]. The data were coded for date, cost, estimated and received financial rewards, and advisor. In the case of any values that were altered, the alteration was carefully selected from verified sources. The data were coded for date by using various sorting methods and cross-references with identification numbers to correct or fill in missing dates. Following this, they were coded for price and financial reward offered and received. Prices were obtained from a price schedule provided by REEP, which contained details of price variation by date and location. The financial rewards offered and received prior to 2007 were coded into the data using a table that described the financial reward structure, found in Appendix A. The data were coded for advisor. In order to compare decisions taken with recommendations, the initial and follow-up evaluation files were matched using their Natural Resources Canada (NRCan) identification number.

As the dependent variable of the study was advice-following, considered as the matching of advice to recommendations, after the data were coded for program characteristics and the initial files were matched with follow-up files, the data were coded for recommendations given and decisions taken. The eight recommendations were measured differently and lent themselves to different analyses with respect to depth, type, and number. While the nominal measures, such as a change in type of heating system, were straightforward to measure, if was more difficult to determine if a change had been recommended or made for the ratio measures. It is for this reason that a threshold of change was determined to measure whether a recommendation was made or an action was taken for each variable.The categorization of these measured and modeled variables, and the selected threshold of change, is provided in Table 3.3.

[16] Appendix B describes this process.
[17] The majority of the files removed were duplicates.

Decision		Type of measurement	Type of Variable	Analysis of Decision	Selected Threshold of change
1	Air-sealing	Heat loss (MJ)	Ratio	Type Depth	1 GJ
2	Insulation to foundation/basement				
3	Insulation to ceiling/attic				
4	Insulation to walls				
5	Improvement of windows and doors				
6	Improvement to heating system	Efficiency (%)	Ratio	Type Depth	
		Fuel switch/ system switch between • Electricity • Natural gas • Oil • Propane • Solar	Nominal	Type	Category (switch from/ switch to)
7	Improvement to hot water system	Efficiency (%)	Ratio	Type Depth	1%
		Fuel switch/ system switch between • Electricity • Natural gas • Oil • Propane • Ground, air or water source heat pump	Nominal	Type	Category (switch from/ switch to)
8	Improve air quality with heat recovery ventilator (HRV)	Addition of HRV	Nominal	Type	Category

Table 3.3 Measurement of Eight Decisions

A recommendation was measured as the difference between the recommended value and the initial or measured value. That is,

$$\Delta X_{recommended} = X_r - X_i \quad (1)$$

Where X is any retrofit defined by a ratio variable, r is recommended and i is the initial measurement.

An improvement was measured as the difference between the follow-up value and the initial or measured value. That is,

$$\Delta X_{improvement} = X_f - X_i \quad (2)$$

Where X is any retrofit defined by a ratio variable, f is follow-up measurement and i is the initial measurement.

The threshold of change selected for each type of decision is described in Table 3.3, and is based on equations (1) and (2) that are described above. Changes were recorded in various ways. In the case of an efficiency change for furnace or hot water heater efficiency, the threshold of change was selected as 1%. The addition or change in the type of system, such as a fuel switch or the addition of a heat recovery ventilator (HRV), was described as a change in category. The selected threshold of change for the heat loss values was 1 GJ (1000 MJ). The rationale for this selection is as follows. The distribution of heat loss amongst homes was positively skewed as some homes had very large heat losses (e.g., 300,000 MJ). For these reasons, using a percentage change of recommended or achieved levels compared to initial would lead to widely varying changes as the threshold measured in mega joules (MJ). Instead, a common threshold change for all types of heat loss was found by observing both the percentage and absolute changes (MJ) between recommended or achieved compared to initial. The selected threshold of change of 1 GJ was larger than the change recorded for more than 99% of cases that had percentage changes of 2% or less, and for nearly 100% of changes of 1% and less. This is displayed in Table 3.4. If a recommendation of less than 1 GJ had been made, it would have been very small compared to most other recommendations and this issue would affect few cases.

Heat Loss Decision	Percentage of group with Recommended Change ≥1GJ	
	2% Change	1% Change
Air leakage	0.4%	0.1%
Basement	0.4%	0.0%
Ceiling	0.0%	0.0%
Walls	0.0%	0.0%
Windows/Doors	0.1%	0.0%

Table 3.4 Selection of Thresholds for Heat Loss

Other outcomes were measured for each home energy evaluation as a recommendation or as a decision. These are described in Table 3.5. Greenhouse gas emissions were not provided as part of the model's output, and so were calculated as kg CO_2 based on the estimated fuel use provided by the model. This was done using Emission Factors from Canada's GHG Inventory (Environment Canada 2010a; Environment Canada 2010b).

$$kgCO_2 = E * 0.21\ kgCO_2/kWh + G * 1.88\ kgCO_2/\ m^3 + O * 2.83\ kgCO_2/l + P * 1.51\ kgCO_2/l$$

Where E is electricity consumed in kWh, G is natural gas consumed in m^3, O is oil consumed in liters, and P is propane consumed in liters.

Recommended or Achieved Outcomes		Type of measurement	Type of Variable	Analysis of Decision
1	Financial reward	Dollars	Ratio	Depth
2	Total energy consumption	Energy use (MJ)	Ratio	Depth
3	Energy rating (EnerGuide for Houses scale)	Score on 1-100 scale 80≈R-2000 standard	Ratio	Depth
4	Greenhouse gas emissions	Kg CO_2	Ratio	Depth

Table 3.5 Outcomes of the Home Energy Evaluation

For the cases in which a homeowner returned for a follow-up evaluation, to determine whether advice-following for each decision taken by homeowners surpassed or fell short of the level of the recommended change, the decisions were categorized in terms of how well they followed the recommendations. Advice-following for each decision was therefore measured by comparing the achieved change to the recommended change as a percent. Advice-following of decisions, measured as percent changes were then categorized as different levels and categories of advice-following. These categorizations of advice following were meant to reflect the level of effort that homeowners put towards completing a retrofit, rather than describing that they did or did not do it. These categories are presented in Table 3.6, and categories did not apply equally to all decisions. The category of "*different than recommended*" was only applied to decisions related to heating and hot water systems. An example of a decision in this category is if a natural gas furnace was recommended to be replaced by a ground source heat pump, but homeowners instead replaced it with a higher efficiency natural gas furnace. This decision is different than "*not recommended and changed*". In this case, for any particular category of decision, the advisor recommended that nothing be done, but upon return for a follow-up evaluation, the homeowner had made the change. An example is if the advisor did not recommend a change to the heating system, but the homeowner installed a new system that was measured in the follow-up. Both the categories of "*different than recommended*" and "*not recommended and changed*" illustrate cases where the homeowner did something, but it was different than what the advisor advised. In each of these cases, the assumption could be made that the homeowner had gathered information from a source other than from the report, and if enough cases are presented and show differences in decision making patterns, this could be an area for future research into information gathering techniques by homeowners. An additional interpretation can be made in the case of "*not recommended and changed*", which is that the homeowner initially wanted to make a retrofit, but the advisor did not believe this to be a good idea, and therefore did not include it in the report.

Once the decisions were categorized as compared to recommendations, counts of each category were made. These counts of each decision could then be grouped by program period or by advisor to assess the level of advice-following as it relates to the two main variables in question: program structure and advice strategy (i.e., by advisor).

Advice-Following as Percent Change Category
not recommended and not changed
recommended and not changed
not recommended and changed
<50% of what was recommended
50% to <75% of what was recommended
75% to <100% of what was recommended
100% to <200% of what was recommended
200% to < 400% of what was recommended
>400% of what was recommended
different than recommended

Table 3.6 Categories of Advice-following

The next stage of data preparation was to define vintage categories for houses. Analyses of similar datasets by Parker et al. (2001), Ryan (2009) and Gamtessa and Ryan (2007) have all used vintage categories to classify the REEP or EnerGuide for Houses data. Additionally, the results presented in Chapter 5 confirm that advisors typically rely on the vintage of the house to make their assessment. The vintage categories were selected based on the categories for housing used by the Census of Canada. The files were categorized into vintage ranges that are presented in Table 3.7.

Vintage category	Collapsed Vintage Categories
<=1920	*<=1945*
1921-1945	*1946-1960*
1946-1960	*1961-1980*
1961-1970	*1981-2010*
1971-1980	
1981-1990	
1991-2000	
2001-2010	

Table 3.7 Selected Vintage Categories for Analysis

For both research questions, it was sometimes useful to have a smaller number of vintage groups in order to reduce the amount of analysis to be done. It was initially thought that advice was given by vintage category and this affected advice overall. This was confirmed during the course of the interviews, as most home energy advisors explained that they assessed a house based on its vintage. Several advisors mentioned that the types of recommendations given depended on whether the house was built before or after the 1960s or 1970s. Another consideration in selecting the vintage groups was that some advisors in particular had small sub-sets of returnees so to subdivide these groups would have limited analysis. Hence, the reason to collapse categories was to compare similar houses, but also to minimize the number of categories to keep group sizes large enough for analyses. The energy rating scores were compared to vintage categories by box plot, and were assessed using visual analysis to collapse vintage categories with similar performance characteristics (see Appendix I for analysis). The groups were selected when the 25th and 75th percentiles of the energy ratings shown in the box plots among two vintage groups were similar. Two points are worth noting. The energy performance of houses increased gradually over the years. Also, previous renovations may have taken place that increased overlap in the distribution of energy rating scores between vintage categories. The resulting selected vintage categories were *<=1945*, *1946-1960*, *1961-1980*, *>=1981* and are shown in Table 3.7.

3.4 Use and Limitations of Dataset

Following the recommendations by Campbell and Stanley (1963), it is important to clarify how these data can be used. For example, it cannot be assumed that this dataset is a random sample of the Region of Waterloo housing population. As such, inferences cannot necessarily be made to the entire housing stock of the Region of Waterloo. Rather, household participation can be understood as self-selection in response to the stimulus of program structure and delivery. A different program structure might therefore attract a different group that self-selects in due to their preferences. For this reason, inferences pertain to this sub-population of residents of the Region of Waterloo. To explore differences and relationships within the dataset, a natural quasi-experimental interventional design was used in which location was held constant and time varied. Two dependent variables were measured in response to a changing program structure. These were the rate of participation and measures of material characteristics. Other relationships were examined through the use of bivariate tables and cross-tabulations.

A key strength of this dataset is that it was internally validated by a third party reviewer and it does not contain the weakness of self reporting as many studies do. Further, there is a breadth of types of data available, such as date, location, home energy advisor, financial reward offered and financial reward received.

One potential limitation is that, as a real world activity, REEP may have been altering its program delivery methods, such as marketing activity, over time to improve processes and outcomes for homeowners and advisors. These would also be difficult to keep track of but could have affected uptake rates and delivery. However, according to Song (2008), the program delivery method stabilized after a few years. Song's (2008) analysis of the spatial uptake of the program and marketing methods between 1999 and 2006 were taken into account in the analysis.

Another potential limitation was that the data were analysed retrospectively, in that the study was designed after the data were collected, and therefore data collection could not be influenced at the outset to improve the study design. If the study could have been designed prospectively, it would have been ideal to include more detail about the decisions measured by changes in heat loss, for example, the specific type of insulation or technique could have been included. It also would have been ideal to have more information about the occupants of the household. For example, the number of occupants, the length of occupancy, and any previous retrofits performed. The dataset also does not contain standard estimates of the cost of each recommendation that could have been used to aid the analysis. Finally, the dataset contains modeled consumption patterns based on technical characteristics and standard assumptions about occupant behaviour. Therefore, the dataset can compare the differences in energy efficiency and explain that there are differences in fuel use between houses, but levels of energy consumption and fuel use are estimates, not actual levels of energy consumption before and after the home energy evaluation(s). While all of these are potential limitations, the breadth of available data still allowed for a detailed analysis of decisions. Furthermore, other studies have been conducted through REEP to explore each type of limitation listed, and these studies can be used for triangulation.

3.5 Qualitative Data Collection

This research project focused on understanding the relative effectiveness of the home energy advisors' strategies in delivering advice to homeowners. For instance, these strategies include understanding homeowners' perceptions and motivations related to having a home energy evaluation, the advisor's rationale for selecting particular advice, and the communication strategies they used to explain advice to homeowners. Qualitative approaches are used to form a complex description of the issues being examined using induction, interpretation, and in this approach reflexivity in the researcher is encouraged (Creswell 2007; Creswell and Clark 2007). Qualitative research allows the researcher to focus on the subjective views of the participants and understand their perspectives and how they give meaning to various phenomena or events (Creswell 2007).

3.6 Sampling Strategy and Recruitment

One intent of this study was to understand the differences in strategies of advice-giving used by home energy advisors in giving advice and recommendations and, as much as possible, connect this to the measured decisions that homeowners made. Accordingly, a purposive sampling technique was used to select home energy advisors to interview. In the REEP database, it was found that 18 home energy advisors each had delivered 50[18] or more home energy evaluations for which the homeowner returned for a follow-up during a program period. For Period 4, where there were more advisors, the distribution of

[18] In the event that t-tests would be used to measure differences of means, De Veaux et al. (2008) explain that larger sample sizes that exceed a minimum of 40 or 50 are better in the case of skewed data (557).

evaluations across vintage groups was also examined, hence, an advisor with just over 50 evaluations, Advisor 16, was not invited to participate. The method of advisor selection is shown in Table 3.9. Each home energy advisor was identified in the database by their NRCan identification number. A list of 17 home energy advisors was selected as potential interviewees from this list.

Advisor Code	Evaluations in Follow-up Period				Invited?	Interview
	1	1.1	2	4		
3	13	113	212	407	y	y
8	0	0	245	379	y	n
11	0	0	77	529	y	y
14	0	0	165	375	y	n
15	0	0	0	456	y	y
9	0	0	0	419	y	y
7	0	0	0	409	Unable to Contact	n
12	0	0	0	389	y	n
4	0	0	0	343	y	y
2	0	0	0	328	y	y
5	0	0	214	0	y	n
13	0	0	0	206	y	n
1	25	117	33	0	y	y
10	12	71	91	0	Unable to Contact	n
18	0	0	0	109	Unable to Contact	n
17	8	70	7	6	y	y
6	0	0	0	84	Unable to Contact	n
19	0	0	1	76	Unable to Contact	n
16	0	0	0	52	n	n
20	3	14	0	0	n	n
21	5	5	0	0	n	n

Table 3.8 Advisor Profile and Selection for Interviews

Advisor Code	Program	Invited	Interview (y/n)	Number of Initial Evaluations by Period 1	2	3	4	Total initial	Number of Follow-Up Evaluations 1	1.1	2	4	Total follow-up
1	EnerGuide	y	y	1418	94	0	0	1512	25	117	33	0	175
2	ecoEnergy	y	y	0	0	0	400	400	0	0	0	0	328
3	EnerGuide + ecoEnergy	y	y	1198	613	31	518	2360	13	113	212	0	745
4	ecoEnergy	y	y	0	0	0	385	385	0	0	0	0	343
5	EnerGuide	y	n	0	597	4	0	601	0	0	214	1	215
6	ecoEnergy	Unable to Contact	n	0	0	0	107	107	0	0	0	0	84
7	ecoEnergy	Unable to Contact	n	0	0	0	525	525	0	0	0	0	409
8	EnerGuide + ecoEnergy	y	n	0	663	40	485	1188	0	0	245	3	627
9	ecoEnergy	y	y	0	0	0	522	522	0	0	0	0	419
10	EnerGuide	Unable to Contact	n	559	224	0	1	784	12	71	91	0	174
11	EnerGuide + ecoEnergy	y	y	1	260	117	840	1218	0	0	77	1	607
12	ecoEnergy	y	n	0	0	0	490	490	0	0	0	0	389
13	ecoEnergy	y	n	0	0	0	263	263	0	0	0	0	206
14	EnerGuide + ecoEnergy	y	n	2	449	38	513	1002	0	0	165	2	542
15	ecoEnergy	y	y	0	0	0	571	571	0	0	0	0	456
16	ecoEnergy	n	n	0	0	0	72	72	0	0	0	0	52
17	EnerGuide	y	y	777	15	0	9	801	8	70	7	0	91
18	ecoEnergy	Unable to Contact	n	0	0	0	142	142	0	0	0	0	109
19	ecoEnergy	Unable to Contact	n	0	1	0	98	99	0	0	1	0	77
20	NA	n	n	195	0	0	0	195	3	14	0	0	17
21	NA	n	n	87	0	0	0	87	5	5	0	0	10

Table 3.9 Advisor Profile and Selection for Interviews

Due to Canadian privacy provisions, the home energy advisors could not be contacted directly by the researcher. The list of 17 NRCan identification numbers was sent to the Executive Director of REEP who contacted 12[19] of these home energy advisors on behalf of the researcher by email. At the request of one home energy advisor, REEP offered one hour of pay to the seven advisors who were at the time employed with REEP for participation in the interview. This email was followed by a recruitment phone call from the researcher's supervisor, who held the dual role of Chair of REEP's board of directors as well as primary investigator in the research project. In this dual role, he could both obtain access to personal information of current and former employees, but also guarantee anonymity to the participants and answer their questions prior to their agreement to participate. Nine advisors were scheduled for an interview, and eight participated in an interview, seven in person, and one by gtalk due to geographic location. Collectively, these eight advisors performed 7,769 initial evaluations of which 3,164 had returned for follow-up evaluations. These account for more than half of the total initial and follow-up evaluations delivered by REEP in the time period of the study. In order to gain an understanding of the assignment of the home energy advisors to evaluations, three schedulers were contacted through REEP, and two participated in interviews. The letters of recruitment and scheduler interviews are contained in Appendix C, Appendix D, Appendix G and Appendix H.

Given the small pool of participants and the geographic proximity to the Elora Centre for Environmental Excellence, a decision was made to strengthen the qualitative data collection by inviting advisors with a minimum of one year of experience from the Elora Centre for Environmental Excellence to participate in the study. The Executive Director invited 12 advisors to participate. Four agreed to participate in an interview, one by Skype and three by telephone call[20].

Particularly in the case of exploring for differences between advice strategies, an ideal sampling strategy would seek contrast through deviation and extreme cases (Teddlie and Yu, 2007). That is, the researcher would analyse patterns of advice-giving in the dataset to first look for maximum variation by examining for advisors who consistently gave many recommendations of large depth, or those who consistently gave few recommendations with low depth. However, due to practical considerations in recruiting the home energy advisors for interviews and the convergent design approach, deviations in the purposive sample were not known at the time of recruitment. Instead, as it will be seen, deviations and differences between advisor strategies and outcomes were accounted for in the analytical stage. Further, although they could not be directly compared to REEP data, the interviews with the four advisors from

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[19] REEP was no longer in contact with five of the listed home energy advisors.

[20] This was mainly due to geographic location as they were all located more than one hour drive away from the Region of Waterloo.

the Elora Centre for Environmental Excellence contributed to a more holistic assessment of the heterogeneity across advice-giving. Sample letters of recruitment are included in Appendices C and D.

3.6.1 Developing the Interview Instrument

The primary instrument of data gathering for the qualitative analysis was a semi-structured interview instrument that was developed with a focus on understanding how the home energy advisor selected and communicated their advice to the homeowners. The interview was initially aimed at uncovering differences in advice-giving strategies and perceptions about homeowner motivations. However, the interviews provided two types of information: on the one hand, home energy advisors were expert observers of homeowner decisions and many elements of the context in which the decisions were made, on the other hand, the advisors can explain their discretion in selecting and delivering advice.

In developing an interview instrument, Berg (2001) recommends that the interviewer first outline the major themes or issues of an interview and the instrument be pretested and refined using several practice interviews to confirm whether it can obtain the information it is seeking. The interview schedule was developed after the researcher accompanied an advisor on a home energy evaluation and followed one tour of the REEP House in Kitchener. The REEP House is a showcase of design and technology to improve a house’s energy performance, and the tour offers a better understanding of the process of a home energy evaluation, the technologies that might be recommended, and how a home energy advisor might relate to homeowners and the public. The interview questions appear in Appendix E. The five main categories covered in the interview were (1) the advisor`s background and motivations for advising; (2) the process of a home energy evaluation; (3) advice selection and communication; (4) elements of success in home energy evaluations; and (5) wrap up. These closely followed the themes identified in the literature review. One theme was of visibility of energy in the home. Another identified theme was the variety of motivations to undertake home energy retrofits, such as learning, comfort, environmental, health, financial rewards, and economic. Another identified theme was the aspects of communicating recommendations to the homeowner, such as credibility of the messenger, framing of messages, commitment, and learning (increase procedural knowledge). To obtain a more direct comparison to the information contained in the quantitative database, some questions focused on number, type and depth of recommendations. For example, one question addressed depth by asking the advisor to describe a single improvement that would typically most increase the overall energy performance of the house. Advisors were also asked to explain how they selected their recommendations, to outline the factors that affected these selections, and how they prioritized their advice to homeowners.

Berg (2001) recommends making use of the four question types: essential questions, probing questions, throw-away questions and extra questions. Essential questions focus on the central concern of the study, extra questions are worded slightly differently to validate responses to essential questions, probing questions are used to draw out more information or focus a response, and throw away questions are used to relax the participant or refocus their attention. The interview schedule made use of the four main question styles. For each major theme or section, an open ended question that focused on process[21] ("how?") was followed with planned probes[22] or closed-ended questions[23] that were sometimes used in order to direct attention to specific themes presented by the literature. The advisors were generally asked to elaborate on their responses. Essential questions were followed by extra questions that were planned to validate or expand on the response given to essential questions[24]. Some of the extra questions were designed to understand how the advisor prioritized recommendations[25]. Long and complex questions should normally be avoided (Berg 2001); however, some were used in the study in order to elaborate on some themes. In these cases, the advisor was offered the question printed in large letters. For example, two structured questions asked the participant to rate items[26] and were included for the purpose of touching on important themes that arose when the researcher observed a home energy evaluation and the tour of the REEP House, and themes from the literature. In this case, advisors were offered the opportunity to circle their ratings, and then to discuss their rating. One of these questions assessed the advisor's perceptions of the homeowners' motivations. The other question assessed the advisor's own motivations. These ratings were compared for advisors' perceptions of the differences in motivation between themselves and homeowners. In the other case, in order to understand how advisors frame information or their recommendations to homeowners when communicating, each advisor was shown eight quotes[27] (in large font on paper) and asked if they would say something similar. If they did not, they were then prompted to give their own statements. The four types of statements were loss framed, gain framed, about "super-conservers", and vivid, and two quotes were presented per statement type.

The information obtained through discussion was transcribed and coded. The interview instrument was then edited and revised with the researcher's supervisor. The interview was practiced four times. One was with a former intern at REEP whose duties included accompanying a home energy advisor on home energy evaluations during the first EnerGuide for Houses program. A second was conducted with a doctoral candidate who was studying energy decisions who had worked as a data analyst at REEP. A third

[21] Examples of open ended and process oriented questions are interview questions 3, 5, 7, 8.
[22] Examples of planned probes are questions 2.1, 6, 6.1, 7.1.
[23] Examples of closed-ended questions are 6.2, 7.2, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7.
[24] Questions 6.1, 9, 9.1, 9.2, 9.3, 9.4 can be considered extra questions used to validate findings.
[25] These questions are 7.1, 7.3, 8.1, and 8.8.
[26] Questions 6.2 and 8.2.
[27] Questions 8.4, 8.5, 8.6, and 8.7.

was conducted with a master's student who was studying homeowner energy decisions. The last was conducted with the expert trainer for the Green Communities Canada's training program for home energy advisors, who had trained the home energy advisors. These interviews gave insights that prompted edits to the sequence and wording of questions. For example, these practice interviews revealed that it would be better to offer two statements of each type of message so that a participant would not focus on the content (e.g., the furnace, or the chimney) but on the wording of the statement.

A second set of interviews was also conducted with the schedulers at REEP. These interviews focused on understanding the assignment of REEP's home energy advisors to different types of situations and a rationale for these assignments. These were used to validate findings and understand differences between the communities that the advisors served.

The interviews were transcribed, and a summary of the transcript was sent to participants so that they could confirm the accuracy of the conversation and to add or clarify any points.

3.6.2 Qualitative Data Analysis

In order to achieve a detailed understanding of the issues being examined and to give voice to subjective viewpoints, qualitative research experts typically describe the coding process as iterative or spiraling. Researchers immerse themselves in the documents to first code, then identify and reduce codes to examine evident patterns. These patterns can be similarities and dissimilarities, and how they are related. This allows findings to "emerge" from the data (Berg 2001; Creswell 2007). However, qualitative researchers can also use what Creswell (2007) terms "prefigured categories" and Berg (2001) calls "sociological constructs"; categories that are considered and laid out during the research design, and "are based on a combination of the researcher's scholarly knowledge and knowledge of the substantive field under study."(Strauss, 1987: 34 in Berg 2001: 244). According to Berg, qualitative researchers do not need to limit themselves only to induction: deductive reasoning is also useful. In fact, Berg summarizes that novice researchers keep in mind these four basic guidelines derived from Strauss (1987):

> (1) ask the data a specific and consistent set of questions, (2) analyze the data minutely, (3) frequently interrupt the coding to write a theoretical note, and (4) never assume the analytic relevance of any traditional variable such as age, sex, social class, and so forth until the data show it to be relevant. (251)

In this research, while remaining open to emergent findings from the data, the focus of the coding process was to understand the broader issue of how advisors select improvements, prioritize them, and deliver advice to homeowners. Some of the sub-questions stemming from this include: what does the advisor believe is the purpose of a home energy evaluation? For example, is it a chance to educate, to convince and persuade, or to give neutral "scientific" information? What kind of information are advisors giving? What motivates the advisor? How do advisors perceive what motivates homeowners? For this reason, coding began with six major categories designed to complement the quantitative analysis. In fact, one emergent category that was identified during the interviewing and transcribing phases was the acknowledgement of the home energy advisor as an expert on the activity that occurred during the four policy periods: these observations were intimately intertwined with their perceptions about the process of an evaluation and homeowner motivations. For this reason, the original research design for the first research question was adapted. The option taken was to use a convergent mixed methods research design with independent strands. This allowed for triangulation of results and achieved complementarity between the data sets by allowing the qualitative data to enhance, illustrate and clarify the quantitative results for both major research questions.

Nvivo software was used for coding. The focus of coding of the transcriptions of interviews was:

a) to document the advisor's professional background and personal or professional motivations/philosophies to deliver home energy evaluations;

b) to understand the advisor's perceptions of homeowners level of knowledge, motivations and decisions;

c) to understand the importance and prioritization of each type of improvement with respect to the improvement of the home's energy performance;

d) to understand how recommendations were selected and the rationale for prioritization;

e) to understand the advisor's pattern of communication and engagement with the homeowner, such as, the level of homeowner participation encouraged, their style of communicating problems and solutions to homeowners, and how they overcome communication barriers (such as the use of dissuasion); and

f) to understand some of the perceived barriers associated with the program's structure in impacting energy usage in homes.

3.7 Other Sources of Data

Others sources of data allowed for the results of the previous analysis to be triangulated. Other studies that were described in Chapter 2 have examined homeowner motivations decisions within the context of REEP's delivery of EnerGuide for Houses and ecoEnergy programs, as well as analysis of EnerGuide for Houses program itself. These analyses can be compared to the first research question about the impacts of various program structures. Studies that yielded insights into home energy advisors' roles and effectiveness were also collected to be compared to the findings of the second research question regarding the effectiveness of advice strategies.

3.8 Merging the Strands

3.8.1 Research Question 1

The first research question focused on the impact of the program structure on participation and advice-following, and the results are presented in Chapter 4. The focus for this section of the research was on the quantitative analysis, and this was related to the qualitative data and secondary sources in the interpretation stage in Chapter 6. The first step of the quantitative analysis was to assign data to program periods following the method for sorting data that was previously described. The EnerGuide for Houses and ecoEnergy programs had different financial reward structures and an analysis to obtain a more direct comparison between the financial reward amounts was performed. As the purpose was to understand the effects of the reward structure on participation, the next step was to determine participation by program period. After participation was determined, the analysis turned to understanding the recommendations and achievements by program period. This included analyses of the levels of achievement compared to recommendations, and the effects of number and time of recommendations. The steps of the quantitative analysis are summarized in Table 3.10.

In order to appreciate the extent to which each group was representative of the population of the Region of Waterloo, percentages of binned vintages were compared between each group and the Region of Waterloo. All groups were compared to data derived from the 2006 Census of Canada[28]. Participation by city or township was also compared to Census data.

[28] 2011 Census of Canada data will not be available until September 2012, and the 2001 data was only available by special request. The 2006 data had already been requested and analysed.

1. Assign data to program period
2. Examine representativeness of each program period compared to the population of the Region of Waterloo
3. Program structure: Compare financial rewards to the recommended improvement in energy rating score for Periods 2 and 4.
4. Examining uptake by period.
    a) Natural quasi-experimental intervention: assess for differences in participation across periods
        i. Total participation, and by characteristics such as vintage, energy rating, total energy consumption, or improvements
    b) Is the group of returnees representative of the initial population by period? (or, differences between follow-up and non-follow-up with respect to vintage, technical characteristics, and recommendations.)
    c) Examine by initial and follow-up cost of evaluation.
5. Recommended and achieved measures and financial rewards by vintage by period
    a) Establish that energy characteristics vary by vintage
    b) Overall counts of recommendations and follow-up by period
        c) Depth of retrofit achieved compared to recommended (include estimated and received financial reward amount and total energy consumption and greenhouse gas emissions), and implementation of retrofits not recommended by type of improvements
6. Number achieved. Examine for relationship between:
    a) Success: number achieved and energy savings
    b) Time between evaluations
        i. number achieved in time
        ii. Type achieved in time
    c) Time limit and trade-offs
        i. number recommended and participation in follow-up
        ii. number recommended and number achieved
    d) Type of decision made compared to
        i. Number of improvements
        ii. Time between evaluations

Table 3.10 Summary of Quantitative Analysis for Research Question 1

The purpose of this research was to understand the importance of program structure as it affects pro-environmental behaviour. For each period that offered a financial reward, the homeowner was given an estimate of the reward they would receive based on the recommendations in the report. To understand the differences between the program structures in Periods 2 and 4, the first step was to compare the financial rewards that were offered during these periods, as the calculations of the reward in each period were based on different outcomes and therefore had different structures. In Period 2, the reward was based on the improvement in the house's energy performance that was calculated by the improvement in the energy rating score of a house. To qualify for a financial reward in Period 2, a house had to improve their energy rating score to a minimum of 60 points and with a minimum of a three point improvement. Points were awarded a financial reward for a minimum initial threshold of 40 points. For example, if a house had an energy rating score of 29 in the initial evaluation, and achieved 62 points in the follow-up evaluation, the financial reward was based on the improvement of 40 to 62 points. Further, the reward paid per point increased as the initial and follow-up scores increased. Hence, a house that improved their energy rating from 70 to 75 would receive a larger financial reward than a house that improved their score from 55 to 60. In Period 4, a financial reward was specified for each type of retrofit decision made. Hence, the homeowner knew the dollar amount associated with replacing their natural gas furnace, which was different than the reward associated with replacing their hot water heater. This rendered a direct comparison difficult. For example, a participant could take an action in Period 2 and not achieve the minimum score of 60 required to receive the financial reward, while the same action in Period 4 would earn a financial reward. The financial rewards could have been compared in two ways. One option was to estimate the change in energy rating score associated with specific improvements for both Periods 2 and 4. The second option was to compare the recommended incentive to the recommended improvement in the energy rating score for the two program periods. The first method was deemed too time consuming, and would not have yielded a better comparison. The second method was selected. First, a scatter plot was produced to compare the recommended change in energy rating compared to the recommended financial reward. Second, two sets of box plots were produced, one for the recommended energy rating score and the other for the recommended incentive. The graphs illustrated whether the differently structured financial rewards were greatly different in amount of money offered per unit of improvement in the energy rating score.

The next analysis was to use a natural quasi-experimental intervention design to examine for differences in participation and material context of participants under each program period. Weekly participation rates were compared for differences between the initial groups and between the follow-up groups. This was supplemented by an analysis of the percentage of participants who had had an initial evaluation and who returned for a follow-up evaluation for each period. A further refinement to understanding the impact of program structure was to conduct a natural quasi-experimental intervention to examine some uptake parameters within periods by the variation in initial and follow-up evaluation price. For this analysis, the price ranges were selected depending on the prices and the size of the group at each price.

The natural quasi-experimental intervention design was further applied to examine whether the program appealed to the general population or if it appealed to subsets of the population with particular characteristics. This was done by comparing the distribution of various material characteristics and recommendations between groups that had an initial evaluation. Differences in distribution of material context would be an indication that the different program structures were attractive to different types of problems. For example, if higher energy consuming houses were present in one group, this could be an indication that the program appealed most to those with very inefficient houses, or “low-hanging fruit”.

The natural quasi-experimental intervention was also applied to assess for reasons why some households returned for a follow-up and some did not within each program period. Analyses of differences in distribution of material context were conducted within program structures by comparing the means of a particular material characteristic between initial-only groups and follow-up groups. This would help identify if particular sub-groups of recommendations or material context returned for a follow-up, and indicate some motivations and perceptions about options that the homeowners found to be more or less attractive in the Region of Waterloo. For example, if a recommendation for a furnace replacement and change to the furnace was more prevalent in the follow-up group compared to initial, it would be understood that furnaces, for whatever reason, were an attractive option for homeowners under that program structure. This would be more interesting if other options were generally ignored, showing a general consumer preference for one decision over another.

In the case of all comparisons, the null hypothesis was that the different program structures did not attract different levels of participation or different types of households, meaning that the program structure did not have an effect on self-selection into the programs. This would be shown by a lack of difference in means amongst the four periods. The alternate hypothesis was that the programs did attract different levels of participation or different types of households, which would be shown by differences of means amongst the four periods. However, as the program structures are made up of a group of variables, there are no expectations regarding how the levels of participation or types of material characteristics may vary. These analyses to detect differences between groups were conducted using SPSS. The Levene's test (F-test) was used to check for equality of variances between the groups. If the variances were equal, then the one-way Analysis of Variance (ANOVA) test was used to compare means between groups. The one-way ANOVA compares the variance between the group means with the variance within the groups. As such, it tests the hypothesis that each group is drawn from the same underlying probability distribution and has the same mean. The alternative hypothesis is that the underlying probability distributions are not the same for all groups and that the means are different. If the Levene's test proved significant, then Welch and Brown-Forsythe tests were used to test for equality of means amongst groups. If the ANOVA or the Welch or Brown-Forsythe tests showed that the means of the groups were not the same, then post-hoc tests were included in the analyses to check for differences between sets of (two) means. If the variances were unequal (by Levene's test), then the Tamhane's post-hoc tests, a t-test[29] for unequal variances, was used. If variances were equal, then the Bonferroni post-hoc test, a t-test for equal variances, was used. All tests were conducted to 0.05 significance. As needed, these are supplemented by graphics for illustration.

[29] T-model compensates for variability in the sample's distribution (de Veaux et al. 2010: 555).

The analysis then turned to describing recommendations and achievement by program period. First, each type of recommendation was counted by vintage group. A bivariate table that describes the counts of each recommendation within periods was produced. This table also describes the percentage of the group to which each recommendation was recommended to. A graph was also produced to illustrate the same data. The chart and table describe differences in rates of recommendation by vintage within periods.

This was followed with an analysis of the counts of each type of decision made within periods. A summary of advice-following is presented as counts of categories that described the extent to which homeowners followed advice in each period are presented in Marimekko charts. Marimekko charts display the column width as proportional to the different group sizes, and the height shows the percentage of each type of response within groups. Hence, a comparison of areas within the charts demonstrates relative impact by program. The advice-following types are described in Table 3.6.

Following this, a series of analyses were performed that examined recommendations and decisions by number and type of improvement in time. There were two objectives behind these analyses. One was to understand which improvements homeowners had made over time, and whether more improvements were achieved in a longer timeframe between evaluations than with a shorter timeframe. Furthermore, homeowners were only eligible for a financial reward if they returned within18 months for a follow-up evaluation (but this was not as strongly enforced for Period 1.1 and Period 2). The time limit may have forced trade-off decisions. Hence, these analyses were used to better illustrate the process-based view and the nature of trade-offs between retrofit decisions by describing how decisions were made in time. Analyses were performed to illustrate the prioritization of different retrofits in time, to determine whether the elapsed time between evaluations was associated with the number of improvements made, and whether the number of recommendations given may have influenced decisions. Furthermore, analyses were performed to examine whether the number of recommendations was associated with the rate of participation in the follow-up evaluation, or the number of improvements made.

Prior to explaining these analyses, it is worth noting that the literature review explained that homeowners are not necessarily aware of how much energy each improvement might make. These analyses are meant to better understand the consumer decision making process and are therefore described in this section as number and type. However, in order to confirm the utility of an improvement, a bivariate table compared the mean and median improvement in energy rating by number of changes made.

Part of elaborating on the process-based view was to analyse the effects of time. Using the dates of the evaluations, the time that had elapsed between evaluations was calculated and binned into eight categories that are presented in Table 3.11. To examine for a relationship between elapsed time and the mean and median number of improvements made, a bivariate table was constructed. Another bivariate table was produced to compare the proportion of the different types of improvements made within each time frame. This was done to understand the extent to which time might be a factor in performing different types of improvements. Each table was constructed by period in order to examine for differences in effects of program structure.

<=1 month
1 to 3 months
3 to 6 months
6 to 9 months
9 to 12 months
12 to 15 months
15 to 18 months
> 18 months

Table 3.11 Categories of Elapsed Time between Evaluations

The effect of the number of recommendations on decision making patterns was examined using two analyses. A bivariate table compared the percentage of homeowners who returned for a follow-up by the number of recommendations made. This was done to examine for effects of breadth of recommendations on motivation to continue with the program and to see whether, as predicted by prospect theory, too many options deter homeowners from returning for a follow-up evaluation. Another bivariate table was constructed to compare the mean and median number of improvements made to the number of recommendations given. This was done to see if a higher number of recommendations were associated with a higher number of actions taken. Again, this was done to see if a higher number of recommendations encourages or deters action taken. The third analysis was the construction of a cross-tabulation that compared the count of the type of decision by category to the number of decisions taken. This would explain the order and combinations by which retrofit decisions were made within the group under analysis. This analysis combined with the analysis of timing of type of decisions would explain decision making in terms of typical first and second decisions or typical groupings of decisions, and how these impact timeframe. This also contributes to the process-based view by adding empirical evidence that may help to explain whether barriers are different for different types of improvements. Each table was constructed by period in order to examine for differences in effects of program structure.

A finding of Hoicka and Parker (2011) was that a high level of success (90% to >100% total recommended energy savings achieved) was associated with implementing improvements that were not recommended. Darby (2006) found that homeowners who were already engaged in renovations tended to do more energy efficiency renovations than others. Furthermore, homeowners who had more procedural knowledge also did more renovations. This research attempts to follow up on these findings by analysing for incongruence in action taken by homeowners compared to the advice given to them. While it is unclear what the causes of any incongruence might be, one possibility is that it is an indication of different information search patterns as homeowners gain procedural knowledge. While the dataset cannot account for all patterns of incongruence, four groupings were possible. Table 3.6 describes categories of advice-following that were used in this analysis. Using these categories, each homeowner was grouped into one of four categories of advice following. These were (1) homeowners who limited the changes made to a subset of the recommended improvements; (2) homeowners who made at least one improvement that had not originally been recommended to do at all ("*not recommended and changed*"); (3) homeowners who made improvements that were different than recommended ("*different than recommended*") (4) homeowners who did a combination of implementing an improvement not initially recommended at all and implementing an improvement different than recommended ("*not recommended and changed*" and "*different than recommended*"). A bivariate table was constructed to compare the mean and median number of improvements made by each group. Another bivariate table was constructed that categorized the participants of each group by elapsed time between evaluations. Due to sample sizes, this is one case where analysis was not conducted across periods.

3.8.2 Qualitative Analysis

The qualitative data analysis was done concurrently and was combined with results from the quantitative analysis in the interpretation stage in Chapter 6. The qualitative data analysis focused on the following interview themes:

b) to understand the advisor's perceptions of homeowners' level of knowledge, motivations and decisions;

c) to understand the importance and prioritization of each type of improvement with respect to the improvement of the house's energy performance; and

f) to understand some of the perceived barriers associated with the program's structure in impacting energy usage in homes.

In order to produce robustness in findings, differences were looked for in b) and similarities were looked for in c) and f). The rationale was to find commonalities in observations about homeowners despite differences in personal philosophies and knowledge among home energy advisors.

3.8.3 Research Question 2

The second research question focused on advice-giving and how it affected advice-following. The qualitative analysis focused on finding differences in the advice-giving strategies or styles of the different advisors. The quantitative analysis described the depth, type, and number of recommendations and achievements of homeowners by advisor. As described in Figure 3.3, the strands were combined interactively within the analytical stage. The findings from the analytical stage were then compared to secondary studies during the interpretation stage that is presented in the discussion.

To understand various parts of the advice-giving process, the qualitative analysis for this section of the research focused on three key areas of findings from the interviews. These were:

a) to document factors related to understanding the advisor's professional background, professional motivations and philosophies relevant to deliver the home energy evaluations;
b) to understand their rationale for selection and prioritization of recommendations; and
c) to understand the advisor's pattern of communication and engagement with the homeowner.

The importance of the advisor's professional background and personal or professional motivations or philosophies to deliver home energy evaluations are threefold. First, these can relate to some components of credibility in terms of message delivery. However, this is not likely to be useful without homeowner perceptions. Second, advisors' professional backgrounds, personal philosophies and motivations can be compared and contrasted with their rationale for advice selection and delivery to examine for consistencies and inconsistencies. For example, do they formulate scientific or behaviourist approaches to delivering messages? Third, rigour in research can be found if similar opinions on advice selection and prioritization converge when there are divergent philosophies.

To examine the component related to understanding personal philosophies and motivations, it proved useful to code and visually map the most frequent and important of advisors motivations. For this particular section, iterative coding, cross-comparisons between codes, examination for the most frequent codes, and re-reading of key sections of transcripts was employed in order to allow the underlying issues to emerge from the data, grounded in the advisor's own words in order to illustrate the complexity of what appeared to be a core, underlying issue.

One area of interest was to examine for cohesiveness of advisor knowledge about the role and importance of each of the eight decisions in question in relation to the house's energy performance. The purpose of this stage of analysis was to understand the nuances in knowledge of the eight decisions, and the relative importance of each decision as defined by the group. Prefigured categories that represented each decision were employed as a coding strategy for this stage in analysis. The objective of this stage of the coding was to examine for agreement and disagreement about each of the eight decisions. Another objective was to understand the relationships between any of the decisions. For example, if it was common knowledge that one decision always preceded another decision.

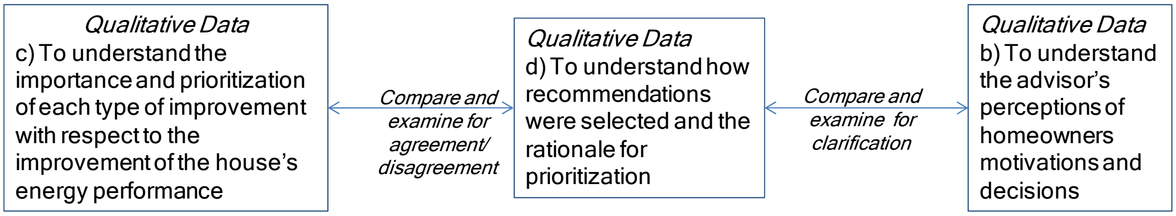


Figure 3.4 Analysis by Advisor: Understanding Prioritization and Selection of Advice

The next step in understanding advice strategies was to review the transcripts to develop an understanding of the process of advice-giving. The first stage of coding focused on the involvement of the homeowner during the evaluation and the pattern of communicating advice to homeowners. This portion of the analysis took a more holistic approach where the main interest was to compare for differences amongst advisors. The first step in this analysis was to outline all of the potential stages of involvement of homeowners in the process. The next step was to document the stages in the process of the evaluation when advisors involved homeowners and the rationale behind this decision. Visual mapping was used to clarify the stages and to compare the process amongst advisors. This section of the analysis gave insights into the delivery of procedural knowledge and how vivid information may have been built into the process and affected communication between the advisor and the homeowner.

The qualitative approach to searching for difference in advice strategies may be understood as grounded in the search and documentation of the data, and may be understood as somewhat in contrast to the criteria of saturation that is typically used in grounded theory approaches. Some qualitative researchers are concerned with issues of inter- or intra-interviewer or inter- or intra-coder variability[30] (e.g., Knox and Burkard 2009), and this concern may arise in response to the situation when a researcher codes for difference, such as the differences in advice strategies in this research. In which case, the questions that might be asked would be: could the inter- or intra-interviewer or the inter- or intra-coder variability be responsible for what appears to be different strategies of advice? However, as the purpose of qualitative research is the formation of complex descriptions and interpretations in order to give meaning to phenomena and events (Creswell 2007), qualitative researchers generally agree that the most important criteria for qualitative research is that it show evidence of being grounded in the collected data. One way of interpreting this is to understand the goals of rigorous qualitative research as credibility, transferability, dependability and confirmability (Lincoln and Guba cited in Finlay 2006). These potential concerns are therefore addressed by grounding the search for difference in process with a thorough search and documentation of the data collected. Furthermore, variation was also examined conservatively by not

[30] These concerns seem to arise most often in medical and nursing studies and are reflective of concerns in quantitative methods.

conflating omissions with statements or positions, and by limiting questions of difference between advisors to subjects where it was appropriate.

The next stage of the analysis also related to understanding communication between advisors and homeowners. This stage examined advisors' reactions to the eight statements of four types of messages. This stage of analysis revealed whether advisors were familiar with loss, gain, normative (super conserver), or vivid (salient) messaging. Related to this, this portion of coding described whether they incorporated any of these into their style or used other forms of messages. The responses were compared for differences among the advisors. Tables were used to describe and compare reactions for each message type.

The next step was to examine, for each advisor independently, for consistencies and inconsistencies between the advisor's motivations, their knowledge of homeowners, their knowledge of technical aspects, and how they selected and prioritized recommendations. This was done to explain some of the complexities that advisors face when determining advice and to identify any simplifying rules they may have followed. These three components examined together were defined as the prioritization and selection component of the advice strategy. This portion of the analysis was directly compared to the quantitative analysis of the type, number, and depth of recommendations with the purpose of identifying consistencies and self-contradictions. For the comparison between the strands, a deductive approach was taken, where, for example, qualitative data about windows and doors was compared with quantitative analysis of recommendations and improvements of windows and doors.

It should be noted that at this stage of the process, an understanding of the cohesion of perceptions of homeowners by the advisors had emerged. This information was compared to the results for the first research question in the interpretation stage. In order to understand the holistic recommendations of the advisors, analyses were performed to examine the depth of advice given by each advisor. At this stage, the relative share of number of changes recommended by advisor was analysed. Further, the initial and recommended energy rating scores were categorized (*<60*, *60-69*, *70-74*, *75-79*, *80-84*, *84-89*, *>90*) and compared by cross-tabulation. The cross-tabulation showed the depth of recommendations compared to differentiated starting points. These were also compared to advisors' motivations, philosophies, technical knowledge, and knowledge of homeowners.

The focus of the analysis shifted towards understanding the impact associated with each advisor. The impact was examined in three ways. First, Marimekko charts were produced for each of the eight decisions. The charts explained how well homeowners followed the advice given to them. The method used to produce the charts was the same as described for the first research question. A second method to analyse impact was to examine the relative share of number of changes made by advisor. Third, the energy rating scores associated with the initial and follow-up evaluations were categorized (*<60*, *60-69*, *70-74*, *75-79*, *80-84*, *84-89*, *>90*) and compared by cross-tabulation. The cross-tabulation showed the depth of change compared to differentiated starting points.

The portion of quantitative analysis that examined impact was compared to a holistic view of the advisor's strategy of advice-giving. This holistic view considered the process of a home energy evaluation, the perceived purpose and variations in delivery. This portion of analysis took an iterative approach. The quantitative results were examined for differences and similarities and for each difference or similarity, the qualitative data were examined for differences or similarities, and vice versa. This was done in order to pinpoint for the elements of effectiveness in advice-giving strategies on advice-following.

Overall, the analysis performed in response to the second research question offers many findings. These include a better understanding of process of a home energy evaluation, the perceived purpose and variations in delivery. The analysis may lead to a more thorough understanding about specific types of decisions being made and the tensions in communication and recommending these.

3.9 Interpretation

The interpretation stage for each research question is presented in Chapter 6. The quantitative results stemming from the first research question were compared to some results from the second research question. Further, the results from both research questions were compared to each other and to findings from other studies. Interpreting the results jointly yielded insights into the possibility that program structure affected advice-giving. Furthermore, the decisions made by homeowners were compared to previous literature, for example, surveys on homeowner motivations. This was done to lead to a better understanding of the homeowner's decision making models, motivations and perceptions.

3.10 Summary

To summarize, the research question focused on a process-based understanding of a pro-environmental behaviour. This approach led to the use of an integrated approach as a framework for analysis that allowed for the inclusion of a variety of perspectives and disciplines in developing the research question and designing the methodology. Further, the relationship between the University of Waterloo and REEP facilitated the collection of a unique combination of data. REEP's quantitative dataset that described the pro-environmental decision in question contained a variety of factors that allowed for a rich description of the advice given and advice-following. REEP facilitated the collection of a strand of qualitative data. This strand consisted of interviews with eight of REEPs home energy advisors who had delivered more than half of the evaluations that were analysed in the dataset. Due to the selected framework for analysis and the ability to collect both qualitative and quantitative data on the same topic, a convergent mixed methods research design was selected. This design was the best approach to examine the impact of program structure and advice-giving on the different stages of the pro-environmental behaviour of participating in a home energy evaluation program.

Several critical choices were made in designing the methodology. These include choices made about the selection and comparison of strands, and choices made about how to analyse data in each of the qualitative and quantitative strands.

The critical choices made about the strands are as follows. The first choice was to collect a third strand of data that consisted of secondary studies conducted about REEP and about the EnerGuide for Houses program. The second choice was to select the point at which to merge the strands. For the first research question that addressed the impact of program structure, the three strands were merged at the interpretation stage. For the second research question that addressed the impact of advice-giving, the qualitative and quantitative strands were merged at the analysis stage. This merging at the analysis stage was treated in a manner similar to the coding process. It was iterative and spiraling, and it examined for similarities, differences and contradictions between elements of the qualitative and quantitative strands. Specific decisions were compared deductively by matching information about each decision. The advice strategy defined as a holistic process was compared to the measures of overall depth and number of decisions. This analysis was merged with the secondary studies strand at the interpretation stage.

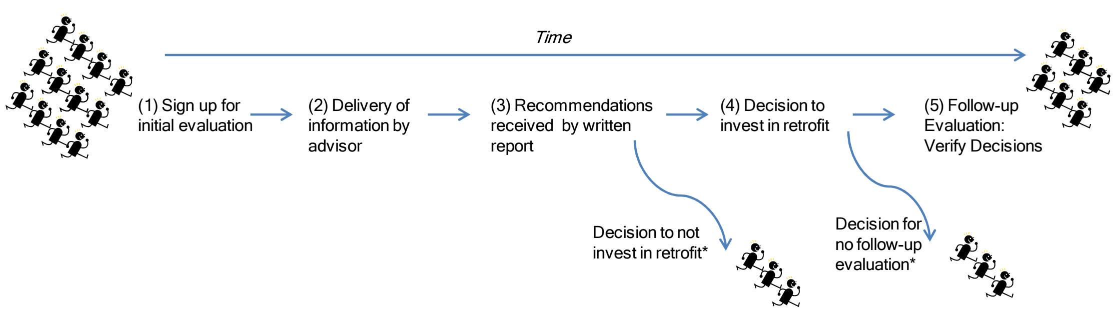
Several key choices were made to analyse the qualitative strand. The first was the inclusion of interviews with four advisors from the Elora Centre for Environmental Excellence that contributed to a more holistic assessment of the heterogeneity across advice-giving. The second was the decision to code both for emergent findings and to use prefigured categories, depending on the topic of analysis. The qualitative coding process was focused on examining for agreement and disagreement amongst advisors about specific retrofits. The coding process was used to search for difference and similarity of each of the process delivery and message communication amongst advisors. The coding process was used to analyse for contradictions in the advice-giving rationale and knowledge of each advisor.

Several key choices were made in the analysis of the quantitative strand. The first choice was to assign evaluation files by program period. The next was to employ a natural quasi-experimental intervention to examine for difference in responses to the four program structures that varied in time. The next was to make subgroups of analysis by vintage, and to analyse recommendations and decisions by these groupings. Advice-following was analysed as the extent to which decisions followed recommendations measured as a percentage. Finally, to expand on a process-based perspective, bivariate tables and cross-tabulations were constructed to analyse for the impacts of number of recommendations, elapsed time between evaluations, combinations and congruence of advice following on decisions taken.

Chapter 4
Effects of Program Structure

The objective of this research was to analyse factors that affect pro-environmental behaviour in order to address the broader challenge of how to design programs and policies that more effectively influence sustainable behaviour. One factor that this study examined was the effect of the program structure on the pro-environmental behaviour of participating in a home energy evaluation program. This chapter summarizes and interprets results from an analysis of the REEP dataset that focused on the research question: where program structure was defined as the combination of the price of the evaluation, the financial reward structure, the level of government support, and the focus on influencing eight specific decisions within a specified timeframe, how did program structure affect participation, advice-giving, and advice-following?

The literature review that was presented in Chapter 2 identified several areas of investigation to which contributions to knowledge can be made. One identified area was to experiment to find heterogeneity of preferences within populations. Another was to be specific about the set of decisions under analysis. Another was to help clarify how financial reward structures and other program parameters affect participation. This research examined advice-giving and the factors that affect participation in a 12-year home energy retrofit program.



***Measurements only from initial evaluation**

Figure 4.1 Decisions in a Home Energy Retrofit Program

In this study, participation in a home energy retrofit program comprises a five-step process for the homeowner. This process is described in Figure 4.1. First was the decision to participate in an initial home energy evaluation. Second was in the exposure to information and potential learning that occurred as a result of interaction with the home energy advisor. Third was the exposure to information and potential learning that occurred as a result of receiving the report. Fourth was the decision to invest in a home energy improvement. Fifth was the decision to have a follow-up home energy evaluation and measure retrofit decisions.

As described in Chapter 1, the general objective related to the first research question was to examine the variations in participation rates, material characteristics, and advice-following in response to variations in program structure. There were five sub-objectives related to this research question.

- The first sub-objective was to identify the differences in program structure between the four program periods in order to articulate the context of the natural quasi-experimental intervention. This included a description of the price of the evaluation, the structure and level of the financial reward, and the level of government support. This facilitated the second sub-objective.
- The second sub-objective was to examine for heterogeneity of preferences in the Region of Waterloo. More specifically, different subsets of the populations that have different material characteristics might be attracted to participate in the initial evaluation of the program. The houses that exhibit the preference of returning for a follow-up evaluation under each program period might also have different material characteristics and a different set of recommendations than the population of initial evaluations from which they originated. The research seeks to understand whether and how the different program structures appealed to different material concerns of participants. This sub-objective is concerned with why some households came for an initial evaluation and then returned for a follow-up and some did not.
- The third sub-objective was to understand how the recommendations varied under each program structure. This sub-objective required the description of recommendations for each type of decision under each program structure.
- The fourth sub-objective was to describe variations in advice-following under each program structure; the matching of decisions to recommendations in terms of type and depth of the houses that returned for a follow-up evaluation.
- The fifth sub-objective was to better understand the multi-stage process of the pro-environmental behaviour under study. There were three components in this sub-objective. The first was to examine for relationships between elapsed time between evaluations and number and type of improvements made. The second was to examine for effects of the number of recommendations on decision making patterns. The third was to analyse for outcomes of households depending on whether their decisions were congruent with the advice given to them.

4.1 Decision to Participate in a Home Energy Retrofit Program

This section presents an examination of the influence that program structure had on the first and fifth stages in the process of a home energy retrofit. The first stage was to participate in an initial evaluation. The fifth stage was the decision to participate in a follow-up evaluation. The first part of the analysis confirmed the differences between the financial reward structures amongst the four periods under study. The next part of the analysis presents findings on whether the participation in each program period was representative of the population of the Region of Waterloo. This is followed by the presentation of the results of the natural quasi-experimental intervention that described the variations in material characteristics and recommendations between the groups of initial participants. The results of the natural quasi-experimental intervention that described the variations between the groups that had an initial evaluation only and the houses that participated in a follow-up evaluation are also presented.

4.2 Participation

The first and fifth decisions in the process of participation were to have an initial and follow-up evaluation. Table 4.1 presents the percent of houses by vintage category of the housing stock in the Region of Waterloo reported by the 2006 Census of Canada data (the only available data). This table also presents the percent of houses of each vintage category that participated in the initial evaluation in each program period. Overall, the percent of houses of various vintage groups does not match the corresponding size of the vintage groups in the Region of Waterloo. Instead, houses built before 1960 were over-represented among participants (38% of participants compared to 28% of regional housing stock), while those built during the 2001 to 2006 period were under-represented (2% of participants compared to 14% of regional housing stock). As a result, the group of houses that participated in each program period is not considered representative of the housing stock in the Region of Waterloo.

It is also possible for houses to be evaluated in multiple periods. However, according to the REEP dataset, only 45 households had an evaluation during multiple periods, meaning that, with the exception of ownership change, different households self-selected into each program period. Table 4.2 shows the cumulative percentage of households within each vintage group that participated in a home energy evaluation. This table shows that at the beginning of each program period, at least 90% of the population of each vintage of the Region of Waterloo had not participated in the program. Hence, the subset of the population does not appear to be affected by the population that had previously participated due to a markedly smaller pool of potential participants. Therefore, it can be considered that the time periods during which participants self-selected were independent. That is, due to the overall small proportion of houses that had participated in comparison to the remaining housing stock of the Region of Waterloo, homeowners self-selected from a similar population of houses during each period.

Vintage	The Region of Waterloo*	Percent of Total (%) Period of Initial Evaluation				Total
		1	2	3	4	
<=1960	28	35	42	37	37	38
1961-1970	12	14	16	10	15	15
1971-1980	14	17	20	16	15	17
1981-1990	16	22	16	20	23	21
1991-2000	16	10	4	11	8	8
2001-2006	14	1	2	7	2	2
>2006		NA	NA	NA	0.3	0.1
Total	100	100	100	100	100	100

* 2006 Census of Canada

Table 4.1 Comparison of Housing Stock of the Region of Waterloo to Housing of Participants by Period

Vintage	Cumulative Percent (%) of the Population of the Region of Waterloo* Initial Period			
	1	2	3	4**
<=1960	5	10	10	18
1961-1970	2	9	9	16
1971-1980	3	9	10	16
1981-1990	3	8	9	17
1991-2000	2	4	4	7
2001-2006	0	1	1	2
>2006	NA	NA	NA	NA

* 2006 Census of Canada

** Due to growth, the cumulative proportion may be smaller

Table 4.2 Cumulative Percentage of the Population of the Region of Waterloo of Houses that Participated by Vintage and by Period

The next assessment was to compare the percent share of houses that participated in an initial evaluation to the percent share of houses by city, township, or utility company in the Region of Waterloo. Table 4.3 presents these percent shares. Alongside are presented the percent share of houses that participated in an initial evaluation by city, township or utility company. This analysis demonstrates that Kitchener had the greatest percent share of dwellings in the Region of Waterloo. Kitchener also had the highest percent share of participation in programs. Kitchener appears to have been somewhat over represented (7% higher) in participation in Period 4. With the exception of Period 3, Cambridge appears somewhat underrepresented in the program. The percent share of Cambridge in the Region of Waterloo was 24%, but the percent share of participating households from Cambridge in Periods 1, 2, 3, 4 were 19%, 20%, 22% and 16%. In a holistic examination by period, it appears as though participation in Period 2 has a similar distribution by location to the population in the Region of Waterloo. The distribution of participation by location in Periods 1, 3 and 4 appear to have been overrepresented in some locations balanced by underrepresented in others.

Location or Utility	The Region of Waterloo*		Period of Initial Evaluation 1		2		3		4		Total
	N	%	#	%	#	%	#	%	#	%	#
Cambridge	43260	24	789	19	591	20	50	22	946	16	2376
Cambridge North Dumphries	3050	2	50	1	41	1	4	2	39	1	134
Remaining towns in The Region of Waterloo			26	1	35	1	4	2	77	1	142
Kitchener	79380	45	2006	47	1376	47	84	37	3139	52	6605
Waterloo	36780	21	1158	27	625	21	65	28	1257	21	3105
Waterloo North Hydro	9420	5	133	3	172	6	10	4	304	5	619
Wilmot	6095	3	99	2	107	4	13	6	229	4	448
Total	**177995**		4261	100	2947	100	230	100	5991	100	13429

*2006 from the Region of Waterloo Bulletin

Table 4.3 Location of Participation of Initial Evaluation by Program Period

4.3 Program Structure

The purpose of each of the four program formats that were delivered by REEP was to inform homeowners about the opportunity to save energy by investing in eight possible retrofits. Between 1999 and 2011, the programs delivered by REEP offered information in nearly identical formats. Each program consisted of an in-person home energy evaluation followed by a written report based on the analysis from the HOT2000 program. Throughout that timeframe, the retrofit options remained nearly identical[31], as did the report formats[32] and the only known variation in the delivery process is that in Period 1 the reports were prepared and delivered to the homeowner during the evaluation whereas the reports were later mailed or emailed in the remaining three periods. Otherwise, the main difference between program structures was the price and the structure of the financial reward. The variations in program structure between the different program periods are summarized in Table 3.1.

[31] Financial rewards for ground source heat pumps and solar hot water heating were offered only in Period 4, and were examined within the eight decision as heating system and hot water system respectively.

[32] There were slight variations between the report formats of the EnerGuide for Houses and ecoEnergy programs. The impacts of the differences have not been studied.

The analysis followed the methods described in Chapter 3. The graphs presented illustrate whether the differently structured financial rewards were greatly different in amount of money offered per unit of improvement in the energy rating score. The scatter plot that compared the recommended change in energy rating to the recommended financial reward is presented in Figure 4.2. The scatter plot demonstrates that there was some overlap in units of recommended improvement in energy rating per dollar paid of the two programs. However, overall the financial rewards were generally larger in Period 4 when compared to a similar change in energy rating in Period 2. The box plot presented in Figure 4.3 shows the recommended improvement in energy rating score for Periods 2 and 4. Directly next to Figure 4.3 is Figure 4.4 that presents the box plot of the recommended financial reward in dollars for Periods 2 and 4. The box plots are presented side by side for better visual comparison. It can be seen that the interquartile range of recommended improvement to energy rating for Period 2 was slightly higher than Period 4. In Figure 4.4 it can be seen that the entire interquartile range of recommended financial rewards for Period 2 was lower than that of financial rewards offered in Period 4. While this did not yield a direct comparison of financial rewards for particular actions, overall, financial rewards offered in Period 4 were higher for a similar change in energy rating. For example, as shown in Table 4.4, the ratio of the mean recommended financial reward was 3.6 and of the median was 3.8.

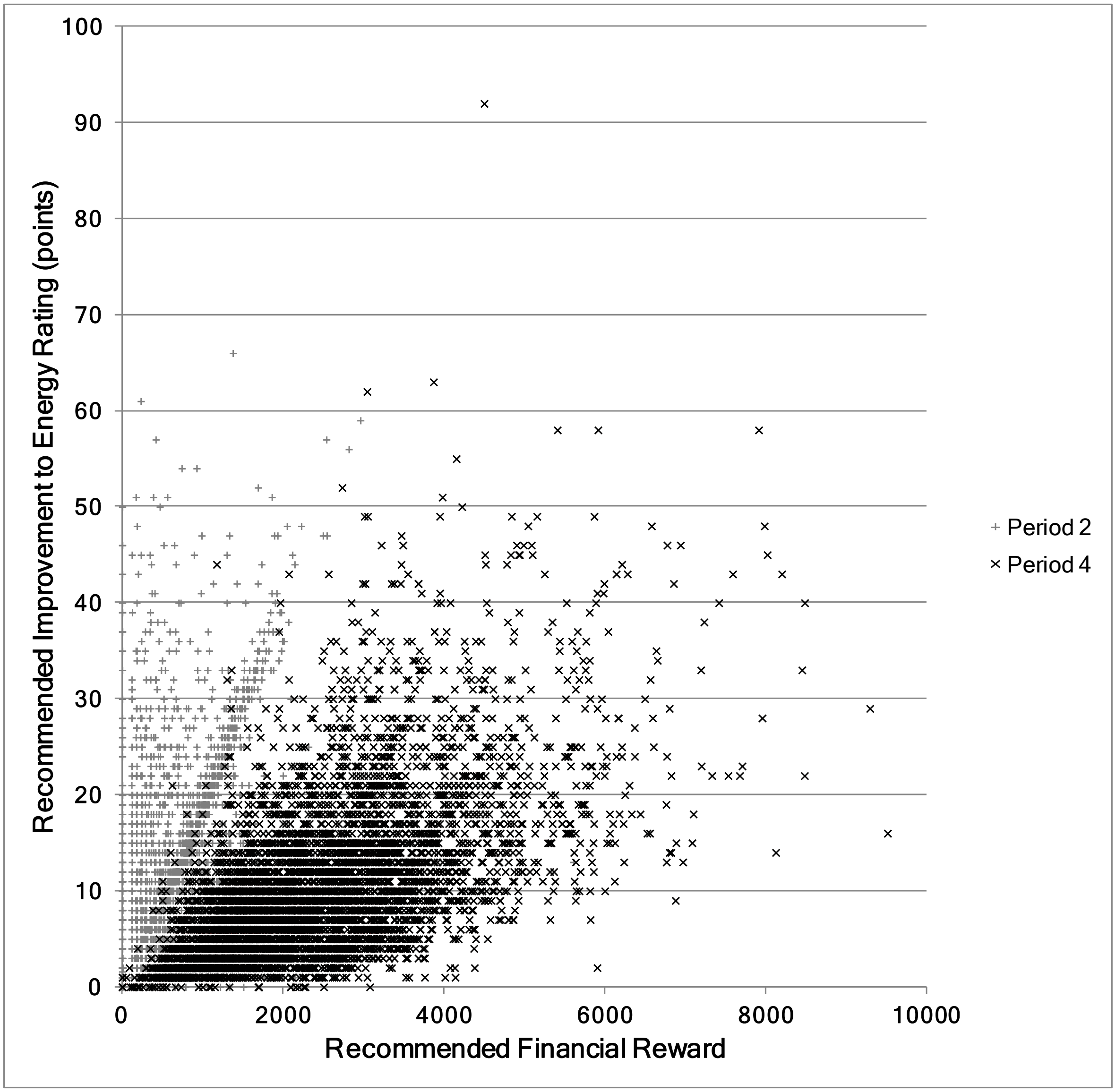


Figure 4.2 Recommended Financial Reward Compared to the Recommended Change to a House's Energy Rating Score

Period of Initial Evaluation	n	Recommended financial reward ($) Mean	Median
2	2947	652	560
4	5991	2371	2140
Ratio (4/2)		3.6	3.8

Table 4.4 Comparison of Recommended Financial Reward for Periods 2 and 4

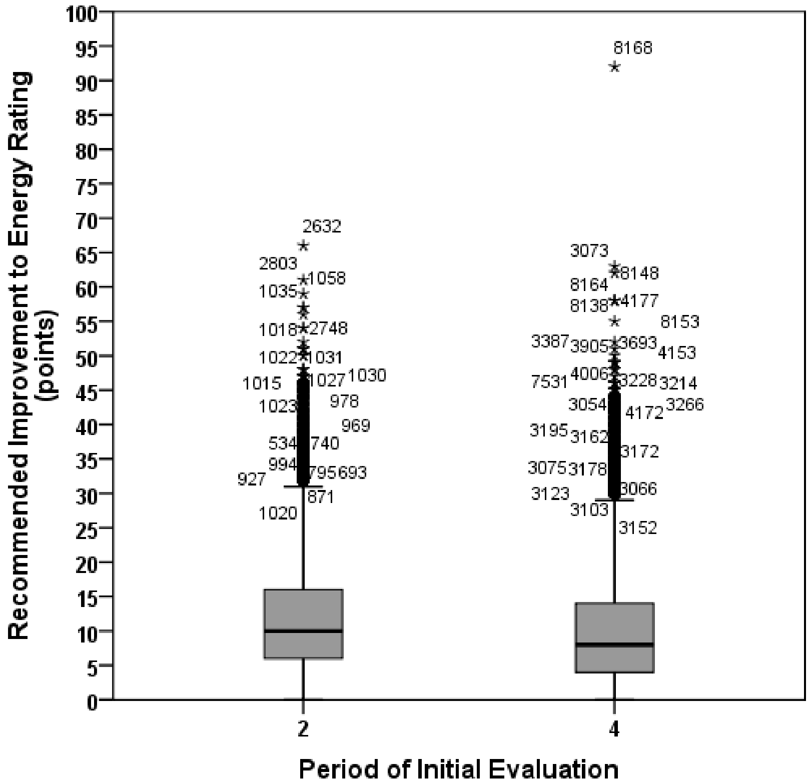


Figure 4.3 Box plot of Recommended Change in Energy Rating for Periods 2 and 4

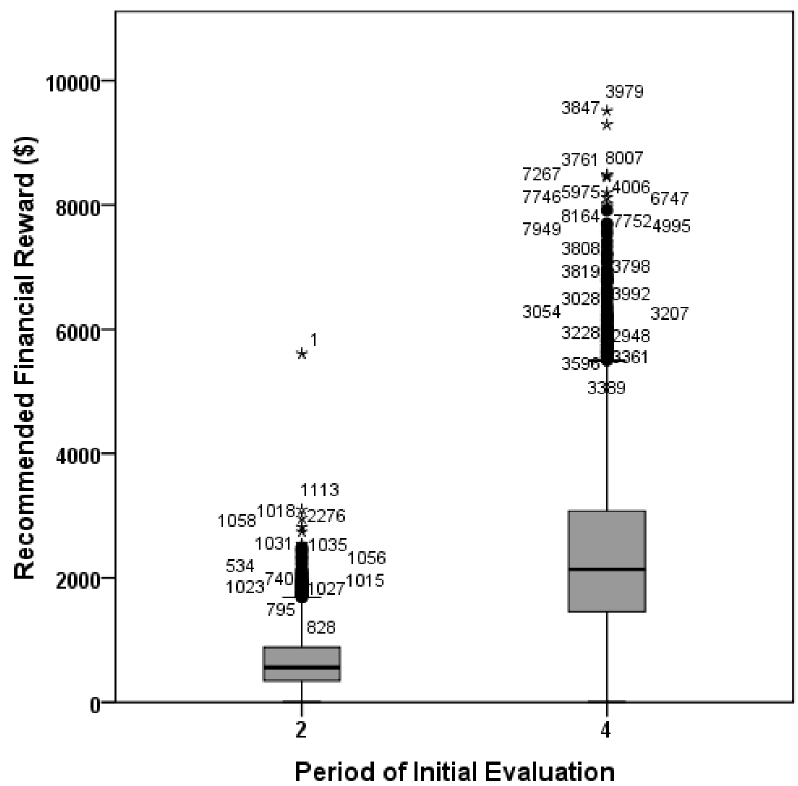


Figure 4.4 Box plot of Recommended Financial Reward for Periods 2 and 4

4.4 Rates of Participation

Summary of Analysis of the Natural Experiment

This section briefly describes how to read the results from Levene's F-test, analysis of covariance (ANOVA) Welch or Brown-Forsythe tests and post-hoc tests contained in the tables throughout this chapter. In the methodology chapter (Chapter 3) it was described that measures of weekly participation and various material characteristics were compared amongst the four periods of initial evaluation. Measures of material characteristics were also compared within periods between the groups that had an initial evaluation only and groups that returned for a follow-up evaluation. In the case of participation, the mean weekly participation was compared for four of the follow-up periods.

For each type of measurement the Levene's (F) test measured whether the variances were equal or not. An analysis of covariance (ANOVA) or a Welch or a Brown-Forsythe test explained whether the means amongst all periods were considered not equal. If the means were not equal, then post-hoc tests explained whether there was a difference of means.
Each results table displays a legend explaining the results of these tests.

The next stage of analysis focused on an examination of the rates of participation for the initial and follow-up evaluations in response to the different program structures. Figure 4.5 shows the monthly rates of participation in both the initial and the follow-up evaluation between 1999 and 2011. The key dates that affected participation in home energy evaluations in the Region of Waterloo are also indicated in Figure 4.5. Across the four time periods of the programs, monthly participation in an initial home energy evaluation varied. During Period 1, participation was higher when the weather was cold. The chart demonstrates that participation in a follow-up home energy evaluation steadily increased after the introduction of a financial reward in a time-lagged manner.

Reading the Results Table of the Natural Experiment for Levene's, ANOVA, Welch or Brown-Forsythe Tests

For tests that compare the means between the periods of initial evaluation, the legend is explained as follows:

Φ : the means of the groups or periods could not be compared, whether due to no differences in material characteristics (for example, the efficiency of electric heating is always 100%) or due to small sample size.

¥: Levene's F-test confirmed that the variances were not equal

The appearance of any superscript symbol in the column of post-hoc test confirms that the ANOVA or Welch or Brown-Forsythe tests showed a difference in means.

The next step in the analysis was to employ a natural quasi-experimental intervention to compare the distribution of weekly participation rates as a response to the different program structures. Table 4.5 presents the results of the ANOVA or Welch or Brown-Forsythe tests and of the post-hoc tests that compared the mean weekly participation rates for an initial evaluation across the four periods. Analysis of the table is as follows. The superscript ¥ confirms that the variances of the groups were not equal. The appearance of any superscript symbol in the column of post-hoc test confirms that the ANOVA or Welch or Brown-Forsythe tests showed that the means across all periods were different. The symbol in the column for the post-hoc tests present the results of the post-hoc test that a difference of means between that program period and that of the program period number listed in the post-hoc test column. For example, the difference of means was significant for the weekly participation between Period 3 and Periods 1, 2 and 4. A difference of means of weekly participation was found between Period 4 and Periods 1, 2, and 3. No difference of means was found for the weekly participation between Period 1 and Period 2. At a mean of 29 participants per week, Period 4 had the highest mean participation, and at a mean of 5 participants per week, Period 3 had the lowest mean weekly participation.

Reading the Post-Hoc Tests of the Natural Experiment Between Periods of Initial Evaluation

Post hoc test results are displayed as superscripts next to the mean as:
1: a difference of means was found between the selected period and that of Period 1
2: a difference of means was found between the selected period and that of Period 2
3: a difference of means was found between the selected period and that of Period 3
4: a difference of means was found between the selected period and that of Period 4

A similar analysis was performed to examine for differences in weekly participation in the follow-up periods. This analysis is presented in Table 4.6 and Figure 4.7. Only seven households returned for a follow-up evaluation in Period 3, so it was removed from analysis. The weekly participation rates for a follow-up evaluation were different across the four periods. The post-hoc tests showed a difference in means for the weekly participation rate between each pairing of periods. For example, the post-hoc tests confirmed a difference in means for the weekly participation for a follow-up evaluation between Period 1, where the mean was 0.3 per week, and those of Period 1.1 (2 households per week), Period 2 (6 households per week), and Period 4 (22 households per week).

Reading the Post-Hoc Tests of the Natural Experiment Between Periods of Initial Evaluation

In the case of comparisons amongst follow-up periods the post-hoc test results are displayed superscripts next to the mean as:
1: a difference of means was found between the selected period and that of Period 1
1.1: a difference of means was found between the selected period and that of Period 1.1
2: a difference of means was found between the selected period and that of Period 2
4: a difference of means was found between the selected period and that of Period 4

Table 4.7 also presents participation as the percentage of participants in the initial evaluation who returned for a follow-up evaluation for each period. More than three quarters of participants who had an initial evaluation during Period 4 returned. More than a third of participants who had an initial evaluation during Period 2 returned for a follow-up evaluation. The percent return of participants for a follow-up in Periods 1 and 1.1 were 2% and 9% respectively.

These analyses can be interpreted as follows. Overall, it appears as though program participation for initial evaluations was affected by program structure and program support from varying levels of government. The introduction of a financial reward was associated with increased levels of participation in a follow-up evaluation. For example, in the case of the EnerGuide for Houses program (Periods 1 and 2), no difference of means was found for the weekly participation in an initial evaluation. However, when a financial reward was introduced, two effects were observed. First, 9% of participants from Period 1 returned for a follow-up evaluation (Period 1.1). Second, a difference in means for the weekly participation in a follow-up evaluation was found between Periods 1 (0.3 households per week) and Period 2 (6 households per week). The removal of financial rewards and support from the federal government in Period 3 was associated with a reduced level of participation for both initial and follow-up evaluations. The introduction of a higher list-based financial reward in Period 4 was associated with the highest mean weekly participation rate for both the initial and follow-up evaluations. It also was associated with the highest percent return of households that participated in an initial evaluation.

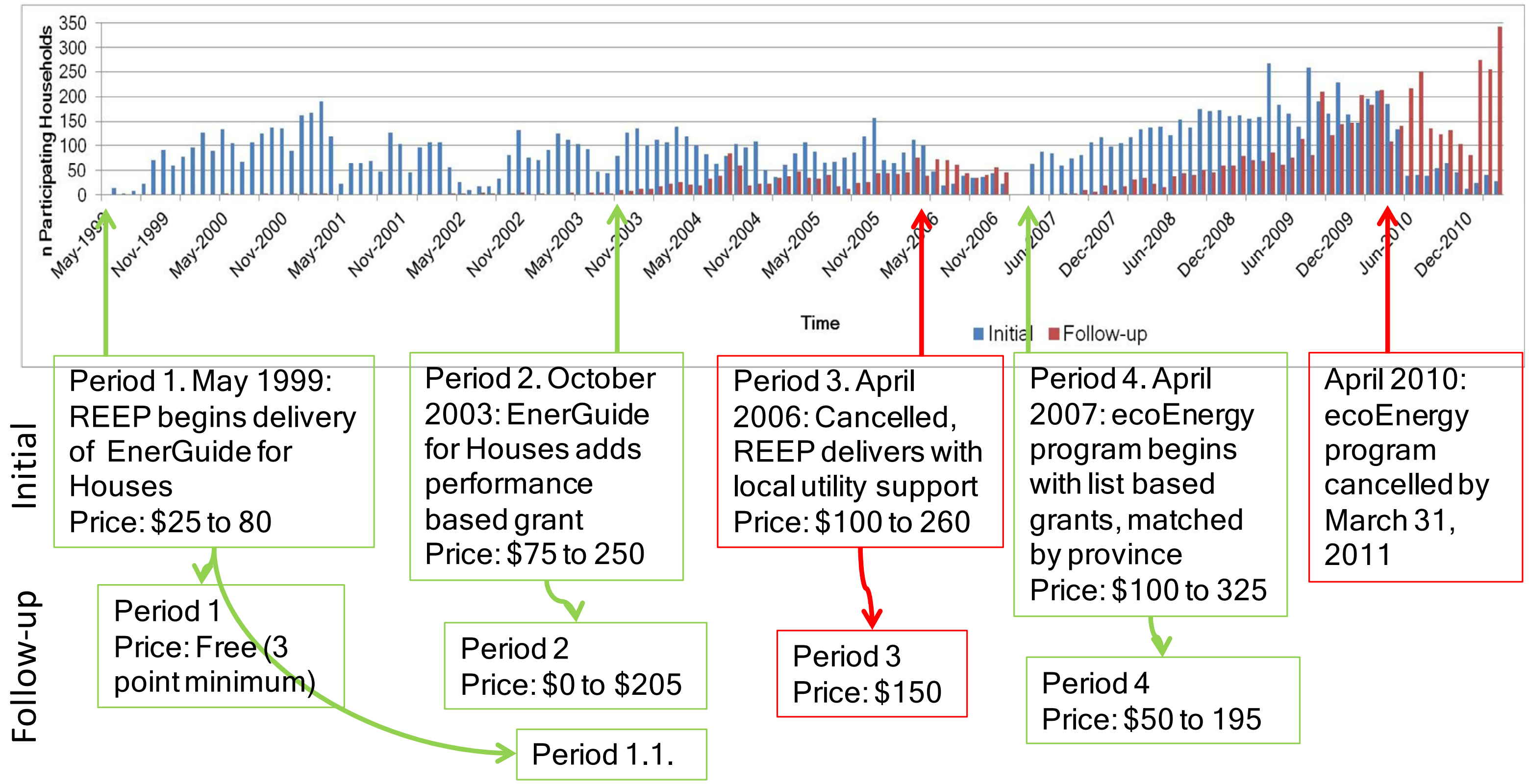


Figure 4.5 Key Dates and Program Participation

Period of Initial Evaluation	Number of Weeks	Mean Number of Participants Per Week¥	Post hoc
1	227	19	3,4
2	138	21	3,4
3	47	5	1,2,4
4	209	29	1,2,3

¥ variances not equal

Post hoc tests: the period number indicates cases where the mean of the period of the initial evaluation is different from the means of the other listed periods (by number)

Explanation: Post-hoc test results show that the mean number of participants per week in Period 4 was different than in Periods 1, 2, or 3. The mean number of participants per week in Period 1 was not found to be different than that of Period 2.

Table 4.5 Mean Weekly Participation in Initial Evaluation

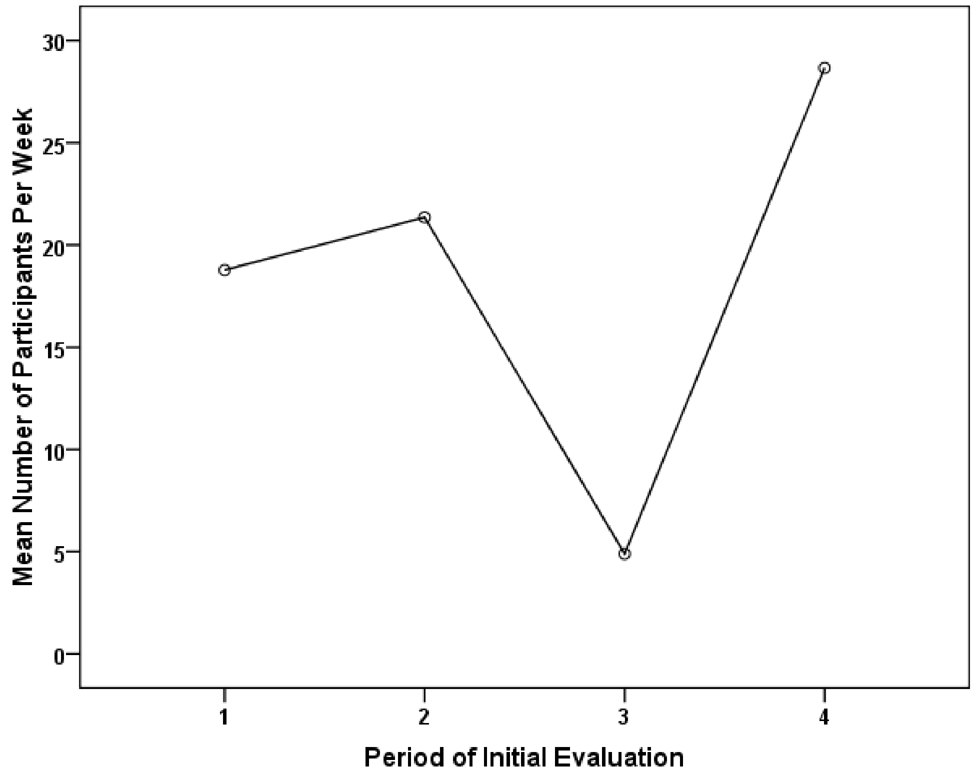


Figure 4.6 Mean Weekly Participation in Initial Evaluation

Follow-Up Period	Number of Weeks of Delivery	Mean Number of Participants Per Week¥	Post hoc Results
1	227	.3	1.1,2,4
1.1	170	2	1,2,4
2	170	6	1,1.1,4
4	209	22	1,1.1,2

¥ variances not equal

Post hoc tests: the period number indicates cases where the mean of the period of the initial evaluation is different from the means of the other listed periods (by number)

Table 4.6 Mean Weekly Participation for Follow-Up Evaluation

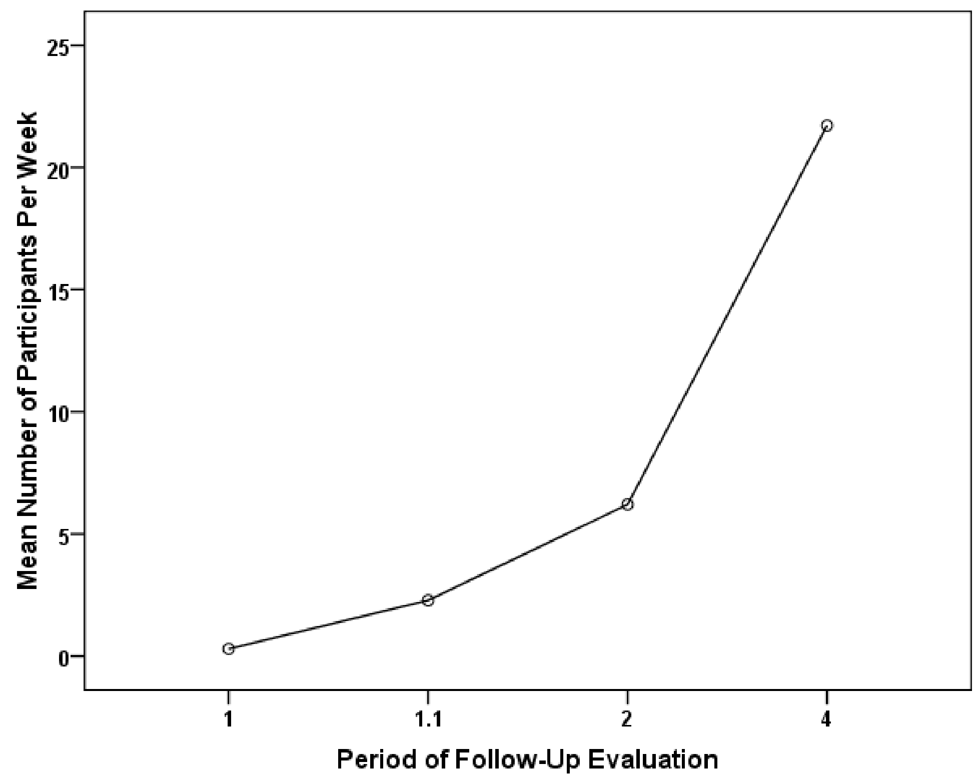


Figure 4.7 Mean Weekly Participation for Follow-Up Evaluation

Policy Period	Period of Initial Evaluation	n	Period of Follow-up Evaluation	n	Percent returned (%)
EnerGuide for Houses	1	4261	1	67	2
			1.1	393	9
EnerGuide for Houses	2	2947	2	1056	36
Local Support Only	3	230	3	7	3
ecoEnergy	4	5991	4	4600	77
Total		13429		6123	

Table 4.7 Proportion of Initial had Follow-Up by Program Structure

4.4.1 Material Characteristics

The material characteristics of the participating groups of houses were examined in order to understand whether the program appealed to the general population or if it appealed to subsets of the population to solve specific types of perceived problems. These material characteristics included the characteristics of the houses, such as area, energy rating, energy consumption, and greenhouse gas emissions. The material characteristics also included the characteristics of the eight decisions under study. Understanding the variations in material characteristics between the response groups may explain the variations in popularity of each type of program structure. Following the methodology described in Chapter 3, a natural quasi-experimental intervention that examined responses to program structures was used to make these comparisons.

This section presents the results of a series of ANOVA and differences of means tests. The tables are read in the same manner as previously described. Table 4.8 presents the mean of vintage (year of construction), area, energy rating, energy consumption, associated greenhouse gas emissions and price paid of the houses that participated in an initial evaluation of each program period. The frequency of distributions of vintage, area, energy rating, and energy consumption are presented in Appendix K. Table 4.9 and Table 4.11 describe the share of heating systems and associated characteristics of each period. This includes the mean operating efficiencies for each type of furnace by period in Table 4.9. The shares of hot water systems and associated characteristics by program period are described in Table 4.10 . This includes the mean operating efficiencies for each type of hot water heater. Table 4.12 describes the number and the share of heat recovery ventilators by program structure. Overall, many differences of means of material characteristics between periods were found.

Focusing first on Table 4.8, which summarizes the material characteristics of the houses that participated, many differences in means can be seen. For example, differences in means were found between the material characteristics of the houses that participated during Period 2 and those of the other three Periods. The mean year of construction during Period 2 was 1957, whereas the mean vintage for Periods 1 and 4 were 1963 and 1964; it appears that Period 2 attracted an older cohort of houses. At mean vintages of 1963, 1964 and 1963 for Periods 1, 3 and 4, respectively, no differences of means were found amongst these three periods.

Period 3 attracted houses with a mean area of 242m^2, which was higher than the means of the other three periods. No difference of means was found for the area of houses in Periods 2 and 4, at 219 m^2 and 216 m^2, respectively. A difference of means was found for the house area between Period 1 and each of Periods 3 and 4: the mean area for Period 1, at 221 m^2, was higher than the mean area in Period 4, and lower than that of Period 3.

A difference in means was found for the energy rating score between Period 2 (60) and each of the other three periods (65, 63 and 63). A difference of means was found for the energy rating between Period 1 (65) and each of Periods 2 (60) and 4 (63), but not between Period 1 and 3 (63).

The differences of means tests confirmed that the participating houses that had an initial home energy evaluation during Period 2 had a higher mean energy consumption at 195 GJ than those of Periods 1 and 4 that were 181 GJ and 172 GJ respectively. The mean energy consumption of Period 4 was lower than those of Periods 1 and 2. It appears that the distribution of energy consumption of houses in Period 4 was lower than during the other periods.

Period 2 also had a higher mean level of greenhouse gas emissions at 10.6 tonnes CO_2 equivalent than the other three periods. The mean greenhouse gas emissions of the houses that participated in Period 4 were lower than those of Periods 1 and 2. It appears that the distribution of greenhouse gas emissions of houses in Period 4 is lower than during the other periods.

No two periods had the same mean evaluation price.

Overall, Period 2 attracted houses with the oldest vintage distribution, the lowest mean energy rating, the highest mean energy consumption and the highest mean greenhouse gas emissions. Meanwhile, Period 1 attracted houses with the highest mean energy rating. Interestingly, Period 4 attracted houses with neither the highest nor lowest distribution of energy rating scores, but it did attract houses with the lowest mean energy consumption and greenhouse gas emissions.

For heating systems, Table 4.9 presents the share of various types of heating systems by fuel type, by period, and their associated mean operating efficiencies. The percent share of each type of heating system does not appear to be very different among periods. At 83%, the mean operating efficiency of natural gas furnaces in Period 2 was lower than the mean efficiencies of Periods 1, 3 and 4, that were 84%, 86% and 84% respectively. Houses that participated during Period 3 had a mean efficiency of natural gas furnaces (86%) that was higher than the other periods. No difference of means for the efficiencies of oil furnaces were found different between Periods 1 and 2 (78%, 77%). However, these means were found to be lower than those of Periods 3 and 4 (81%, 81%). The efficiency of electric heating is always 100%, so statistical tests were not performed for this system type. The data presented in Table 4.11 shows that each period had a low percent share of heat pumps.

The data presented in Table 4.10 demonstrates only slight or no differences between hot water heating systems in type or efficiencies. The majority of houses for any period had natural gas systems, followed by electric hot water heating. Propane and wood had lower percent shares of heating and hot water systems for any period.

Table 4.12 describes that few houses in any period had a heat recovery ventilator (HRV) (3% overall).

Tables 4.8 to 4.12 demonstrate that the distribution of energy performance characteristics varied by program structure, indicating that the various program structures attracted houses with different material characteristics. Section 4.4.3 presents analysis that offers a better understanding of how the material characteristics may have been associated with various motivations to participate.

Period of initial evaluation		Vintage¥			Area (m^2) ¥			Energy rating ¥			Energy consumption (MJ) ¥			KgCO2¥			Evaluation Price ¥		
	n	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*
1	4260	1963	2	30	221	34	80	65	24	12	180913	24	70860	9693	24	4009	31	234	12
2	2948	1957	134	32	219	3	85	60	134	13	195077	14	74785	10641	134	4482	115	134	27
3	230	1964	2	32	242	124	102	63	2	13	184680		75220	9772	2	3985	107	124	28
4	5991	1963	2	30	216	13	93	63	12	12	171732	12	66497	9216	12	3750	274	234	47
Total	13429	1962		31	216		87	63		12	179991		70499	9689		4043	159		113

¥ variances not equal
SD indicates standard deviation
Post hoc tests: the period number indicates cases where the mean of the period of the initial evaluation is different from the means of the other listed periods (by number)

Table 4.8 Material Characteristics of Participating Groups by Period

Period of Initial Evaluation		Electricity Δ		Natural Gas ¥					Oil ¥					Propane Φ		Wood Φ		Total
	n	*#*	*%*	*#*	*%*	*Eff (%)*	*post hoc*	*SD*	*#*	*%*	*Eff (%)*	*post hoc*	*SD*	*#*	*Eff (%)*	*n*	*Eff (%)*	*%*
1	4260	221	5	3769	88	84	23	7	263	6	78	34	6	7	90	6	90	100
2	2948	147	5	2415	82	83	134	7	366	12	77	34	6	13	88	0	NA	100
3	230	15	7	193	84	86	124	7	20	9	81	12	5	0	NA	1	91	100
4	5991	289	5	5259	88	84	23	7	410	7	81	12	5	26	91	0	NA	100
Total	13429	672	5	11636	87	84		7	1059	8	79		6	46	90	7	90	100

¥ variances not equal, Δ all electricity efficiencies are 100% and means cannot be compared, Φ due to small group size the means cannot be compared

SD indicates standard deviation, Eff (%) indicates mean system efficiency

Post hoc tests: the period number indicates cases where the mean of the period of the initial evaluation is different from the means of the other listed periods (by number)

Table 4.9 Existing Heating System Characteristics by Period

Period of Initial Evaluation		Electricity ¥					Natural Gas ¥					Oil ¥					Propane Φ		Total
	n	*#*	*%*	*Eff (%)*	*post hoc*	*SD*	*#*	*%*	*Eff (%)*	*post hoc*	*SD*	*#*	*%*	*Eff (%)*	*post hoc*	*SD*	*#*	*Eff (%)*	*%*
1	4260	590	14	82	2	1	3634	85	55	4	2	31	1	55		7	4	62	100
2	2948	585	20	82	14	1	2294	78	55	4	2	53	2	54		4	12	57	100
3	230	53	23	82		2	176	77	56		3	1	0	53	*	NA	0	0	100
4	5991	966	16	82	2	2	4933	82	56	12	3	60	1	53		2	21	60	100
Total	13429	2194	16	82		2	11037	82	55		2	145	1	54		4	37	59	100

¥ variances not equal, Φ due to small group size the means cannot be compared

SD indicates standard deviation, Eff (%) indicates mean system efficiency

Post hoc tests: the period number indicates cases where the mean of the period of the initial evaluation is different from the means of the other listed periods (by number)

Table 4.10 Existing Hot Water System Characteristics by Program Structure

Period of Initial Evaluation		Air Heat Pump		Ground Heat Pump		Water Heat Pump		No Heat Pump		Total
	n	#	%	#	%	#	%	#	%	%
1	4260	42	1	0	0.0	10	0.2	4208	99	100
2	2948	36	1	0	0.0	8	0.3	2904	99	100
3	230	3	1	0	0.0	3	1.3	224	97	100
4	5991	52	1	12	0.2	18	0.3	5909	99	100
Total	13429	133	1	12	0.1	39	0.3	13245	99	100

Table 4.11 Existing Heat Pump by Program Structure

Period of Initial Evaluation		HRV	
	n	*n*	%
1	4260	151	4
2	2948	58	2
3	230	15	7
4	5991	157	3
Total	13429	381	3

Table 4.12 Existing Heat Recovery Ventilator (HRV) by Period

4.4.2 Effect of Price on Energy Use Characteristics of Participating Houses

The initial price of a home energy evaluation varied within program structures. A natural quasi-experimental intervention was used to examine whether material characteristics varied by price of the initial evaluation within program structures. Periods 1 and 3 were combined in order to compare more price points within structures with no financial rewards. The energy rating was selected as an example of a material characteristic. Table 4.13 and Figure 4.8 present the mean energy rating for houses by the range of initial price paid during Period 2. The mean energy rating score across the five compared groups were confirmed different. The post-hoc tests confirmed that differences could not be detected between many groups. The median energy rating score decreased as the price increased. The group of houses that participated in the lowest price period ($50-75) had a higher mean energy rating of 63 than those in the mid-price period ($101--125 and 126 - 150). An inverse relationship would be expected; as price increased, homeowners who participated would become more invested in solving a perceived problem. Overall, no relationship could be determined in any of the analyses (Periods 1 and 3 and Period 4 relationships are shown in Appendix J). It appears that combinations of factors within program structure beyond price were important to participation decisions.

Period 2 Price Paid ($)	#	Energy Rating (points)				
		Mean ¥	Post hoc	Median	Min	Max
(a) 51 - 75	652	63	c,d	66	3	83
(b) 76 - 100	359	60		65	8	89
(c) 101 - 125	1005	60	a	63	3	81
(d) 126 - 150	729	60	a	64	-1	78
(e) 151 - 175	183	59		64	6	79
(f) 176+*	14	47		55	11	73
Total	2928	61				

¥ variances not equal, *Not included in mean comparisons due to small group size
Post hoc tests: the group label indicates cases where the mean of the group is different from the means of the other listed groups (by label)

Table 4.13 Price Category versus Energy Rating in Period 2

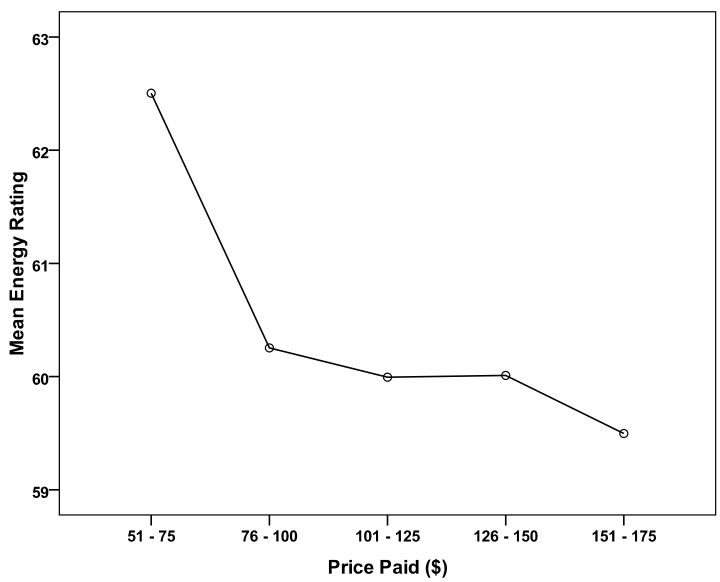


Figure 4.8 Price Category versus Energy Rating in Period 2

4.4.3 Material Characteristics of Returning Houses

In order to examine whether the program appealed to the general population or if it appealed to subsets of the population to solve specific types of perceived problems, analyses of differences of means of variables that represent the material context were also conducted within program structures (grouped as initial only and follow-up). The participation group labels for this section are described in detail in the legend presented in Table 4.14. In this case, one type of participation is considered as only having an initial evaluation (group 1i, 2i, or 4i). The other type of participation is to return to participate in the follow-up evaluation (group 1f, 1.1f, 2f, 4f). In the case of Period 1, there are two groups that returned for a follow-up: group 1f was for information only, and group 1.1f returned after the introduction of a financial reward. Table 4.15 presents the results of the ANOVA and the post-hoc differences of means tests between participation by type of vintage, area, energy rating, energy consumption, associated greenhouse gas emissions and price paid of each group by participation type. Table 4.16 and Table 4.17 describe the percent share and associated characteristics of heating systems by participation type Table 4.16 presents the percent share of heating systems and associated characteristics. Table 4.19 gives counts of heat recovery ventilator within program structures. Overall, differences were found within periods by participation type. This demonstrates that within each period, the subsets of houses that returned had different types of material characteristics, an indication of different types of perceived problems.

For the tests that compared within periods (either Period 1, or Period 2 or Period 4) between the groups which had an initial evaluation only and groups that returned for a follow-up evaluation. The groups are labeled as: 1i: this group of houses had only an initial evaluation in Period 1 1f: this group of houses returned for a follow-up evaluation during the follow-up Period 1 1.1f: this group of houses returned for a follow-up evaluation during the follow-up Period 1.1 2i: this group of houses had only an initial evaluation in Period 2 2f: this group of houses returned for a follow-up evaluation in Period 2 4i: this group of houses had only an initial evaluation in Period 4 4f: this group of houses returned for a follow-up evaluation in Period 4

Table 4.14 Legend of participation type

Reading the Post-Hoc Tests of the Natural Experiment Between Groups of Initial Evaluation Only and Follow-Up Evaluation

When these groups were compared within periods the results of the Levene's F-test between returnees and initial only groups are displayed as:
∞ variances are not equal among the groups 1i, 1f, and 1.1f
Ɛ the variance of group 2i is not equal to that of group 2f
Ə the variance of group 4i is not equal to that of group 4f

When these groups were compared within periods, the post-hoc or t-test results are displayed as:
1i: a difference of means was found between the selected group and that of group 1i
1f: a difference of means was found between the selected group and that of group 1f
1.1f: a difference of means was found between the selected group and that of group 1.1f
2i: the selected period's mean is not equal to the mean of group 2i
4i: the selected period's mean is not equal to the mean of group 4i

Table 4.15 shows a difference of means for vintages and energy rating scores between group 1i and groups 1f and 1.1f. Groups 1f and 1.1f had higher mean energy consumption and greenhouse gas emissions than those of group 1i. The only material characteristic for which a difference of means was not found between groups in Period 1 was the house area.

For Period 2, no difference of means for the vintage was detected between groups 2i and 2f. A difference of means for area and energy rating was detected between group 2f and 2i: the means of group 2i were higher than those of group 2f. A difference of means of energy consumption and green house gas emissions was found between groups 2f and 2i: the means of group 2f was higher than group 2i.

For Periods 1 and 2, it appears as though the group of houses that returned for a follow-up energy evaluation generally had a lower energy performance and higher energy consumption than the group that had only had an initial evaluation.

In Period 4, some of these trends appear reversed. The mean vintage of the houses in group 4f was higher than that of 4i, hence, in Period 4, a larger share of newer houses returned for a follow-up evaluation. This could be attributed to the larger rate of return overall. The mean area of houses was smaller for group 4f than that of group 4i. This was similar to the trend in Period 2. The mean energy rating for group 4f was higher than that of group 4i. This is the reverse trend of what occurred during Periods 1 and 2. Related to this, the mean energy consumption and mean greenhouse gas emissions for group 4f was lower than that of group 4i.

Participation Type by Period		Vintage ∞ƐӘ			Area (m^2)ƐӘ			Energy rating (points)∞ƐӘ			Energy consumption (MJ)∞ƐӘ			$KgCO^2$∞ƐӘ		
	n	*mean*	*post hoc*	*SD*	*mean*		*SD*	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*
1i	3800	1965	1f1.1f	30	222		81	66	1f1.1f	11.1	176493	1f1.1f	68858	9423	1f1.1f	3834
1f	67	1949	1i	32	231		77	57	1i	12.5	232910	1i	87067	12633	1i	4866
1.1f	393	1950	1i	32	215		70	58	1i	11.8	214785	1i	74335	11798	1i	4635
Total	4260	1963		30	221		80	65		11.5	180913		70860	9693		4009
2i	1892	1957		34	225		89	61		13.4	192819		79095	10418		4669
2f	1056	1957		28	209	2i	77	59	2i	11.4	199121	2i	66212	11041	2i	4096
4i	1391	1959		32	230		103	62		12.3	180657		69599	9654		3844
4f	4600	1964	4i	29	212	4i	89	63	4i	11.3	169034	4i	65298	9084	4i	3712

i = indicates group participated only in initial evaluation   f = indicates group participated in follow-up evaluation

∞ variances are not equal among the groups 1i, 1f, and 1.1f , Ɛ the variance of group 2i is not equal to that of group 2f, Ә the variance of group 4i is not equal to that of group 4f

SD indicates standard deviation

Post hoc tests: the group label indicates cases where the mean of the group is different from the means of the other listed groups (by label)

Table 4.15 Material Characteristics by Participation Type Within Periods

Participation Type by Period		Electricity ¥		Natural Gas∞ƐƏ					Oil ƐƏ					Propane		Total
	n	*#*	*%*	*#*	*%*	*Eff (%)*	*post hoc*	*SD*	*#*	*%*	*Eff (%)*	*post hoc*	*SD*	*#*	*Eff (%)*	*%*
1i	3800	206	5	3391	89	85	1f1.1f	7	197	5	78	1.1f	6	6	90	100
1f	67	4	6	55	82	81	1i	6	8	12	76		7	0	NA	100
1.1f	393	11	3	323	82	80	1i	5	58	15	75	1i	6	1	91	100
Total	4260	221	5	3769	88	84		7	263	6	78		6	7	90	100
2i	1892	116	6	1595	84	85		7	167	9	78		6	9	90	100
2f	1056	31	3	820	78	80	2i	5	199	19	75	2i	6	4	91	100
4i	1391	78	6	1217	87	86		7	85	6	82		4	8	90	100
4f	4600	211	5	4042	88	84	4i	7	325	7	81		5	18	91	100

i = indicates group participated only in initial evaluation f = indicates group participated in follow-up evaluation
∞ variances are not equal among the groups 1i, 1f, and 1.1f , Ɛ the variance of group 2i is not equal to that of group 2f, Ə the variance of group 4i is not equal to that of group 4f
SD indicates standard deviation, Eff (%) indicates mean system efficiency
Post hoc tests: the group label indicates cases where the mean of the group is different from the means of the other listed groups (by label)

Table 4.16 Heating System Characteristics by Participation Type Within Periods

Table 4.16 presents the share and associated characteristics of heating systems by participation type. Electric heating has a fuel share of 3 to 6 %. The efficiency of electric heat is always 100% in the HOT2000 model; hence no analysis compared the distribution of efficiencies. Natural gas had a share of 78% to 89%, depending on the group and participation type. In the case of natural gas, within every period the mean furnace efficiency was lower for the follow-up group (labeled "f ") than for the group that only had an initial evaluation (labeled "i"). In the case of oil, during Periods 1 and 2 the share of oil as heating fuel was larger for the group that returned for a follow-up evaluation. For example, in Period 1, 5% of group 1i used oil, but 12% of group 1f and 15% of group 1.1f had oil furnaces. Similarly, in Period 2, 19% of group 2f had oil furnaces, but only 9% of group 2 i had oil furnaces. In Period 4, the share of oil furnaces was similar across the groups of participation type at 6% for group 4i and 7% for group 4f. In Period 1, a difference in mean efficiency of oil furnaces could not be calculated for group 1f. However, the mean efficiency for group 1.1f was lower than group 1i. For Period 2, the mean efficiency of oil furnaces was lower for group 2f than that of group 2i. However, for Period 4, no difference of mean was found for oil efficiencies between the two types of participation. Table 4.17 shows the return rates for Period 1 were 1% in both 1i and 1.1f with a heat pump rarely returned.

Participation Type by Period		Air Heat Pump		Ground Heat Pump		Water Heat Pump		No Heat Pump		Total
	n	*#*	*%*	*#*	*%*	*#*	*%*	*#*	*%*	*%*
1i	3800	38	1	0	0	10	0	3752	99	100
1f	67	0	0	0	0	0	0	67	100	100
1.1f	393	4	1	0	0	0	0	389	99	100
Total	4260	42	1	0	0	10	0	4208	99	100
2i	1892	33	2	0	0	5	0	1854	98	100
2f	1056	3	0	0	0	3	0	1050	99	100
Total	2948	36	1	0	0	8	0	2904	99	100
4i	1391	12	1	6	0	6	0	1367	98	100
4f	4600	40	1	6	0	12	0	4542	99	100
Total	5991	52	1	12	0	18	0	5909	99	100

i = indicates group participated only in initial evaluation f = indicates group participated in follow-up evaluation

Table 4.17 Existing heat pumps by participation type within periods

Table 4.18 shows hot water system characteristics. The only differences between initial only and follow-up was between Periods 1i and 1f for natural gas systems.

Participation Type by Period		Electricity				Natural Gas ∞					Oil$^{\varepsilon}$			
	n	*#*	*%*	*Eff (%)*	*SD*	*#*	*%*	*Eff (%)*	*post hoc*	*SD*	*#*	*%*	*Eff (%)*	*SD*
1i	3800	496	13	82	1	3272	86	55	1f	2	27	1	55	8
1f	67	13	19	82	0	53	79	55	1i	0	1	1	53	NA
1.1f	393	81	21	82	1	309	79	55		2	3	1	53	0
Total	4260	590	14	82	1	3634	85	55		2	31	1	55	7
2i	1892	346	18	82	1	1509	80	55		2	28	1	55	6
2f	1056	239	23	82	2	785	74	55		0	25	2	53	0
4i	1391	233	17	82	2	1136	82	56		3	13	1	53	0
4f	4600	733	16	82	2	3797	83	56		3	47	1	53	2

i = indicates group participated only in initial evaluation f = indicates group participated in follow-up evaluation
∞ variances are not equal among the groups 1i, 1f, and 1.1f , Ɛ the variance of group 2i is not equal to that of group 2f, Ə the variance of group 4i is not equal to that of group 4f
SD indicates standard deviation, Eff (%) indicates mean system efficiency
Post hoc tests: the group label indicates cases where the mean of the group is different from the means of the other listed groups (by label)

Table 4.18 Hot Water System Characteristics by Participation Type Within Periods

Table 4.19 shows counts and percent share of heat recovery ventilators (HRV). Overall, a smaller proportion or no houses with a heat recovery ventilator returned within each period. Period 4 had the largest percentage of returning houses with heat recovery ventilators of 2 %.

Participation Type by Period		HRV	
	n	*#*	*%*
1i	3800	151	4
1f	67	0	0
1.1f	393	0	0
Total	4260	151	
2i	1892	45	2
2f	1056	13	1
Total	2948	58	
4i	1391	50	4
4f	4600	107	2
Total	5991	157	

Table 4.19 Existing Heat Recovery Ventilator (HRV) by Participation Type

These results point to differences in perceived problems to be solved. For example, with respect to energy performance, groups 1f, 1.1f, and 2f contained more poorly performing houses than those that did not return. Group 4f had a larger percentage of houses return for a follow-up evaluation than other periods. These returnees as a group also had better performing energy characteristics than the houses that did not return.

4.5 Recommendations

Prior to examining whether advice was followed, recommendations to homeowners are described, organized by vintage groups (following Table 3.6). Table 4.20 and Figure 4.9 present the size of the participating group for each of the eight recommendations, by vintage group and by period.

A reduction to heat loss due to air leakage was one of the most recommended measures across periods and vintage groups. For example, at the low end, it was recommended to 70% of the houses of vintage 1961-1980 that participated in Period 1. At the high end, it was recommended to 98% of the oldest houses that participated in Periods 2 and 3.

The percentage of houses for which a reduction to heat loss to walls was recommended varied by vintage group. For example, for the oldest houses (1945 and older), a reduction in heat loss through walls was recommended in only half of the home evaluations in Period 1 but to nearly three-quarters of the houses evaluated in Period 2. However, the percentage of houses to which this recommendation was made reduced dramatically for newer vintages. To illustrate this point, during Period 4 it was recommended to over a third of participating houses that had been built between 1946 and 1960 vintage but to only 6% of the houses built between 1981and 2010.

The same pattern occurred for recommendations for reductions to heat loss basements, ceiling, and windows and doors in that the recommendation was made most often to the oldest vintage, and the percentage to which it was recommended reduced as vintage increased. What is interesting about recommendations to reduce heat loss to basements is that within each period, the percentage to which it was recommended was generally higher for older houses and lower for newer houses. However, for the newest group of houses, built between 1981 and 2010, the percentage to which it was recommended increased across the periods. For example, in this vintage group of houses built between 1981 and 2010, this recommendation was made to 28% of houses in Period 1, 45% of houses in Period 2, and 59% of houses in Period 4.

A reduction to heat loss to windows and doors was recommended to a larger percentage of houses in Periods 2 and 3 than in other periods. Overall, the reduction to heat loss to windows and doors was recommended to 61% of houses participating in each of Periods 2 and 3, but only 41% of houses in Period 1 and 48% of houses in Period 4.

What is interesting about heating system recommendations is that this change was recommended to a greater percentage of houses during Periods 2 and 4 than during Periods 1 and 3. Within the periods, the rate of recommendations did not vary by vintage. This means that a change to a heating system was recommended to a greater share of participants when there were financial rewards offered than when houses received information only. In Period 4, the group to which it was recommended to the least often was 1945 and older, when it was recommended to 60% of houses. In Period 2, the group to which it was recommended the least often was 1981 to 2010 when it was recommended to 54% of participating houses. Meanwhile, considering Periods 1 and 3 the highest share of houses to which it was recommended was 53% (1961-1980 for Period 3).

The replacement of the hot water system was the least recommended measure across periods and vintages. The maximum rate at which this was recommended was to 40% of the houses built between 1946 and 1960 in Period 4. Overall, a change to the hot water system was most often recommended during Period 4 when compared to other periods by vintage group.

The recommendation to install a heat recovery ventilator was the only one that was recommended to a larger percentage of participating houses of newer vintages.

Table 4.21 presents the number of recommendations to switch to air and ground source heat pumps. These recommendations were made to the highest percentage of participating houses during Period 4, and this was a very small percentage of recommendations (1% and 4% for air heat pump and ground source heat pump respectively). The highest number of recommendations to switch to water source heat pumps occurred in Period 2.

Period of Initial Evaluation	#	Heat Loss Air Leaks		Heat Loss Basement		Heat Loss Ceiling		Heat Loss Walls		Heat Loss Windows and Doors		Heating		Hot Water		HRV	
<1945																	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1	848	765	90	722	85	600	71	433	51	433	51	365	43	209	25	61	7
2	754	736	98	699	93	523	69	548	73	532	71	470	62	141	19	34	5
3	49	48	98	42	86	34	69	32	65	37	76	20	41	10	20	8	16
4	1184	1126	95	1064	90	750	63	750	63	653	55	710	60	435	37	92	8
1946-1960																	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1	653	466	71	554	85	438	67	119	18	301	46	261	40	164	25	270	41
2	479	442	92	441	92	290	61	162	34	299	62	305	64	77	16	148	31
3	37	34	92	35	95	20	54	11	30	28	76	16	43	14	38	14	38
4	1033	869	84	890	86	678	66	358	35	525	51	642	62	414	40	384	37
1961-1980																	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1	1346	948	70	943	70	826	61	188	14	610	45	670	50	425	32	854	63
2	1069	892	83	858	80	530	50	207	19	708	66	751	70	205	19	571	53
3	59	49	83	45	76	32	54	6	10	41	69	31	53	14	24	38	64
4	1803	1412	78	1371	76	1109	62	304	17	872	48	1245	69	666	37	888	49
1981-2010																	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1	1414	1099	78	402	28	537	38	109	8	397	28	521	37	349	25	1019	72
2	645	542	84	289	45	174	27	72	11	268	42	351	54	121	19	465	72
3	85	75	88	36	42	23	27	7	8	34	40	28	33	21	25	57	67
4	1971	1593	81	1171	59	840	43	121	6	802	41	1382	70	637	32	1165	59
Total																	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1	4261	3278	77	2621	62	2401	56	849	20	1741	41	1817	43	1147	27	2204	52
2	2947	2612	89	2287	78	1517	51	989	34	1807	61	1877	64	544	18	1218	41
3	230	206	90	158	69	109	47	56	24	140	61	95	41	59	26	117	51
4	5991	5000	83	4496	75	3377	56	1533	26	2852	48	3979	66	2152	36	2529	42

Table 4.20 Recommendations by Vintage and by Period

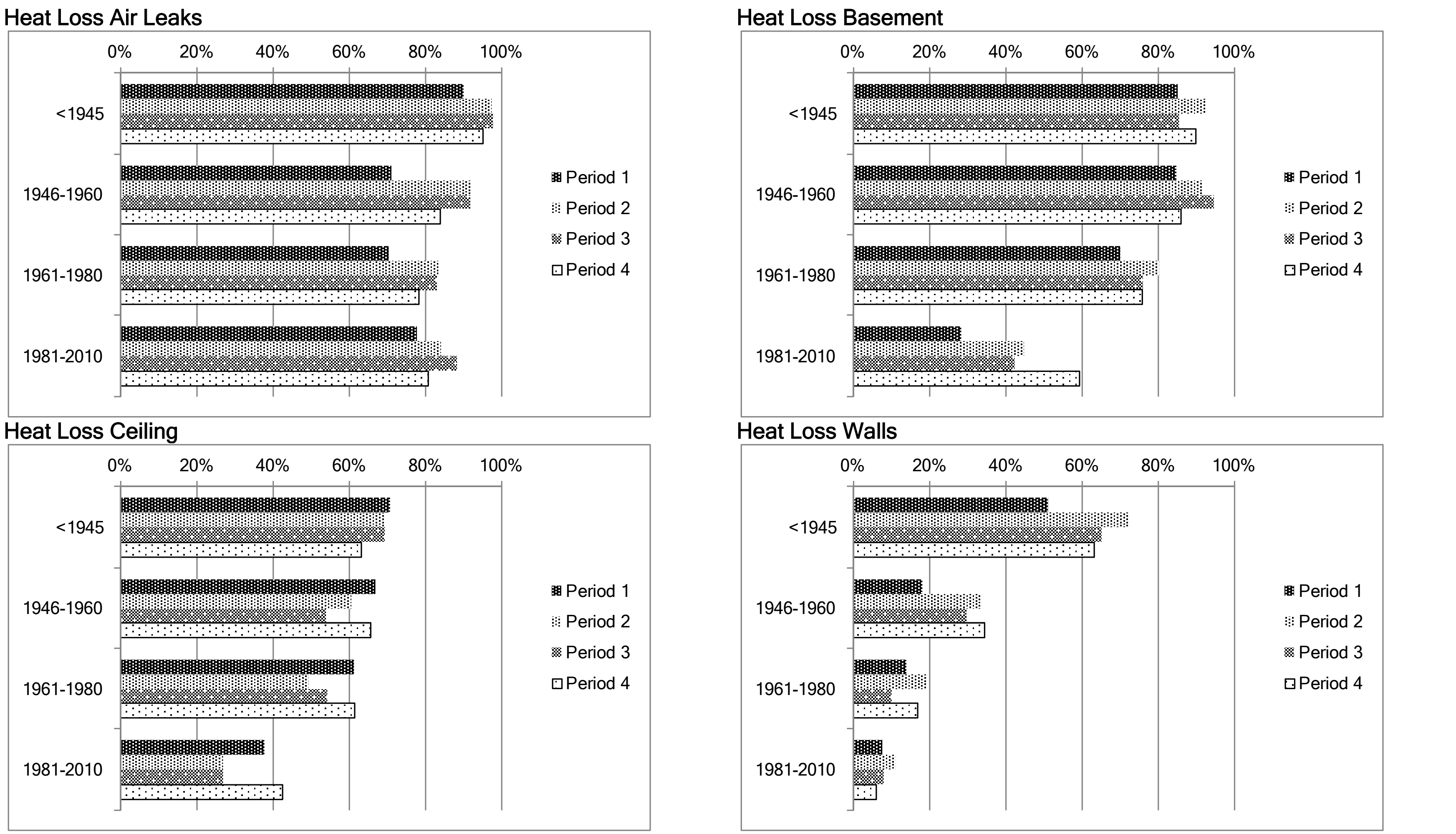


Figure 4.9 Recommendations by Vintage and Period

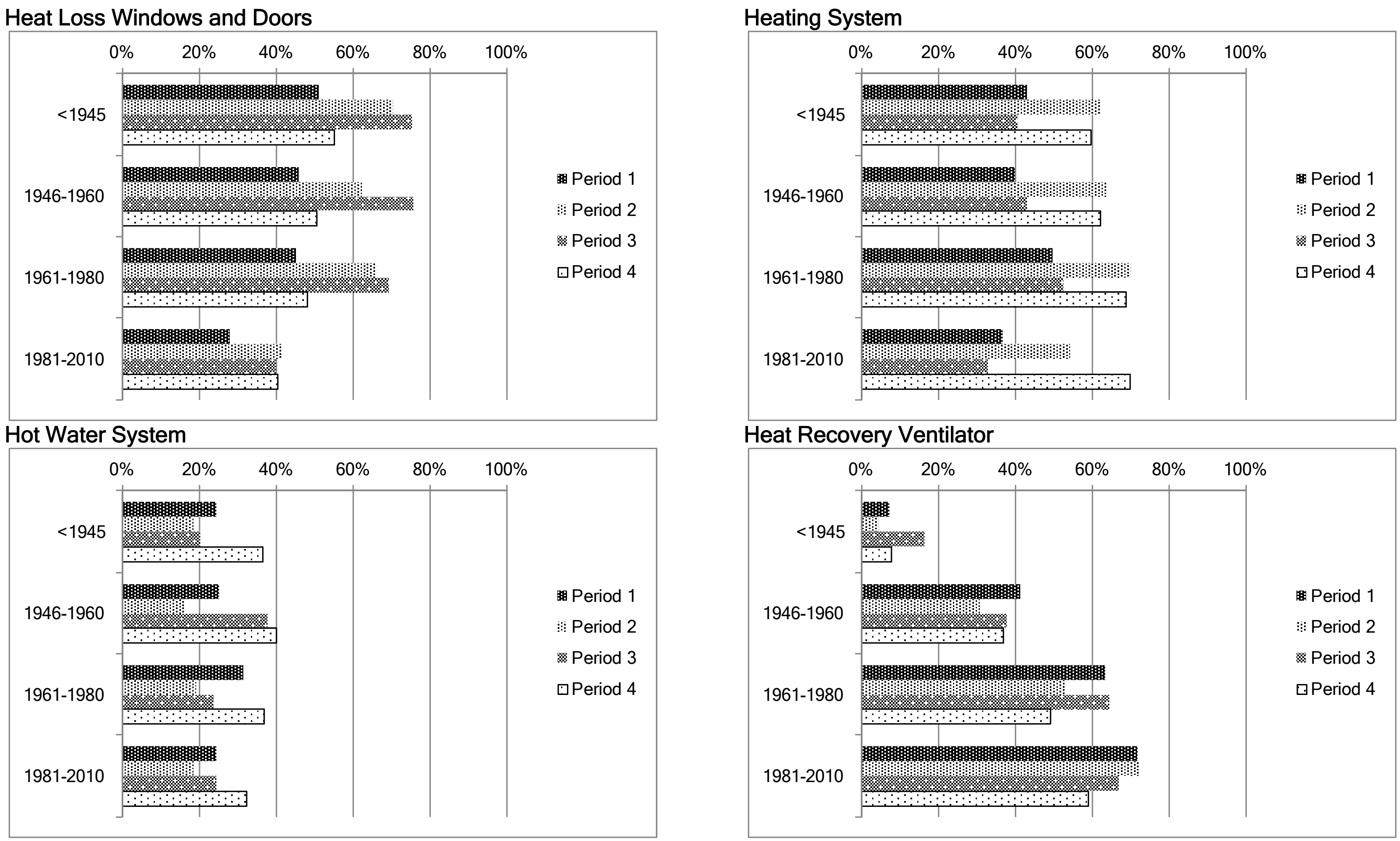


Figure 4.9 Recommendations by Vintage and Period (continued)

Period of Initial Evaluation		Air Heat Pump		Ground Heat Pump		Water Heat Pump		No Heat Pump	
	n	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
1	4260	2	0	0	0	26	1	14	0
2	2948	2	0	1	0	105	4	16	1
3	230	0	0	0	0	17	7	0	0
4	5991	46	1	234	4	9	0	14	0
Total	13429	50	0	235	2	157	1	44	0

Table 4.21 Fuel Switch Recommendations for Heating System by Program

Period of Initial Evaluation		Improvement to Energy Rating (Points)¥			Reduction to Energy Consumption (MJ) ¥			Reduction to $KgCO_2$¥		
	n	*mean*		*SD*	*mean*		*SD*	*mean*		*SD*
1	4261	7.9	[234]	7.2	41226	[234]	39497	2262	[24]	2356
2	2947	12.5	[134]	9.4	62558	[14]	51186	3601	[134]	3368
3	230	10.1	[12]	9.9	52464	[1]	58665	2781	[1]	3079
4	5991	10.2	[13]	8.2	47896	[12]	41586	2635	[12]	2522
Total	13429	10.0		8.4	49075		44273	2731		2737

¥ variances not equal
SD indicates standard deviation
Post hoc tests: the period number indicates cases where the mean of the period of the initial evaluation is different from the means of the other listed periods (by number)

Table 4.22 Recommended Changes in Material Characteristics by Period

Table 4.22 describes the recommended changes to the energy rating, energy consumption and greenhouse gas emissions by period. Differences of means tests confirmed that the mean improvement to energy rating score and the mean reduction to greenhouse gas emissions were higher in Period 2 than in other periods. The mean recommended improvement in energy rating and the mean reduction to energy consumption were lower for Period 1 than other periods. The mean recommended improvement to energy rating, reduction to energy consumption and reduction to greenhouse gas emissions for Period 4 were different than those of other periods, but were neither the lowest nor the highest. This makes sense as the houses that came during Period 2 had the lowest mean levels of energy performance, and those in Period 1 the highest.

In order to understand whether certain types of advice were more appealing to those who had a follow-up evaluation, the recommendations given to participants were analysed by participation type within groups. Similar to previous analysis, the participation types were defined as those who had an initial evaluation only and those who had a follow-up evaluation. Table 4.23 presents the mean recommended reduction in heat losses by participation type. The table demonstrates that the mean recommended reduction to heat loss due to air leaks and basements of groups 1f and 1.1f were different and larger than those of group1i. The mean recommended reduction to heat loss to ceiling, walls, and windows and doors were all found to be different and larger in group 1.1f than those of group1i.

However, in Periods 2 and 4, no differences were detected in the mean recommended reduction to heat loss to air leaks or ceilings by participation type. Interestingly, the mean recommended reduction to heat loss to walls is lower for group 2f than group 2i. The mean recommended reduction for each of heat loss to basements and walls are found to be different and lower for group 4f than group 4i.

Table 4.24 describes the mean recommended change to heating systems within periods by participation type. In terms of the recommendation to improve the efficiency of a natural gas furnace, the same pattern is observed for all periods. The mean recommended change to natural gas furnace efficiency was different and higher for each follow-up group when compared to its corresponding initial only group. Due to small group sizes, results are inconclusive for oil furnaces.

Table 4.25 describes the mean recommended changes to hot water heating system efficiencies. The only detected differences between participation types within each program period was that the mean recommended change to the efficiency of an electric hot water heater was different and higher for group 2 f than group 2i.

During Period 1, the subsets of houses that returned had higher recommended reductions to heat loss air leaks and basement than those that participated only in an initial evaluation. Group 1.1f was associated with a higher mean recommendation to reduce heat losses to ceiling, walls and windows and doors than group 1i as well. The mean recommended reduction to heat losses does not appear to be much different between participation types for Periods 2 or 4. The recommended improvement in efficiency to natural gas furnaces was higher for the returning group than the initial only for all three periods. Recommended changes to hot water systems did not appear to be a strong influence as few differences in mean efficiencies were found.

Participation Type by Period		Heat Loss Air Leaks (MJ) ∞Ə			Heat Loss Basement (MJ) ∞Ə			Heat Loss Ceiling (MJ)∞			Heat Loss Walls (MJ) ∞ƐƏ			Heat Loss Windows and Doors (MJ) ∞Ɛ Ə		
	n	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*	*mean*	*post hoc*	*SD*
1i	3800	7108	1f1.1f	9188	7516	1f1.1f	10425	2707	1.1f	5117	4200	1.1f	13095	2319	1.1f	4179
1f	67	11750	1i	13491	13255	1i	13673	5999		11483	7482		17314	3765		5379
1.1f	393	10367	1i	11312	12994	1i	13641	5345	1i	11101	8056	1i	17488	3747	1i	6861
Total	4260	7482		9544	8111		10950	3002		6121	4607		13679	2473		4534
2i	1892	9033		11058	12855		12625	3492		6634	8239		16112	4560		5660
2f	1056	8134		8683	13770		12286	3509		6028	6842	2i	13913	4491		5301
4i	1391	6151		7023	12671		13377	3168		5788	6179		14027	3673		6252
4f	4600	5377		6397	11206	4i	12838	3005		6750	4958	4i	12607	2845	4i	5026

i = indicates group participated only in initial evaluation   f = indicates group participated in follow-up evaluation
∞ variances are not equal among the groups 1i, 1f, and 1.1f , Ɛ the variance of group 2i is not equal to that of group 2f, Ə the variance of group 4i is not equal to that of group 4f
SD indicates standard deviation
Post hoc tests: the group label indicates cases where the mean of the group is different from the means of the other listed groups (by label)

Table 4.23 Recommended Reductions to Heat Loss between Initial Only and Follow-Up Evaluation by Program Structure

Participation Type by Period		Natural Gas∞ƐƏU				Oil∞Ɛ	
	n	*#*	*Eff (%)*	*post hoc*	*SD*	*#*	*Eff (%)*
1i	3800	3389	6	1f1.1f	7	114	3
1f	67	55	11	1i	7	3	0
1.1f	393	322	10	1i	8	15	4
Total	4260	3766	6		8	132	3
2i	1892	1571	6		6	35	3
2f	1056	814	11	2i4f	5	15	5
4i	1391	1200	7		8	26	1
4f	4600	4015	10	4i2f	8	86	1

i = indicates group participated only in initial evaluation   f = indicates group participated in follow-up evaluation
∞ variances are not equal among the groups 1i, 1f, and 1.1f , Ɛ the variance of group 2i is not equal to that of group 2f, Ə the variance of group 4i is not equal to that of group 4f
SD indicates standard deviation, Eff (%) indicates mean recommended change to system efficiency
Post hoc tests: the group label indicates cases where the mean of the group is different from the means of the other listed groups (by label)

Table 4.24 Recommended Changes to Heating System Characteristics by Participation Type Within Periods

Participation Type by Period		Electricity∞ Ɛ				Natural Gas			Oil¥		Propane	
	n	*#*	*Eff (%)*	*post hoc*	*SD*	*#*	*Eff (%)*	*SD*	*#*	*Eff (%)*	*#*	*Eff (%)*
1i	3800	369	0		6	3271	2	7	20	0	3	0
1f	67	8	-8		30	53	3	8	0	0	0	0
1.1f	393	55	0		1	309	2	7	2	0	0	0
Total	4260	432	0		7	3633	2	7	22	0	3	0
2i	1892	304	-6		21	1495	1	4	8	0	3	-9
2f	1056	208	-2	2i	13	778	1	3	3	0	3	10
4i	1391	151	-3		15	1052	10	14	8	0	2	0
4f	4600	494	-3		15	3605	9	14	25	0	11	0

i = indicates group participated only in initial evaluation   f = indicates group participated in follow-up evaluation
∞ variances are not equal among the groups 1i, 1f, and 1.1f , Ɛ the variance of group 2i is not equal to that of group 2f, Ə the variance of group 4i is not equal to that of group 4f
SD indicates standard deviation, Eff (%) indicates mean recommended change to system efficiency
Post hoc tests: the group label indicates cases where the mean of the group is different from the means of the other listed groups (by label)

Table 4.25 Recommended Changes to Hot Water System Characteristics by Participation Type Within Periods

4.6 Advice-following

This part of the research is focused on understanding how well homeowners followed advice. This section presents results of the levels of achievement by homeowners compared to what was recommended to them. As Chapter 3 describes, the possible outcomes for any specific recommendations are described in Table 3.6. As described in Section 3.8.1, a Marimekko chart structure was employed to describe advice-following for each decision. The recommendations presented in Table 4.20 and in Figure 4.9 are for all of the initial evaluations for each program period. The Marimekko charts presented in Figure 4.10 represent the decisions made by the subset of homeowners who returned for a follow-up evaluation.

Overall, within each program period, for seven of the eight decisions, a larger percentage of the houses that returned for a follow-up had been given the recommendation than had not been given the recommendation. The first assessment of interest that was made with these tables and charts was to compare the percentage of homeowners in each period that returned and fall into the category of "*Not recommended and not changed*" to the percentage of houses to which that measure was not recommended, as presented in Table 4.20. The decision that had the highest percentage of "*Not recommended and not changed*", depending on the vintage group, was the heat recovery ventilator (~60% to 90%), followed by heat loss walls (~59% to ~72%), followed by hot water systems (~47% to ~69%), followed by windows and doors (~30% to ~45%), ceiling (~27% to ~45%), heating system (~12% to ~25%), basement (~15% to ~22%), followed by air leaks (~5% to ~10%). Referring back to Table 4.20 and Figure 4.9, these percentages are smaller than the percentage of houses to which each of these decisions was not recommended for all decisions except in the case of the heat recovery ventilator.

The next type of advice-following that was examined was the decision "*recommended and not changed*". These are obviously retrofits that homeowners avoided making despite advice to do so. The retrofits with the largest percentage of households in this category were hot water systems (~15% to ~40%), the reduction to heat loss through the ceiling (~10% to ~30%), basement (~15 to 20%), followed by walls (~10% to ~20%). There was a significant percentage (~15%) of heating systems "*recommended and not changed*" in Period 4. Period 2 had a larger percentage of "*recommended and not changed*" than other periods for windows and doors (20%), basement (25%), ceiling (~27%), and walls (20%).

Seven of the eight decisions were examined for the extent to which homeowners achieved what was recommended. One quarter to one third of homeowners performed poorly at less than half ("*<50% of what was recommended*") of the recommended reduction to heat losses through the basement. Of the seven decisions, this was the decision that was most often implemented poorly. Homeowners performed poorly ("*<50% of what was recommended*") when they addressed recommendations to reduce heat lost through air leaks. This poor level of achievement of decisions was found for air leaks (up to 22%) and windows and doors (up to 25%). It was rare for the heat loss of walls or basements to be improved more than the amount recommended. Usually the level of achievement of these decisions was only moderate, with the greatest percentage achieving less than 50% of what was recommended. The decisions for which it was more common for the change to outperform the recommendation ("*100% to <200% of what was recommended*" or better) were reductions to heat loss air leaks (up to 35%), ceiling (up to 30%), and heating systems (up to 70%).

Another decision of interest was the decision "*not recommended and changed"*. This decision type was most common in the case of reducing heat loss through air leaks (up to 25%), followed by heat loss to windows and doors (up to 18%). For heat loss air leaks, one explanation could be that a reduction was not recommended, but it could also have been that sometimes the reduction that was recommended was smaller than the selected threshold of 1GJ. If that had been the case, the homeowner would have reduced heat losses to air leaks to a greater extent than what was recommended initially, as the recommendation would have been less than 1GJ and the change would have been more than 1 GJ. Overall, a larger percentage of houses had a high level of achievement compared to recommendations for air leaks than those who did poorly. A larger percentage of households in Period 2 did better at reducing air leaks than other periods.

The examination of how advice was followed in the decision to replace windows and doors revealed that this decision was a unique category. Across all periods, 5 to 10% of houses that returned fell into the decision category of "*not recommended and changed*". Approximately 15% to 20% of the houses that returned for a follow-up evaluation addressed windows and doors, but achieved a much smaller reduction to heat loss than the recommendation ("*<50% of what was recommended*"). A large percentage of houses (up to 15%) did more than what was recommended ("*100% to <200% of what was recommended*" or better). One possible explanation is that homeowners, even when advised not to, changed their windows and doors anyway. For those that followed advice poorly, it could be that they were recommended to change their windows to a certain standard, such as EnerGuide label or triple glazed windows, and they may have chosen a lower standard. For those who changed their windows and doors and did more than what was recommended, they may have either followed a recommended higher standard, or, they might have changed more windows than what had been recommended.

Homeowners rarely added heat recovery ventilators (HRV), whether it was recommended or not.

In the case of ceiling insulation, the change was either done poorly or quite well. Approximately 15% to 30% of decisions to ceiling were "*recommended and not changed*", approximately 5% to 15% achieved "*<50% of what was recommended*", and 15% to 20% of homeowners who returned achieved "*100% to <200% of what was recommended*" or better.

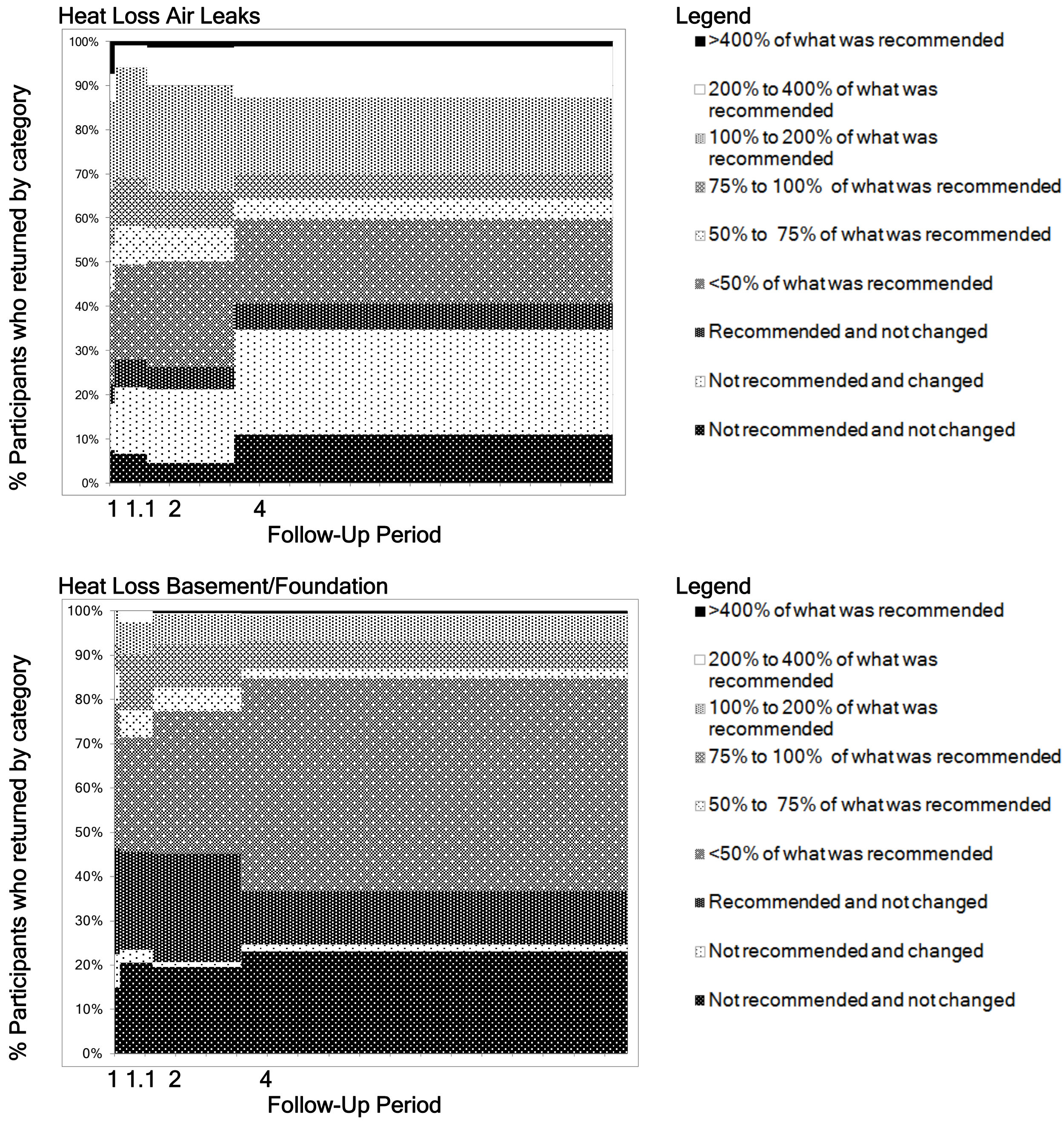
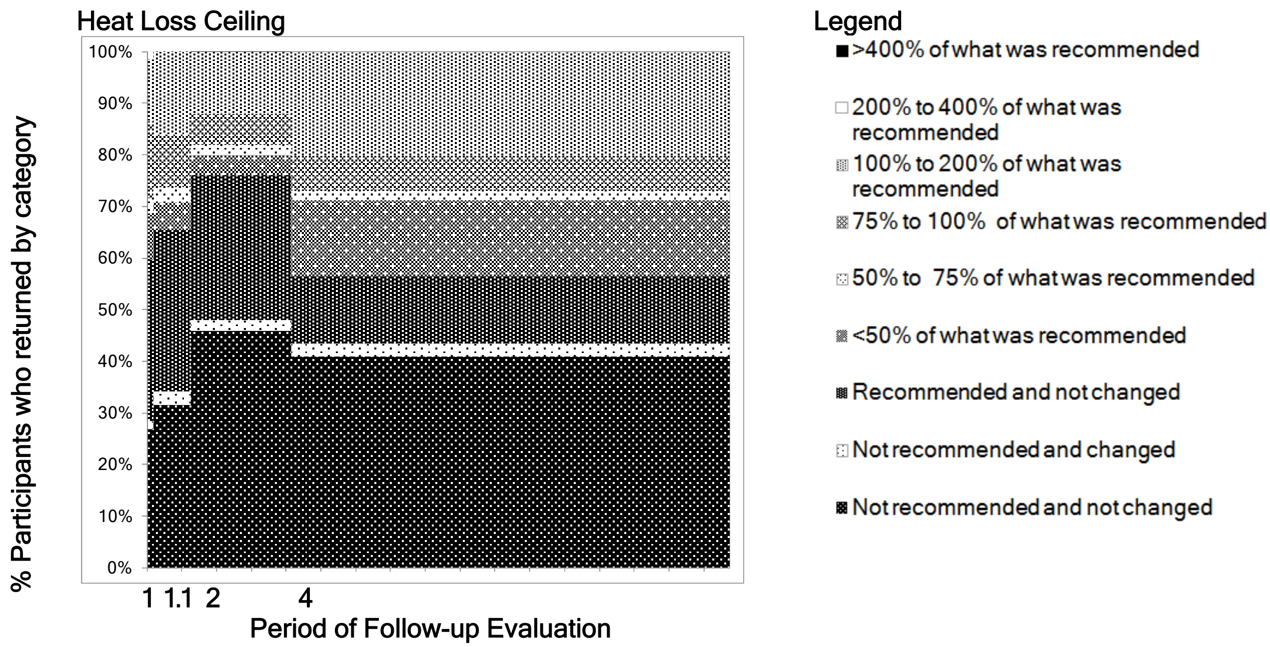


Figure 4.10 Advice-following: Extent to Which Recommendations Were Achieved



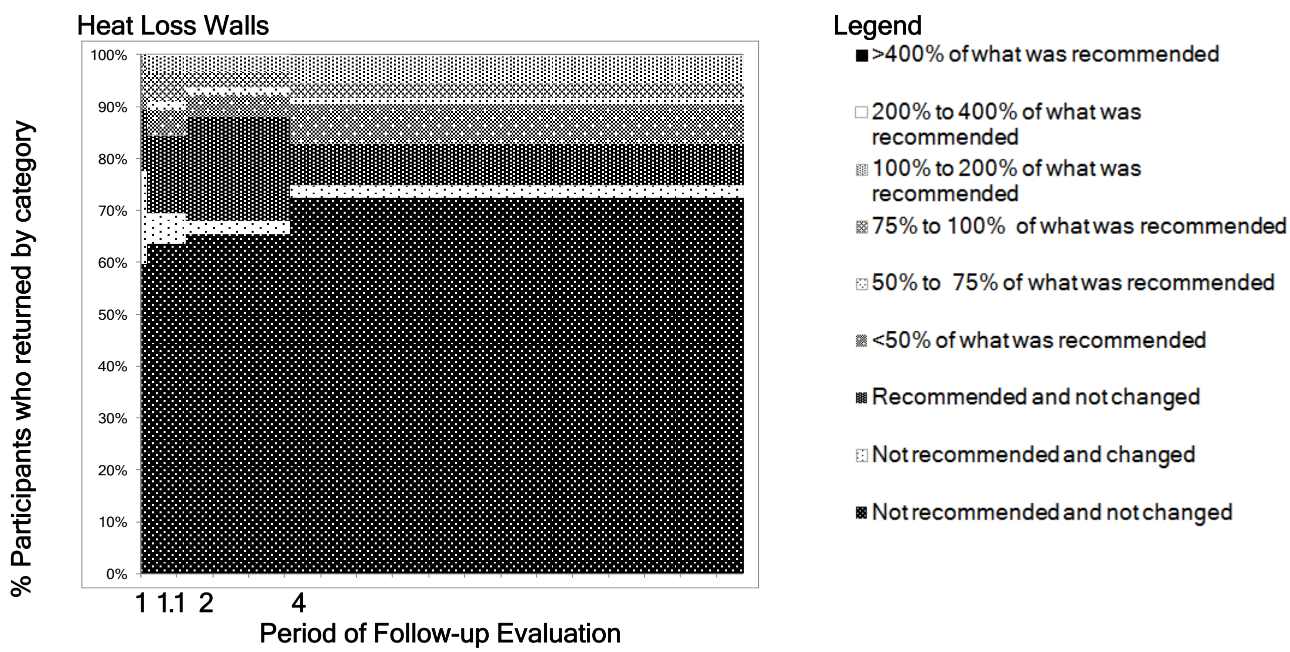
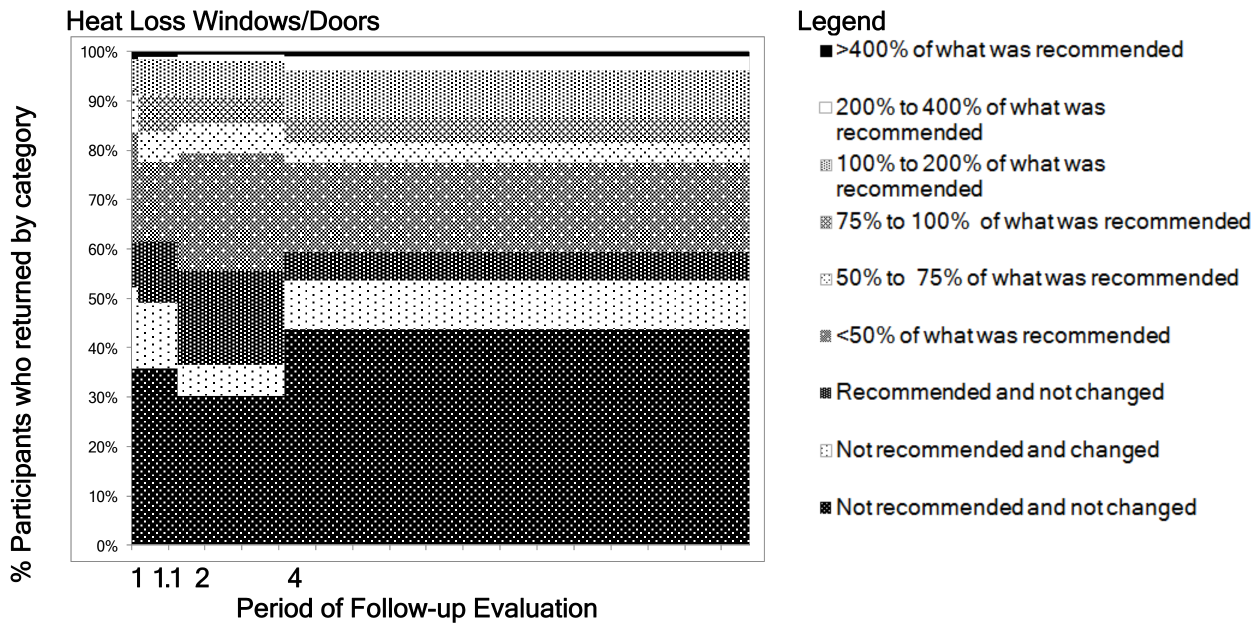


Figure 4.10 Advice-following: Extent to Which Recommendations Were Achieved (continued)



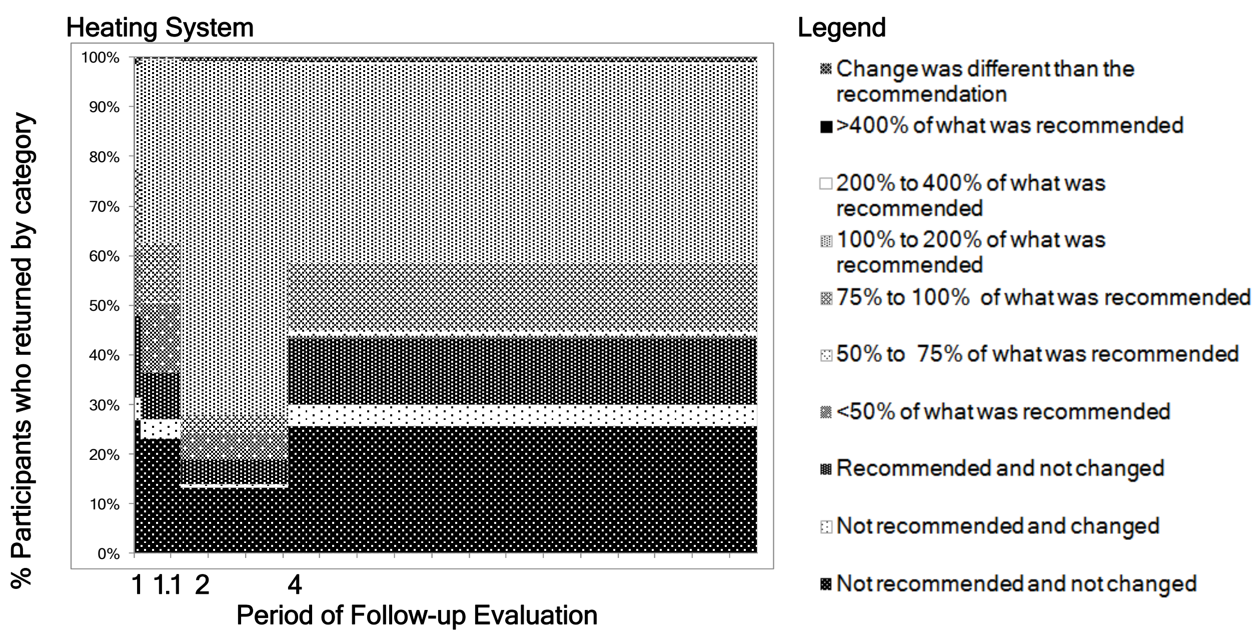
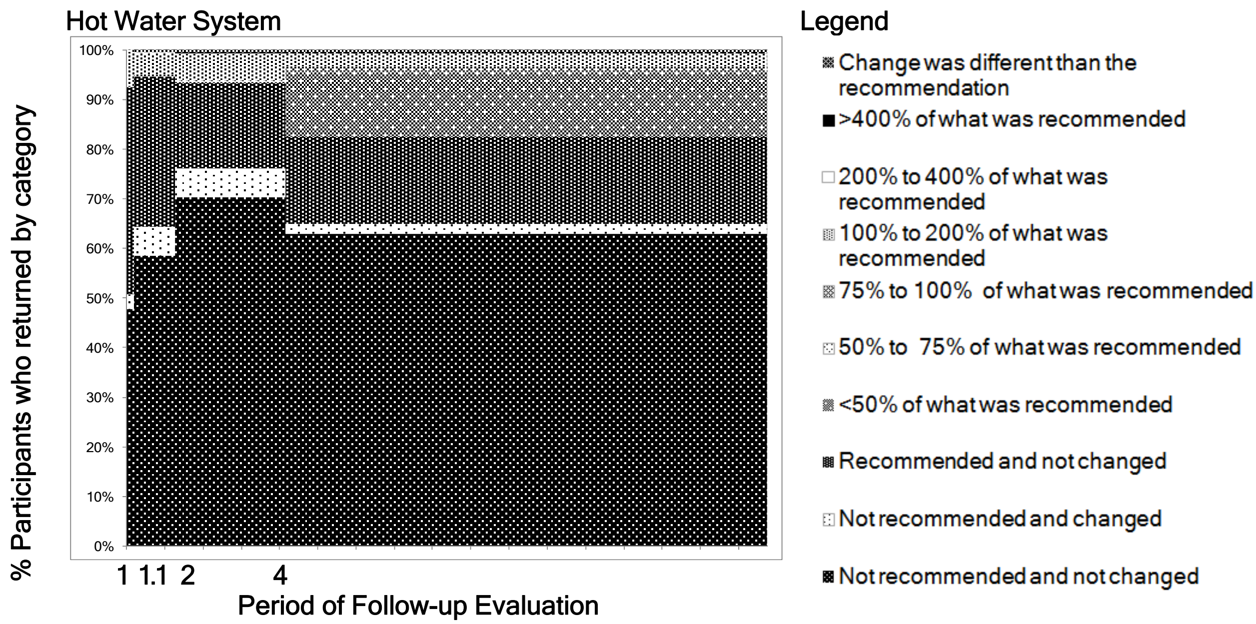


Figure 4.10 Advice-following: Extent to Which Recommendations Were Achieved (continued)



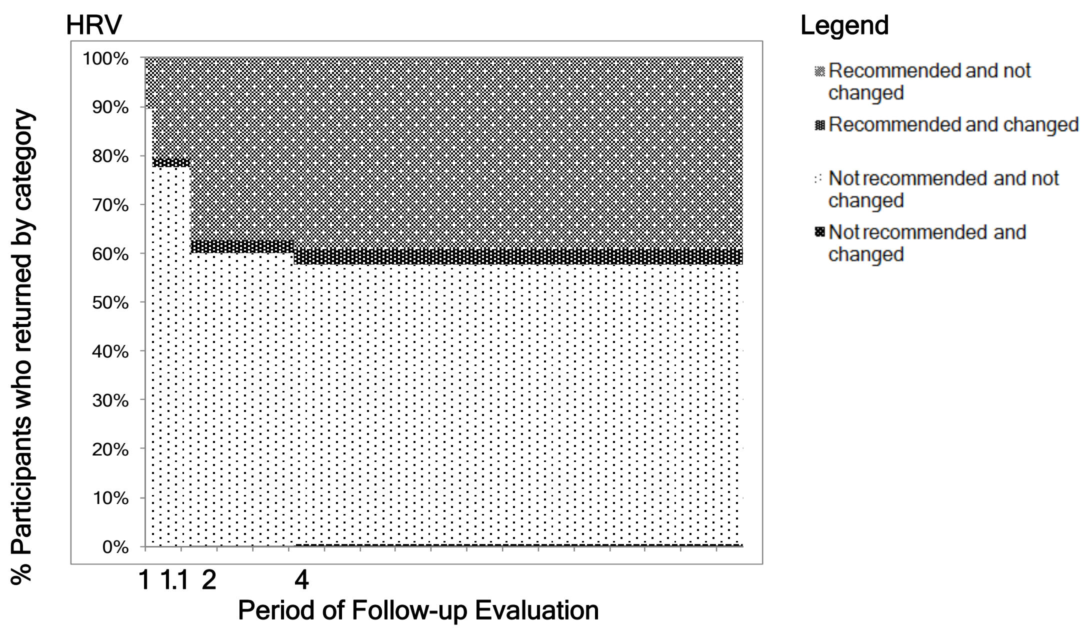


Figure 4.10 Advice-following: Extent to Which Recommendations Were Achieved (continued)

4.6.1 Process-Based Perspective

The analysis presented in this section contributes to extending the current understanding of the process-based perspective of participation in a home energy evaluation program. This section presents an analysis of the advice offered during the evaluation process about the package of home energy retrofits as a group of decisions. When the advice offered was analysed as a group of independent recommendations and decisions, the advice and decisions were examined in terms of prioritization and trade-off decisions. This section also presents the results of the examination of the different decision making patterns that homeowners used as they relate to the advice given and how these related to the number of improvements made. The analysis on advice and decisions that was performed in this way also contributes to elaborating on current understandings of the social learning perspective, how homeowners learn new procedural knowledge to reduce uncertainty and complete retrofits. The nature of these trade-offs and favoured decisions were examined within the various program structures. Due to the small number of houses that returned, Period 3 was excluded from this analysis.

Although homeowners were not necessarily aware of how each improvement would improve the energy efficiency of their house, the utility of an improvement was confirmed. Table 4.26 and Table 4.27 are bivariate tables that show the show the mean and the median change in energy rating score associated with the number of retrofits made. Figure 4.11 shows the mean change in energy rating associated with the number of retrofits made, from one to six retrofits. This analysis established that as the number of completed retrofits increased, the mean and median improvement in energy rating increased. Table 4.26 shows that the size of the change in energy score for each number of completed retrofits varied during each program period. Table 4.27 shows that the mean change in energy rating score was different for each of one to six retrofit decisions made.

Period 1

Number of Retrofits Completed	#	Improvement in energy rating (points)			
		Mean	**Median**	**Min**	**Max**
1	3	0	1	-8	6
2	17	5	4	-1	20
3	25	8	7	0	27
4	19	9	8	3	20
5	1	12	12	12	12
6	2	20	20	14	27
Total	67	8	6	-8	27

Period 1.1

Number of Retrofits Completed	#	Improvement in energy rating (points)			
		Mean	**Median**	**Min**	**Max**
1	37	4	4	-2	9
2	108	6	6	-1	16
3	132	8	6	0	31
4	73	10	9	-1	31
5	34	14	11	2	28
6	7	14	14	7	19
7	2	19	19	15	23
Total	393	8	7	-2	31

Period 2

Number of Retrofits Completed	#	Improvement in energy rating (points)			
		Mean	**Median**	**Min**	**Max**
0	3	2	2	0	3
1	167	6	6	1	33
2	330	8	8	0	56
3	301	10	9	-1	45
4	160	12	11	3	36
5	69	16	13	3	45
6	24	25	23	9	53
7	2	27	27	22	31
Total	1056	10	8	-1	56

Period 4

Number of Retrofits Completed	#	Improvement in energy rating (points)			
		Mean	**Median**	**Min**	**Max**
0	72	0	0	-3	6
1	1304	3	2	-9	20
2	1552	5	5	-4	35
3	905	8	7	-3	39
4	468	11	10	-2	46
5	214	17	15	1	49
6	67	20	17	3	57
7	15	30	22	10	99
8	3	9	9	7	12

Table 4.26 Number of Retrofits Versus Improvement in Energy Rating by Period

Number of Retrofits Completed	#	Improvement in Energy Rating (points)			
		Mean ¥Ψ	Median	Min	Max
1	1513	3.4	2.0	-9	33
2	2009	6.0	6.0	-4	56
3	1363	8.2	7.2	-3	45
4	722	11.4	10.0	-2	46
5	319	16.2	14.0	1	49
6	100	20.6	18.0	3	57
7	19				
8	3				

¥ variances not equal
Ψ the means of the six compared groups are not equal

Table 4.27 Number of Retrofits Versus Improvement in Energy Rating

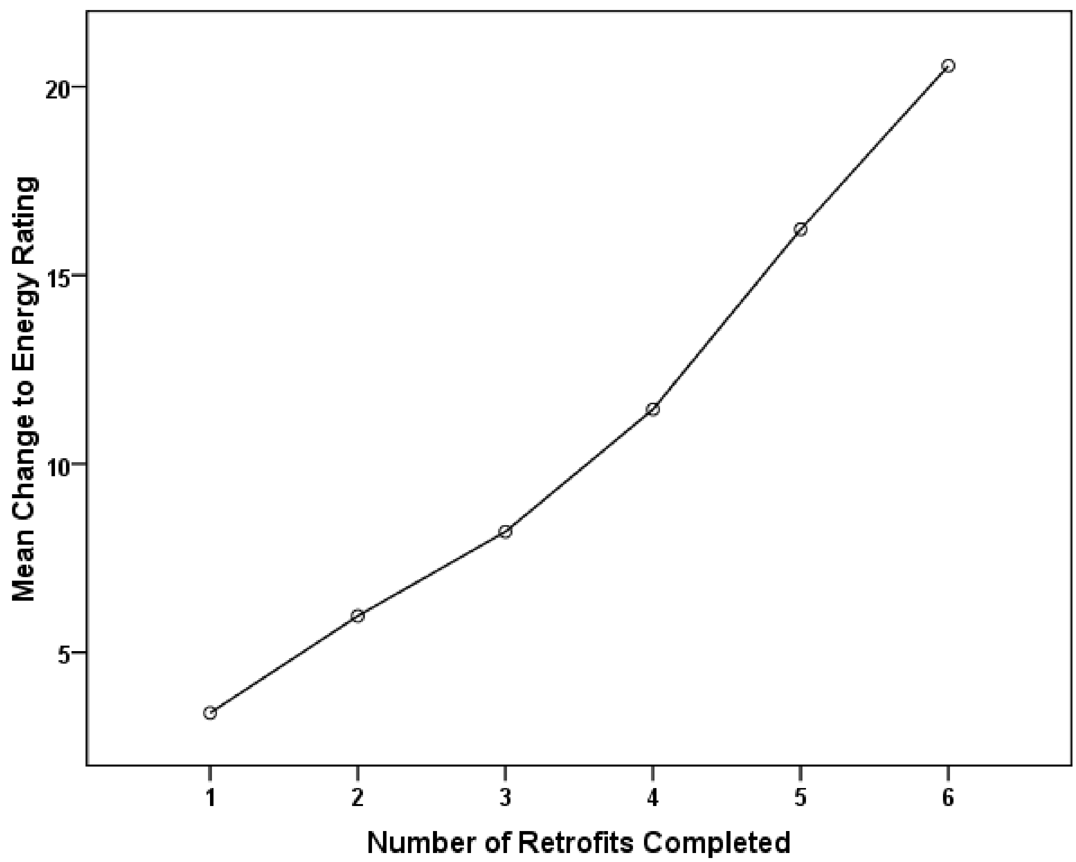


Figure 4.11 Number of Retrofits Versus Improvement in Energy Rating

Table 4.28 was constructed and presents both a cross-tabulation and a bivariate table that helped to assess whether the number of recommendations given influenced the decision to return for a follow-up evaluation, the cross-tabulation presents the counts of households that participated in the initial evaluation by the number of recommendations given for each program period. The bivariate table presents the percentage of the houses from each initial period that returned for a follow-up evaluation grouped by the number of recommendations given.

The peak count for each period occurred at four recommendations. From the bivariate table that reports the percentage of houses that returned, the follow-up for Period 1 was difficult to analyse due to little data. For the groups of houses that had a follow-up evaluation during Periods 1.1 and 2, the same pattern can be seen: the percentage that participated in the initial evaluation and returned for a follow-up did not correspond to the distribution of number of recommendations. Rather, as the number of recommendations increased, so did the percentage of those who returned for a follow-up.

The relationship between the percentage that returned for a follow-up compared to the number of changes recommended in Period 4 was different than those of Periods 1.1 and 2. For the households that were recommended zero changes or one change, the percentages that returned were 64% and 66% respectively. These were the lowest percentages of an initial group that returned during Period 4, but higher than any other percentage of return in the other three follow-up periods (Periods 1, 1.1, and 2). In Period 4, of those homeowners who were recommended to make eight changes, 85% returned for a follow-up evaluation. This was the highest percentage of a group that returned overall. For the groups that were recommended two to seven recommendations, the percentage that returned was similar for all groups, ranging from 76 to 78%.

Overall, it appears that homeowners were not necessarily deterred from returning for a follow-up evaluation when confronted with a large set of options. In Period 2, a higher number of recommendations was associated with a higher rate of further participation.

Number of Changes Recommended	Recommended in Period of Initial Evaluation (#)			Percent Returned for Follow-Up (%)			
	1	*2*	*4*	*1*	*1.1*	*2*	*4*
0	31	10	11	0	3	0	64
1	168	33	70	0	2	6	66
2	660	195	361	1	4	16	76
3	1041	538	1186	2	7	27	76
4	1076	797	1700	1	10	37	78
5	750	769	1552	1	12	41	76
6	365	463	795	4	16	42	77
7	155	135	289	3	17	50	78
8	14	8	27	0	21	38	85

Table 4.28 Number of Recommendations Given and Percentage of Return by Period

Table 4.29 was constructed to assess for a relationship between the number of recommendations given and the number of changes made. Table 4.29 presents a bivariate table that summarizes the number of changes made according to the number of recommendations given. The table has multiple parts to assess whether the relationship was different within the differed periods. Period 1 had so few houses return that it was difficult to discern any pattern. In all other follow-up periods, as the number of recommendations increased, the median number of changes made increased as well, although it was a gradual increase. Overall, the median number of changes made was two or three. As the median number of changes was only two values, the mean was also calculated. The mean increased slightly more rapidly for Periods 1, 1.1, and 2 than for Period 4. For example, in Period 1.1, the median number of changes made reached three changes at three recommendations, in Period 2 it reached three changes at five recommendations, and in Period 4 it reached three changes at six recommendations. Overall, when all the data for all time periods was aggregated, the same general pattern presented itself. In summary, the number of recommendations given was associated with the number of changes made.

Table 4.30 summarizes the number of changes made by the elapsed time between home energy evaluations. The dates for both evaluations were only available for 6084 of the 6123 houses that had both an initial and a follow-up evaluation. Although only 50 of the 67 houses that returned in Period 1 had associated dates, the majority of follow-up evaluations that were held in Period 1 returned after 18 months and completed between 2 and 6 changes. The majority (340 of 393) of homeowners who returned for a follow-up evaluation during Period 1.1 also returned after 18 months. Neither of these periods had a financial reward associated with them when homeowners had an initial evaluation. It is not clear that homeowners returned as soon as retrofits were completed, rendering it difficult to analyse the relationship of time to retrofits.

It was assumed that during the periods in which there were financial rewards, homeowners returned for a follow-up as soon as they had completed their selected retrofits. In Period 2, as the timeframe between evaluations increased, so did the counts of the follow-up evaluations. The peak number of follow-up evaluations occurred at 15 to 18 months at 246, and dropped slightly to 209 evaluations after 18 months. In Period 4, the count of follow-up evaluations had two peaks: one at up to 3 months (up to 1 month and 1 to 3 months combined) at 18% of follow-up evaluations, and another peak occurred at 15 to 18 months, a timeframe in which 19% of follow-up evaluations returned. Between these two peaks, as the timeframe between evaluations increased, the percentage of households that returned decreased from 15% down to 12%. The timeframe with the lowest returning percentage of houses at 9% returned just after 18 months. It appears that different program structures were associated with different timeframes of participation, even when each program structure had the same 18 month limit. To illustrate, participants in Period 2 took longer to return, whereas participants of Period 4 tended to return across all three month timeframes before 18 months.

For both Periods 2 and 4, the median and the mean number of changes made generally increased as elapsed time increased (except between nine and 18 months for Period 2 which were approximately the same). In Period 2, the median number of changes reached three at nine to 12 months, whereas it reached three at 15 to 18 months during Period 4. Overall, as time increased, the number of retrofits completed increased, although the number appeared to increase more gradually in Period 4 than in Period 2.

Period 1 Follow-Up			Number of Changes Completed			
Total Changes Recommended	# Houses Returned	Percent (%)	Mean*	Median	Min	Max
0	0	0				
1	0	0				
2	5	7	2.2	2	1	4
3	19	28	3.2	3	2	6
4	13	19	3.1	3	2	4
5	11	16	3.1	3	2	4
6	15	22	2.9	3	1	4
7	4	6	4.0	4	2	6
8	0	0				
Total	67	100	3.1	3	1	6

Follow-Up Period 1.1			Number of Changes Completed			
Total Changes Recommended	# Houses Returned	Percent (%)	Mean*	Median	Min	Max
0	1	0.3	5.0	5	5	5
1	3	0.8	1.7	2	1	2
2	25	6	2.5	2	1	5
3	74	19	2.6	3	1	7
4	110	28	3.0	3	1	6
5	91	23	3.0	3	1	6
6	59	15	2.9	3	1	5
7	27	7	3.8	4	1	7
8	3	1	5.0	5	4	6
Total	393	100	3.0	3	1	7

Follow-Up Period 2			Number of Changes Completed			
Total Changes Recommended	# Houses Returned	Percent (%)	Mean*	Median	Min	Max
0	0	0				
1	2	0	1.5	1.5	1	2
2	32	3	2.0	2	1	4
3	146	14	2.3	2	0	6
4	291	28	2.5	2	0	6
5	319	30	2.8	3	1	6
6	195	18	3.0	3	1	7
7	68	6	3.4	3	1	7
8	3	0	4.3	5	2	6
Total	1056	100	2.7	3	0	7

Follow-Up Period 4			Number of Changes Completed			
Total Changes Recommended	# Houses Returned	Percent (%)	Mean*	Median	Min	Max
0	7	0	2.1	2	0	6
1	46	1	1.8	2	0	7
2	276	6	1.8	2	0	6
3	904	20	1.9	2	0	6
4	1318	29	2.2	2	0	7
5	1185	26	2.5	2	0	8
6	615	13	2.8	3	0	8
7	226	5	2.7	3	1	8
8	23	1	2.6	2	1	6
Total	4600	100	2.3	2	0	8

*The variable is ordinal, so a mean calculation is represented only to show a shifting distribution

Table 4.29 Number of Recommendations Versus Number of Changes Completed by Period of Follow-Up Evaluation

Follow-Up Period 1			Number of Changes Completed			
Elapsed Time Between Evaluations (months)	# Houses Returned	Percent (%)	Mean*	Median	Min	Max
< 1	0	0	NA	NA	NA	NA
1 to 3	0	0	NA	NA	NA	NA
3 to 6	3	6	2.7	2	2	4
6 to 9	0	0	NA	NA	NA	NA
9 to 12	0	0	NA	NA	NA	NA
12 to 15	2	4	2.5	2.5	1	4
15 to 18	5	10	3.6	3	2	6
>18	40	80	3.1	3	2	6
Total	50	100	3.1	3	1	6

Follow-Up Period 1.1			Number of Changes Completed			
Elapsed Time Between Evaluations (months)	# Houses Returned	Percent (%)	Mean*	Median	Min	Max
< 1	0	0	NA	NA	NA	NA
1 to 3	7	2	1.9	2	1	2
3 to 6	6	2	2.7	3	1	4
6 to 9	6	2	3.2	3	1	5
9 to 12	8	2	2.3	2	1	4
12 to 15	18	5	3.1	3	1	6
15 to 18	44	11	3.2	3	1	5
>18	304	77	3.0	3	1	7
Total	393	100	3.0	3	1	7

Follow-Up Period 2			Number of Changes Completed			
Elapsed Time Between Evaluations (months)	# Houses Returned	Percent (%)	Mean*	Median	Min	Max
< 1	4	0	1.8	2	1	2
1 to 3	85	8	2.0	2	1	4
3 to 6	120	11	2.1	2	1	6
6 to 9	110	10	2.5	2	0	6
9 to 12	118	11	2.9	3	0	6
12 to 15	162	15	2.8	3	1	7
15 to 18	246	23	2.9	3	1	6
>18	209	20	3.1	3	0	7
Total	1054	100	2.7	3	0	7

Follow-Up Period 4			Number of Changes Completed			
Elapsed Time Between Evaluations (months)	# Houses Returned	Percent (%)	Mean*	Median	Min	Max
< 1	143	3	1.6	1	0	6
1 to 3	683	15	1.8	2	0	5
3 to 6	672	15	2.0	2	0	7
6 to 9	652	14	2.3	2	0	7
9 to 12	569	12	2.3	2	0	6
12 to 15	560	12	2.5	2	0	8
15 to 18	886	19	2.7	3	0	8
>18	416	9	2.8	3	0	8
Total	4581	100	2.3	2	0	8

*The variable is ordinal, so a mean calculation is represented only to show a shifting distribution

Table 4.30 Elapsed Time Versus Number of Changes Completed

To understand how homeowners prioritized decisions related to the eight possible recommendations, Table 4.31 presents a cross-tabulation of decision type by the number of changes made. It can answer the following questions, "for homeowners who only made one (two, etc.) change(s), what was (were) the most common change(s) made?" The small number who did follow-up in Period 1 made any assessment difficult for this period. Across follow-up Periods 1.1, 2 and 4, the most common single change made was to the heating system. When two changes were made the most typical two decisions were to change the heating system and to reduce heat loss due to air leakage. When three changes were made, the most common changes were to replace the heating system, a reduction to heat loss due to air leakage and a reduction to heat loss through windows and doors. In Periods 1.1 and 2, a reduction in heat loss through the basement had the fourth highest count when three or four changes were made. In Period 4, reduction in heat loss through ceiling was the fourth most common change made when three changes were made. Further, a reduction to the heat loss through the basement had the fourth highest count when three or four decisions were made.

In terms of how specific decisions were made, some common patterns can be seen to have occurred. For example, changes to the heating system were made alone or in combination with other measures. Despite the large number of houses in which heat loss due to air leaks was improved, this decision was typically done in combination with other measures—it was rare for a house to return having only improved heat loss due to air leaks. Decisions to reduce heat loss through the building envelope were completed in combination with other decisions. Following the results presented in Table 4.31, changes to reduce heat loss through walls, changes to the hot water system, and heat recovery ventilator were not commonly done, no matter how many changes were made.

Period 1

Number of Changes Completed	Type of Change Completed (#) (1) Air Leaks	(2) Basement	(3) Ceiling	(4) Walls	(5) Windows and Doors	(6) Heating System	(7) Hot Water System	(8) HRV
1	0	0	0	0	1	2	0	0
2	9	4	3	2	4	10	2	0
3	21	12	7	6	14	13	2	0
4	19	15	13	8	9	10	2	0
5	1	1	1	1	0	1	0	0
6	2	2	2	2	1	2	1	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0

Period 1.1

Number of Changes Completed	Type of Change Completed (#) (1) Air Leaks	(2) Basement	(3) Ceiling	(4) Walls	(5) Windows and Doors	(6) Heating System	(7) Hot Water System	(8) HRV
1	2	6	3	0	4	22	0	0
2	60	29	16	5	4	80	1	1
3	99	64	41	23	71	87	7	4
4	63	60	40	28	44	42	14	1
5	30	32	26	18	21	26	17	0
6	7	7	7	4	6	6	4	1
7	2	2	2	2	2	2	2	0
8	0	0	0	0	0	0	0	0

Period 2

Number of Changes Completed	Type of Change Completed (#) (1) Air Leaks	(2) Basement	(3) Ceiling	(4) Walls	(5) Windows and Doors	(6) Heating System	(7) Hot Water System	(8) HRV
1	2	13	3	0	3	146	0	0
2	212	53	29	12	57	280	12	5
3	244	136	64	32	139	241	35	12
4	139	114	80	40	103	117	37	10
5	66	57	53	33	51	55	29	1
6	23	24	22	20	16	23	15	1
7	2	2	2	2	2	2	2	0
8	0	0	0	0	0	0	0	0

Period 4

Number of Changes Completed	Type of Change Completed (#) (1) Air Leaks	(2) Basement	(3) Ceiling	(4) Walls	(5) Windows and Doors	(6) Heating System	(7) Hot Water System	(8) HRV
1	48	45	89	31	220	860	10	1
2	995	186	403	80	445	931	41	23
3	661	362	448	144	491	492	61	56
4	392	345	302	157	280	282	78	36
5	197	189	159	132	156	151	62	24
6	61	67	61	42	58	61	38	14
7	15	14	14	13	15	11	11	8
8	3	3	3	3	3	3	3	3

Table 4.31 Prioritization of Changes: Number and Type of Changes Completed

The number of decisions completed was compared to the number recommended and to the timeframe between the initial and follow-up evaluations. The analysis also examined the prioritization of decisions by homeowners. Table 4.32 adds insights to the process of retrofit decisions by summarizing the counts of specific decisions by elapsed time period between evaluations. For each type of retrofit, Table 4.32 also shows the percentage share of houses that completed the decision within each timeframe. In this case, the categories of "*up to 1 month*", and "*1 to 3 months*" were collapsed into a single category of "*up to 3 months*". As it was established that timeframe was only a meaningful measurement of decisions during periods with financial reward, the analysis is only presented for Periods 2 and 4.

Table 4.32 demonstrates that for both periods, the percentage of changes to heating systems that were measured was similar across timeframes up to 15 months. In Period 2, during each of the five timeframes up to 15 months, the percentage of the measured changes to heating systems ranged from 10% to 13%. During Period 4, a similar percentage of changes to heating systems were measured across the five timeframes between 3 and 15 months, and ranged from 13% to 17%. In Period 4, the largest percentage of changes to heating systems was measured during the timeframe of within three months, at 21%

Similarly, in Period 4, the highest percentage of the decisions to reduce heat loss due to air leakage were measured during the two timeframes of within three months and between 15 and 18 months at 16% and 20% respectively. The percentage of reductions to air leakage that were measured during the four timeframes between three and 15 months, were similar at13% to 15%.

A similar pattern was seen for the decision to add a heat recovery ventilator.

Despite relatively similar levels of participation across timeframes during Period 4 (as shown in Table 4.30), the decision to reduce heat loss to the basement, through walls, and through windows and doors all took the same pattern with respect to time. For each of these decisions, a larger percentage of the decisions made were measured at longer timeframes, and as the timeframe increased, so did the percentage of decisions. This shows that when participation across timeframes was similar, those who reduced heat loss through the basement, walls, or windows and doors usually returned for a follow-up after a longer period of time had passed. According to the results presented in Table 4.31, these three changes were made in combination with other changes, and this may also have affected the timeframe of return of each.

During Period 2, the pattern of counts by timeframe for heating systems was similar to that seen in Period 4, but less pronounced. The highest percentage of heating system replacements (22%) was measured at 15 to 18 months. The second highest percentage of replacements of heating systems (18%) was measured after 18 months. The percentage of heating systems that were confirmed to be replaced was similar across the five timeframes of up to 15 months, at 10% to 15%. A similar pattern between the periods also occurred for the decision to reduce heat loss due to air leaks. The largest percentage of reductions to air leaks were measured during the timeframes of 15 months or longer, but a similar percentage of these changes were measured across the five timeframes that were shorter than 15 months. Also similar to the pattern in Period 4, the decision counts to address heat loss through the basement, walls, and windows and doors increased as the time between evaluations increased, however, a larger percentage of these decisions were made after 15 months in Period 2 than in Period 4. Table 4.30 shows that different to Period 4, the number of follow-up evaluations increased as the timeframe increased during Period 2. This may explain why several of the different types of retrofits were confirmed as implemented after longer timeframes during Period 2 that during Period 4.

Summarizing these results, it appears that the decisions to replace the heating system and reduce heat loss due to air leaks were completed within nearly any timeframe. When only one change was made, the replacement of the heating system was the most common change. When two changes were made, reduction to air leakage was the second most common change. Meanwhile, most of the decisions to reduce heat loss through the basement, walls windows and doors were measured after a longer amount of time had passed between the evaluations. This makes sense as Table 4.31 shows that these decisions, particularly reductions to heat loss through the walls and basement, were typically done in combination with other decisions. This analysis confirmed that for the eight decisions, there were differences in the prioritization and combination of decisions made, and the some decisions are associated with longer periods of time between the initial and the follow-up evaluation. Considering the results in Table 4.30, Table 4.31, and Table 4.32, it appears that a longer timeframe allowed for the completion of more retrofits, particularly to improve the building envelope.

Period 2	Type of Change(s) Completed															
Elapsed Time Between Evaluations (months)	(1) Heat Loss Air Leaks		(2) Heat Loss Basement		(3) Heat Loss Ceiling/ Ceiling		(4) Heat Loss Walls		(5) Heat Loss Windows and Doors		(6) Heating System		(7) Hot Water System		(8) HRV	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
<3	51	7	10	3	8	3	1	1	7	2	88	10	10	8	2	7
3 to 6	71	10	16	4	16	6	4	3	22	6	113	13	7	5	2	7
6 to 9	61	9	42	11	22	9	11	8	32	9	89	10	16	12	3	10
9 to 12	84	12	51	13	36	14	16	12	43	12	97	11	15	12	0	0
12 to 15	118	17	67	17	38	15	25	18	58	16	127	15	19	15	4	14
15 to 18	156	23	110	28	67	26	40	29	109	29	192	22	38	29	7	24
>18	146	21	103	26	66	26	42	30	100	27	156	18	25	19	11	38
No time code	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Total	688	100	399	100	253	100	139	100	371	100	864	100	130	100	29	100

Period 4	Type of Change(s) Completed															
Elapsed Time Between Evaluations (months)	(1) Heat Loss Air Leaks		(2) Heat Loss Basement		(3) Heat Loss Ceiling/ Ceiling		(4) Heat Loss Walls		(5) Heat Loss Windows and Doors		(6) Heating System		(7) Hot Water System		(8) HRV	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
<3	382	16	91	8	228	15	44	7	85	5	579	21	34	11	19	12
3 to 6	331	14	137	11	158	11	64	11	203	12	411	15	41	13	26	16
6 to 9	331	15	138	11	227	15	75	12	236	14	414	15	37	12	23	14
9 to 12	355	13	142	12	161	11	91	15	205	12	358	13	33	11	17	10
12 to 15	300	13	171	14	215	15	71	12	263	16	316	11	37	12	23	14
15 to 18	471	20	351	29	338	23	159	26	466	28	464	17	77	25	34	21
>18	225	9	180	15	151	10	97	16	210	13	237	8	44	14	23	14
No time code	10	0	1	0	1	0	1	0	0	0	12	0	1	0	0	0
Total	2372	100	1211	100	1479	100	602	100	1668	100	2791	100	304	100	165	100

Table 4.32 Elapsed Time versus Type of Change Completed

4.6.2 (In)congruence Between Recommendations and Actions

The final component of the process-based analysis was to examine for the effects of different patterns of following advice. As described in Chapter 3, four different patterns of advice-following were established from the dataset: (1) homeowners who made a subset of the recommended improvements; (2) homeowners who made improvements that were not recommended; (3) homeowners who made improvements that were different than the one recommended, for example, if a natural gas furnace was recommended to be replaced by a ground source heat pump, but homeowners instead replaced with a higher efficiency natural gas furnace; (4) homeowners who did a combination of implementing an improvement not recommended and implementing an improvement that was different than what was recommended. Due to the low number of participants associated with group (4), this analysis combined all periods. As discussed in Chapter 3, these patterns could be indications of disagreement with the home energy advisor, for example, in a case where a homeowner had an intention and the advisor did not recommend that intention. They could also be indications of an information search pattern that can be associated with learning procedural knowledge. For example, homeowners in group (4) could be weighing various options and learning about the one recommended and the one selected that was different. However, groups (2), (3) and (4) all indicate some form of incongruence of decisions compared to what was recommended.

Table 4.33 describes the mean and median number of changes made by decision type group. It is difficult to compare due to the small size of group for groups (2) and (4). Despite its small size, group (4) had the highest mean and median number of changes made. Table 4.34 describes the percentage of each group that had a follow-up evaluation in each timeframe. Table 4.33 shows that 20 out of the total 31 in the decision type (4) group returned for a follow-up evaluation after 15 months. In both Periods 2 and 4, a longer elapsed time between home energy evaluations was associated with an increased number of changes made.

It should be noted that the pattern of decisions similar to decision type (4) may have occurred in other groups (for example, if a homeowner was advised to change insulation in a certain way and selected a different method). However, those identified in decision group (4) were the only ones that could be verified to have made this type of decision. In the group (4) decision type, homeowners it seems plausible that homeowners examined various options. However, this cannot be confirmed without further research. This analysis indicates that a decision making pattern in which incongruence in decisions against advice occurred for several decisions was associated with a longer elapsed time between evaluations, as well as a slightly higher number of changes made. This follows with findings in Table 4.34.

Advice-following Pattern	# Houses	Number of Changes Completed				
		Mean	Post hoc	Median	Min	Max
(1) Followed Advice	4578	2.2	234	2	0	7
(2) Different than Recommended	70	2.8	14	3	1	7
(3) Change not Recommended	1444	3.2	14	3	1	8
(4) Different and Not Recommended	31	4.3	123	4	2	7
Total	6123	2.4		2	0	8

Post hoc tests: the group label indicates cases where the mean of the group is different from the means of the other listed groups (by label)

Table 4.33 Advice-following Pattern Versus Number of Changes Completed

Elapsed Time Between Evaluations (months)	Advice-following Pattern							
	(1) Followed Advice		(2) Different than Recommended		(3) Change not Recommended		(4) Different and Not Recommended	
	#	%	#	%	#	%	#	%
Up to 1	129	3	1	1	16	1	1	3
1 to 3	661	15	6	9	108	8	0	0
3 to 6	653	14	13	19	135	9	2	6
6 to 9	616	14	6	9	146	10	1	3
9 to 12	541	12	7	10	144	10	3	10
12 to 15	515	11	9	13	214	15	4	13
15 to 18	803	18	14	20	357	25	8	26
>18	629	14	14	20	316	22	12	39
Total	4547	100	70	100	1435	100	31	100

Table 4.34 Elapsed Time versus Advice-following Pattern

4.7 Summary of Results

This study presents several findings about the importance of program structure as it affected participation and advice-following in a home energy evaluation program. This section presents a brief summary of results that will be compared to the results from Chapter 5 and to the results from other studies in the interpretation stage in Chapter 6.

The findings are an indication of heterogeneity of preferences that were attracted to each program structure. First, by comparing the houses that participated to housing stock of the Region of Waterloo, it appears that the vintage and location of participating houses was a result of self-selection, and was not necessarily a random sample of the population. It appears as though the distribution of participation by location during Period 2 was similar to the population in the Region of Waterloo. The distribution of participation by location in Periods 1, 3 and 4 appeared to have been overrepresented in some locations and underrepresented in others. This finding of the distribution of participants in various cities and utility company territories in the Region of Waterloo agrees with Song's (2008) analysis of the distribution of participants. Overall, it does not appear that participation in any of the programs was necessarily representative of the housing stock of the Region of Waterloo as owners of new houses were less likely to participate.

It appears that, while homeowners were interested in the information given during the initial evaluation, the promise of receiving only information as feedback was not sufficient to provoke a follow-up evaluation. The introduction of a financial reward, however, was associated with the action return for a follow-up to confirm that changes were made. The level of participation for initial evaluations was different depending on the program structure and the program support from varying levels of government. It was established that for a similar change in energy rating, the financial rewards offered in Period 4 were higher than those offered in Period 2. Participation in an initial evaluation did not vary whether a financial reward was offered, but it was markedly lower when there was no federal support (Period 3). Participation increased when the financial reward was list based instead of performance based. Summarizing, the introduction of a financial reward that generally offered more money per improvement of energy rating score and was list based was associated with the highest rate of participation in an initial evaluation, the highest rate of participation in a follow-up evaluation, and also associated with the highest percent of initial houses that returned for a follow-up.

The results show that the various program structures attracted groups of houses with different distributions of material characteristics. Period 2 attracted houses with the oldest mean vintage, the lowest mean energy rating, the highest mean energy consumption and the highest mean greenhouse gas emissions. Period 1 attracted houses with the highest mean energy rating. Period 4 attracted houses with neither the highest nor lowest distribution of energy rating scores. Period 4 attracted houses with the lowest mean energy consumption and greenhouse gas emissions.

The variation of the initial price within program structures did not seem to affect the types of houses that participated. Overall, no relationship could be determined in any of the analyses (Periods 1 and 3 and Period 4 relationships are shown in Appendix H). It appears that combinations of factors within the program structure beyond price were important to participation.

Within each program period, there was a subset of houses that returned for a second evaluation that had different types of material characteristics than the houses that did not return. The information-only groups (Period 1 and 1.1) and the performance-based financial reward (Period 2) seemed to attract houses with poorer energy performance characteristics to the follow-up evaluation than did the list-based reward structure (Period 4). For example, households in Period 1.1 and, to some extent, Period 1 seemed to be motivated to return when there were larger recommended reductions to heat losses, but this was not the case in Periods 2 and 4. While the larger list-based financial reward was associated with more than double the number of homeowners returned than the lower performance-based financial reward, it was not all lowest performers that returned. Chapter 7 presents a discussion of whether the financial reward in Period 4 could be better targeted in terms of reducing energy consumption and associated greenhouse gas emissions.

The analysis confirmed that as the number of retrofits completed increased, the mean improvement in energy rating increased as well. It also showed that more changes were associated with more recommendations, particularly in the case of a performance-based financial reward (Period 2). Further, in the case of a performance-based financial reward (Period 2), more recommendations were associated with a higher participation in the follow-up evaluation. The number of recommendations did not appear to affect the decision to return for a follow-up evaluation during Period 4. This corresponds with the finding that during Period 2, those who returned for a follow-up evaluation had lower mean energy performance and higher mean recommended changes to energy rating than Period 4; Period 2 was made up of lower performing houses, and of these, the lower performers returned for a follow-up evaluation. With respect to timeframes between home energy evaluations, as time increased, the number of retrofits completed increased. The analysis shows that a broader information search was associated with a longer time period between evaluations, as well as a slightly higher number of changes made. However, different decisions were associated with different timeframes. This analysis confirmed differences between the types of decisions and their associated timeframe of completion.

The analysis indicates that it was likely that homeowners were more motivated to replace heating systems than other changes. A change to a heating system was associated with the existence of a financial reward, as a change to the heating system was recommended to a greater share of participants when there were financial rewards offered that when houses received information only. Across all periods, those who returned and had a natural gas furnace had a higher mean recommended change to efficiency than those who did not return. Compared to the achievements of other decisions compared to the advice given, the heating system was the decision for which the highest percentage of homeowners that returned achieved results that exceeded the recommendation. The heating system was the most common decision taken when only one decision was made. The decision to replace the heating system was measured to be completed within nearly any timeframe, whereas other decisions were associated with longer timeframes between evaluations. This may be due to the fact that the heating system was commonly changed in combination with other decisions.

Overall, a larger percentage of houses had a high level of achievement compared to those who did poorly when reducing heat losses associated with air leaks. A larger percentage of households in Period 2 did better at reducing air leaks than other periods. Homeowners who addressed heat loss due to air leaks returned in nearly any three month timeframe following the initial evaluation.

Recommendations to change hot water heater and heat recovery ventilators did not seem to be important to homeowners.

With the exception of heat losses due to air leakage improvements, decisions related to the building envelope were typically done in combination with other improvements. They were measured after longer periods of time had elapsed between evaluations than other improvements. Most of the decisions to reduce heat loss through the basement, walls, or windows and doors appear to have taken homeowners more time to complete. This makes sense as these decisions, particularly heat loss due to walls and basement, were typically done in combination with other decisions. Decisions to reduce heat loss to walls, basements, and ceilings appeared to be associated with more barriers than heating systems. Although it is not clear why, except for the vintage group of <1945, reducing heat loss through walls was one of the least recommended retrofits. Reducing heat loss through walls was also associated with the highest proportion of "*not recommended and not changed*" decisions compared to other decisions across all periods. Changes to reduce heat loss through walls were not commonly done, no matter how many changes were made. When homeowners did attempt to make reduce heat loss through their basement, a typical achievement was less than 50% of what was recommended. Although a reduction to heat loss through basements was commonly recommended, it had one of the higher percentages of "*recommended and not changed*" amongst decisions. Heat losses to ceilings were addressed by homeowners more often than heat losses to walls, and retrofits to ceiling were completed to a higher level of achievement than basements, but still, a maximum of 20% of homeowners achieved better than recommended for this decision. Heat losses through windows and doors were the decisions with the highest percentage of "*not recommended and changed*" (besides air leakage). The reasons for this are further discussed in Chapters 5 and 6.

Chapter 5
Impact of Advice Strategies

The objective of this research was to analyse factors that affect the pro-environmental behaviour of participating in a home energy evaluation program that encouraged homeowners to implement energy efficient retrofits. The findings of this research will address the broader challenge of how to design programs and policies that motivate behaviour that is more environmentally sustainable. This chapter summarizes results from 12 interviews with home energy advisors, and provides quantitative summaries of the recommendations made by each of 14 advisors and the associated decisions made by homeowners. Interviews and quantitative data of eight of these advisors overlap. The research question to be addressed by this chapter is: where advice-giving was considered the selection and communication of advice during the home energy evaluation and the recommendations included in the report, how did advice-giving affect advice-following? More specifically, what were the employed strategies of advice-giving and how did these affect advice-following? The main objective in answering the second research question was to understand the importance of advice-giving on advice-following. There were four sub-objectives of the second research question.

- The first sub-objective was to interview a purposive sample of home energy advisors from REEP in order to understand the differences in the strategies or styles of advice-giving of each advisor.
- The second sub-objective was to understand the rationale of each advisor for the selection and prioritization of advice that was given to homeowners. This included the selection and prioritization of the eight specific decisions.
- The third sub-objective was to analyse REEP's quantitative dataset for the recommendations by advisors and to compare these to decisions taken by homeowners.
- The fourth sub-objective was to compare the qualitative and quantitative results in order to better understand the importance of advice-giving as it affected advice-following.

5.1 Sample description

The sample was made up of three different subsets of data. The advisors who had worked for REEP and who had been selected to be contacted for recruitment had each conducted a sufficient number of evaluations to provide useful descriptions of number, type and depth of recommendations by vintage. Table 5.1 lists 14 of the advisors who were identified for recruitment, and describes by the number of initial evaluations, and number of these that resulted in a follow-up evaluation. This group of 14 advisors was divided into two subsets. The first subset included the eight home energy advisors from REEP who participated in an interview, and they are identified as participants in Table 5.1. The second subset included six advisors who had worked for REEP, but could not be contacted for an interview, and this is also indicated in Table 5.1. In order to gain a better understanding of the evaluation and the advice-giving process, four home energy advisors from the Elora Center for Environmental Excellence were interviewed. A summary of the periods in which they gave advice and their service territories is in Table 5.2.

All of the home energy advisors were trained in the same Green Communities Canada (GCC) training program. This training required background experience in topics of the house as a system, windows and doors, ventilation, appliances, insulation, mechanical equipment, indoor air quality and leakage. All topics are assessed by a written test (Elora Environment Centre 2009). Candidates undergo two weeks of training, following which they must pass a certification test (Elora Environment Centre 2009). Hence, all had the same formal training, although advisors had varying types of experience that contributes to procedural knowledge (e.g., home building and renovation).

Besides this formal part of the training, the advisors had other life experience through which they had gained knowledge and skills to deliver home energy evaluations. The experience and interests of all of the interviewed advisors are detailed in Table 5.4. To maintain the anonymity of those who participated in interviews, the advisors described in Table 5.4 are not identified by the identification in Table 5.1 or Table 5.2. One immediately obvious deviation was that one of the twelve advisors interviewed was a woman. This is reflective of the lack of gender parity in this occupation. Advisors ranged fairly equally between early or mid-career or retired as the starting point for becoming a home energy advisor. Most of the home energy advisors were either certified home inspectors or had formal technical background training. The remainder, and some with formal certification and training, had training of procedural knowledge. For example, some had built and renovated houses. One home energy advisor had political experience in setting up the Green Party of Ontario. Another had a background as a social worker. Two advisors had experience in computer programming. Two advisors had experience in a previous home energy evaluation program called the Green Communities Initiative. The advisors' service territories also varied. In the case of REEP advisors, Advisor 17 was the only advisor who discussed working both inside and outside REEP's service territory-he had worked all over Southern Ontario in a variety of communities.

Advisor	Main Period of Analysis	Total Initial Evaluations	Years of Advisor Experience	Total Follow-Up Evaluations	Interview (y/n)	Specialties
1	1	1512	1999 to 2003	175	y	
17	1	801	1998 to 2007	91	y	
5	2	601		215	n	
12	4	490		389	n	
15	4	571	2007 to 2011	456	y	Solar Evaluations
2	4	400	2008 to 2011	328	y	
4	4	385	2009 to 2011	343	y	
7	4	525		409	n	
9	4	522	2008 to 2011	419	y	
10	1,2	784		174	n	
3	1,2,4	2360	1999 to 2011	745	y	Multi-Unit
11	2,4	1218	2005 to 2011	606	y	
14	2,4	1002		542	n	Solar Evaluations
8	2,4	1188		627	n	

Table 5.1 Sample Description of REEP Advisors

Three of the four advisors from the Elora Centre for Environmental Excellence had worked in urban service territories. Advisors EEE2 and EEE3 both mentioned working in subdivisions with similar housing. Advisor EEE1 worked in the countryside evaluating large old homes with many additions from different eras. These descriptions are given in Table 5.2.

The location where REEP advisors conducted evaluations is described in Table 5.3. Although in Chapter 4 it was described that the highest number of evaluations were delivered in Kitchener, according to the cross-tabulation presented in Table 5.3, most advisors have delivered evaluations in most locations within REEP's service area. According to REEP's schedulers, there is effort to schedule advisors closer to their homes. However, the narrowest distribution of locations for an advisor is in the case of Advisor 4, with 60% in Kitchener, and 26% in Cambridge.

Advisor	Period of Analysis	Years of Advisor Experience	Type of Service Area
EEE1	1,2,4	1992 to 2011	Rural service area, mainly old homes with various additions
EEE2	1,2	2003 to 2006	Urban service area Aimed to help lower income homes
EEE3	2,4	2005 to 2011	Urban service area with many subdivisions of similar homes.
EEE4	1,2,4	2002 to 2011	Urban service area

Table 5.2 Description of Service Territory of Advisors from the Elora Centre for Environmental Excellence

Location	Advisor													
	1	2	3	4	5	7	8	9	10	11	12	14	15	17
	% of Evaluations in Location													
Cambridge	21	17	18	26	20	11	19	18	11	15	13	16	16	21
North Dumphries	2	1	1	0	1	1	2	0	0	1	0	1	1	2
Remaining towns in Region of Waterloo	1	2	1	1	0	1	1	1	1	1	2	1	2	1
Kitchener	46	49	50	60	46	52	46	46	48	50	57	53	49	44
Waterloo	25	21	24	9	22	28	22	25	34	22	21	19	23	25
Woolwich	3	8	5	1	6	5	7	5	3	5	4	5	6	3
Wilmot	2	2	3	4	4	2	4	4	3	5	3	4	3	2
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 5.3 Location of Evaluations by REEP Advisors

Experience and Interest of 12 Interviewees
(a) Certification and experience in home inspection. Built homes with his father and learned how insulation and building envelopes work
(b) Mechanical background and interested in renewable energies. Originally interested in net zero homes, and in certifying homes. Background in construction and renovations. Experience is what prepares you. Less confident about computer modeling skills
(c) Mechanical Engineer Worked at factory built housing company, Canadian Standards Association Knowledge of standards and building codes
(d) Certified home inspector by American Society of Home Inspectors (ASHI) Politically active in creation of Ontario's Green Party Created and taught solar heating course at Conestoga College Insulation salesperson Trained to remove urea formaldehyde from walls Water chemistry studies and bottled water association
(e) Worked in construction most of his life Interest in energy conservation Sales person for renewable technologies for 25 to 30 years
(f) Geologist Courses and certification in R-2000, Heating Refrigerating and Air Conditioning Institute (HRAI), and home inspection. 500 audits for Green Communities Initiative 1994 to 1996 1600 visits under EnerGuide for Houses and beyond. Evaluations all over Southern Ontario Returned to work as a geologist in 2005
(g) Social worker Renovation technology course at Conestoga College Renovated a house in Waterloo
(h) Retired mechanical technologist Science and principles of thermodynamics Experience in industrial energy audits Renovated a house and built a cabin
(i) Bachelor of Environmental Studies Started degree in computer science Interest in buildings, read a lot about building science (government and CMHC publications) and learned from other advisors as an intern Computer experience prepared him to use the modeling program Certified for multi-unit residential and churches
(j) Architect, cheaper to set up as a home energy advisor than an architecture practice Concern about peak oil
(k) Computer programmer No formal training in renovation science, interest in sustainability Raised by a carpenter and learned building science growing up
(l) Exploration geophysicist in oil and gas industry Worked on residential construction for 6.5 years Knowledge of environmental impact scenarios

Table 5.4 Summary of Experience of the Interviewed Advisors

5.2 Interacting Factors Affecting Advice

The coding process described in Chapter 3 was followed, and it was found that four elements were important and affected the advice-giving process; these were the advisor's own norms and motivations, the advisor's knowledge, the advisor's perceptions of homeowners, and the advisor's patterns of communication. The advisor's pattern of communication was a result of how the first three elements came together, and this occurred in different ways, depending on the advisor. This section describes these elements and how their combination resulted in different advice-giving strategies in different contexts. Ultimately, it was the pattern of communication with homeowners that defined the process of advice-giving, and this was found to be affected by the advisor's perceived purpose of the evaluation, the process of delivering the evaluation, the selected message framing, and the advisor's perception of the receptiveness of the homeowner.

Overall, advisors were strongly motivated to give good quality information and this connected to a strong desire to improve homeowners' procedural knowledge, whether to understand the problem more deeply, to be able to make an improvement themselves, or to have the knowledge to find an appropriate contractor. Most, but not all, advisors believe that homeowners were economically rational with respect to energy and worried about their energy bills. They also described thinking that homeowners were strongly focused on grants. Advisors perceived grants as influential on program participation and decisions taken. At the same time, many advisors described homeowners who were focused on a preconceived retrofit or pre-conceived ideas before the evaluation had started. Advisors' preferred communication styles were a result of their focus on quality of information and their understanding of homeowners, as was revealed through their responses to questions about communication styles. The advice-giving strategies were thus varied, and ranged from only recommending to the homeowner what was important, to giving the homeowner information on the energy impacts of the various choices while explaining what they recommended the best choice to be, to choice editing in order to help homeowners focus on what they thought was achievable for the homeowner.

5.2.1 Advisor Norms and Motivations

The interview probed for a variety of norms and motivations that underlie the advice selected and given by advisors. The first indication of beliefs and motivations came from a discussion of reasons for becoming a home energy advisor and what they enjoyed about their job. Reasons offered included possessing an environmental ethic and the importance of sustainability (Advisors 1, 4, 15). Some said that they liked feeling that they made a difference in the community (Advisors 1, 2, EEE2). Many mentioned that they felt as if they were helping people learn and achieve something (Advisors 2, 4, 9, 15, 17, EEE3, EEE4). There was for some, a sense of enjoying a variety of work and people and challenges (Advisors 3, 11, EEE2, EEE3) and enjoying the problem solving process (Advisors 17, EEE1, EEE2, EEE4).

Advisors clearly have multiple motivations, but the importance of quality of information emerged during the coding process as a central theme related to advice-giving. Overall, quality of information was found to be a guiding principle, or rationale, for the advice-giving process amongst all advisors. This is one of the main threads of the analysis in this chapter. Related to this, quality of information was clearly linked to a collective desire shared by the advisors for homeowners to learn about their house or gain procedural knowledge about how their house works and how to do a renovation. Although quality of information was found to be a guiding principle that appeared to affect nearly all aspects of selecting and delivering advice, advisors relied on it in different ways.

Figure 5.1 is an illustration that summarizes the advisors' perspectives of which factors affect the quality of information and the rationale for quality of information. Broadly speaking, if advisors can take accurate measurements and make accurate observations, they can give better recommendations that will give homeowners the information they need to make a decision. Further, quality of information was generally acknowledged to affect the quality of a renovation, another high priority for most home energy advisors. All home energy advisors had a common understanding of the house as a system, that energy usage, comfort, and health aspects of the house are affected by the relationship between occupant behaviour and material characteristics. As shown in Figure 5.1, some home energy advisors discussed shifting their attention to how to manage energy bills by addressing lifestyle and behavioural or habitual advice (e.g., Advisors 9, 17, EEE2). Hence, quality of information was also a guiding principle that shaped how the advisors delivered advice to homeowners. Figure 5.1 summarizes and illustrates the factors described by advisors that affect and are affected by quality of information. It also recognizes that there are other factors, shown as a filter, that affect the selected recommendations, and other factors that affect their communication of information to homeowners, shown as another filter.

The types of concerns that advisors related to quality of information are outlined in Table 5.5. These concerns include issues such as minimizing information overload for homeowners during the evaluation (Advisor EEE3), accuracy of statements, managing homeowner expectations and minimization of liability as examples.

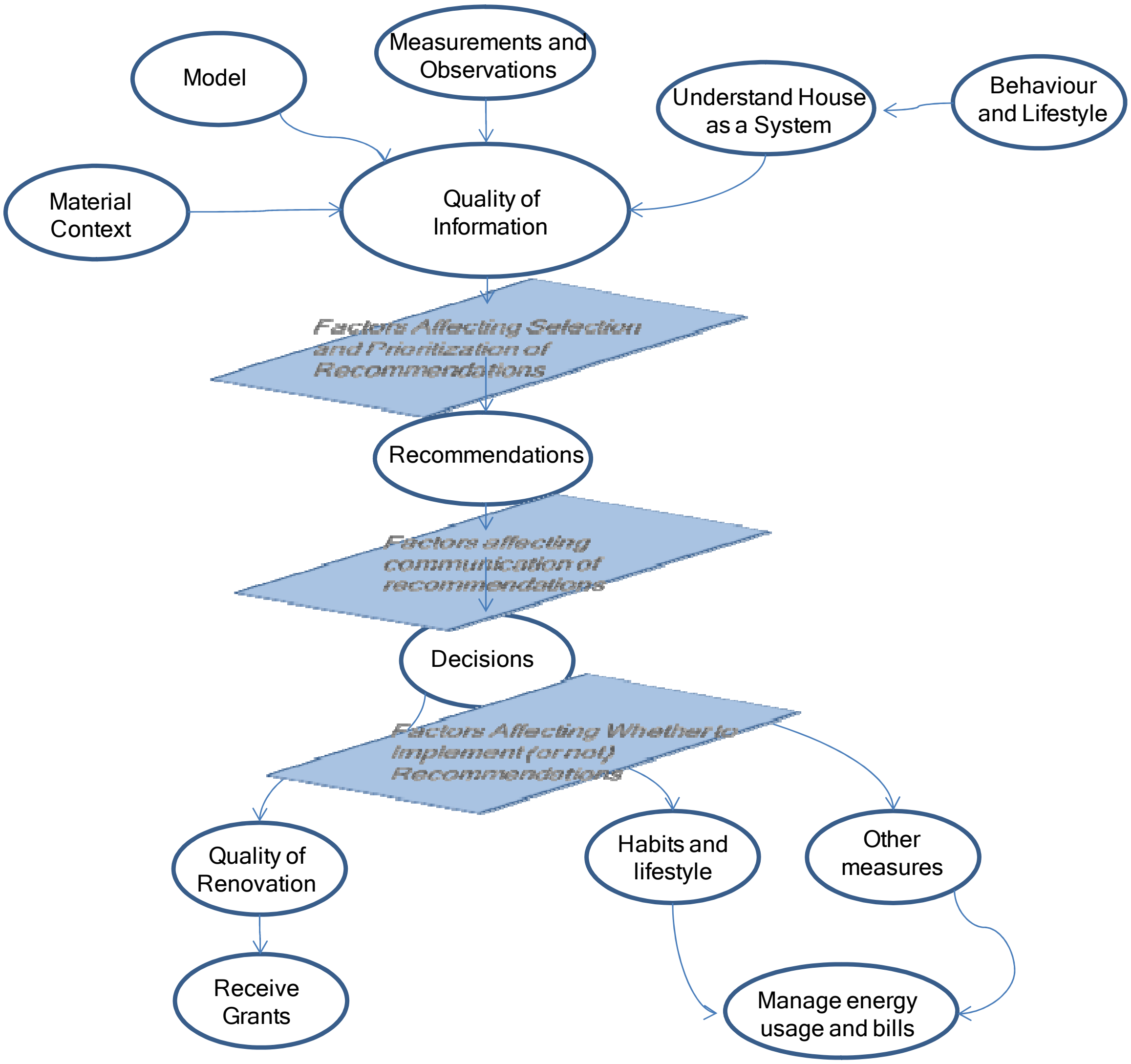


Figure 5.1 Quality of Information and Elements of the Home Energy Evaluation Process

Selection of Advice	Communication of Advice	Follow-Up Evaluation
• Importance of accurate measurements and documentation of the house • Accuracy of model's estimations of energy savings due to technical and behavioural algorithms of the model • Length of time spent on report • Type of information added to the report	• Inform decisions • Details included in report • Information overload to homeowners • Minimization of liability • Accuracy of statements • Manage expectations	• Documentation in a follow-up evaluation to receive grants

Table 5.5 Themes and Actions Related to Quality of Information

Quality of information was upheld as the main metric of success of a home energy evaluation, and several advisors discussed the importance of taking proper measurements and developing an accurate model of the house. The quality of information can be compromised in several ways and this can affect the selection of advice. For example, some advisors mentioned limitations of the Hot2000 energy model. One limitation is related to erroneous assumptions that the model uses; it underestimates the potential reductions to heat loss air leakage when various parts of the house are insulated (Advisor 4). Other advisors pointed out that it is a model for technology change, not behaviour change. This limited the quality of advice overall, because it did not necessarily accurately describe energy consumption in the house. Other mentioned limitations to quality of information related to measurement and observation of material characteristics. A typical example given was the measurement of the amount of insulation in a house: several advisors explained that it was common to make an educated guess based on the period and characteristics of construction. Some advisors mentioned previously un-encountered technology or configurations, for which they were required to research a solution. Some home energy advisors acknowledged the importance of behaviours of homeowners on the house as a system. This related to the concerns about the model, which uses a standard model of behaviour across all houses, and that the lack of knowledge about the habits of household members energy use or energy bills. With respect to the latter, advisors noted that energy bills provide insights into usage and habits; if these are unavailable this can be a major impediment to providing useful advice.

5.2.2 Quality of Information

The importance of homeowners gaining knowledge from the assessment was brought up by nine of the 12 advisors (all except Advisors 15, EEE3 and EEE4). Related to this and in connection with the identification of the need for more procedural knowledge, it was generally coupled with an explanation of the complexities involved with home renovations. Seven different advisors (Advisor 1, 2, 3, 9, 15, and EEE1) mentioned the quality of the renovation as an important concern and barrier to homeowners' achievements.

Advisor 3 expressed that advisors should have more knowledge about the best way to do certain renovations, particularly with respect to the building envelope. Many advisors expressed concerns that each contractor will give different advice, confusing homeowners about the process of accomplishing quality renovations. Advisor 2 reported that many different problems can have several solutions and this can be confusing to the homeowner. Several advisors (Advisors 3, 4, 9, 11) echoed this concern. Interestingly, given that the programs operated in part as a response to climate change, not all advisors expressed that they were motivated by concern for the environment or climate change. In contrast to other advisors, Advisor 17 and Advisor 11 said that they do not think that greenhouse gas emissions are a pressing problem. One advisor expressed the belief that peak oil and fuel poverty are major problems.

Advisors also differed in their opinions about how deep the improvements to energy performance should be. In terms of depth, Advisor EEE2 believes that insulation standards are too low, even R-2000 is too low. Another advisor entered the industry to certify Net Zero Energy homes. Advisor 4 expressed a belief that there is a clear connection between the improvement of the building envelope and significant improvements in comfort. Advisors 3 and 11 stressed strong concerns about health impacts. Overall, advisors expressed a shared belief in quality of information, but their beliefs regarding the importance of environmental outcomes, depth of recommendations, health and comfort issues varied.

5.2.3 Advisor Knowledge

Advisor knowledge was examined in two ways. First, its relationship to the guiding principle of quality of information was examined. Further, this section discusses what was learned from the interview in terms of what advisors thought at the time of the eight decisions studied in this paper in terms of their own knowledge and opinions about the potential for energy savings in a house.

5.2.3.1 Cohesiveness of Advisor Knowledge

A few of the advisors discussed the development of knowledge in relation to the quality of information. Several advisors mentioned that they improved their knowledge about retrofits to houses as they accumulated experience (Advisors EEE2, EEE3, and 4). Both Advisor EEE3 and Advisor 4 mentioned that it took several hundred evaluations before they were really comfortable with assessing each decision and giving advice. This was also mentioned by Advisor EEE2, who pointed out that some advisors in his region did not give good advice. Advisor 3 mentioned that there could be potential benefits if there was more "push" in an institutionalized way to give more procedural knowledge on how to go about changing things, but he did not clarify how this could be done. Advisor 4 mentioned that some advisors disagreed during meetings about whether and how to make specific types of recommendations. He expressed a desire for an increase in cohesiveness in Canada's home energy advisor community using social networking to strengthen their knowledge through open discussion. Advisor EEE2 confirmed this lack of cohesiveness, saying that among organizations that deliver home energy evaluations, the philosophies are like different religions that offer different ways of saving energy.

5.2.3.2 Advisor Knowledge Related to Specific Decisions

In order to fully understand some of the perceived complexities of implementing various retrofits, it is important to understand advisor knowledge related to the eight decisions that affect the energy performance of a house and sometimes in relation to other factors, such as occupant health, comfort and economic concerns. First, as described in Table 5.6, decisions 1 through 5 are related to the building envelope that prevents heat loss from the house. The less heat lost through the building envelope, the less heat that needs to be produced to warm the home. Decisions 6, 7 and 8 are all mechanical systems. Decision 6, the heating system, is the main mechanical system supplying heat for the house. Decision 8, the heat recovery ventilator, provides mechanical ventilation for a house, and may reduce moisture and associated problems.

Decision		Type of measurement
1	Air-sealing	Heat loss (MJ)
2	Insulation to foundation/basement	
3	Insulation to ceiling/attic	
4	Insulation to walls	
5	Improvement of windows and doors	
6	Improvement to heating system	Efficiency (%)
		Fuel switch/system switch between • Electricity • Natural gas • Oil • Propane • Ground, air or water source heat pump
7	Improvement to hot water system	Efficiency (%)
		Fuel switch/system switch between • Electricity • Natural gas • Oil • Propane • Solar
8	Improve air quality with heat recovery ventilator (HRV)	Addition of HRV

Table 5.6 Description of Decisions

5.2.3.2.1 Decisions 1 and 8: The Balance between Air Leakage and Ventilation

Air leakage is a significant source of heat loss, and heat recovery ventilators (HRVs), that exchange air in an air tight house, are associated with health and comfort. Interviews with advisors revealed that there is a relationship between air sealing and the installation of an HRV. They offered varying opinions about how much air sealing is adequate and when an HRV should be installed. Some advisors believe that there is a problem of recommending too much air sealing without recommending the installation of an HRV.

In the process of a home energy evaluation under the EnerGuide for Houses or ecoEnergy programs, air leakage to a house was measured by using a blower door test. The test measured air changes (how quickly air entered and exited a house) in response to changing air pressure. Advisor EEE1 discussed at length that air leakage is responsible for a high amount of heat loss, possibly up to 40%, but that addressing air leakage is a complex issue. He said that even the professionals who claim to be air leakage experts do not always address the problem. When asked what the single change that could be made to improve a house’s energy performance the most, Advisor 2 immediately said reducing air leaks, followed by "Well, hold on, that's theoretical. It's very difficult. So, insulation. Air sealing would be but it's very difficult, even getting in a professional." Advisor 4 discussed the interactions between air leakage and insulation, and said that the Hot2000 model does not appropriately account for air leakage reductions due to insulation retrofits.

As previously mentioned, some advisors mentioned decisions 1 and 8 in relation to each other. According to Advisor 17 "For a lot of homeowners I was pointing out how small it [air leakage] was, because for a lot of houses, the air quality is an issue and I was trying to sell HRV's, and before they started to do massive amounts of sealing they actually had to look at improving ventilating systems. This is where the sale on sealing all your cracks to me is insanity, because 90% of the homes don't need more air sealing until they get better ventilation. Air quality is a huge issue and it's only going to get worse." Advisor 3 explained the consequences of lack of ventilation: "And if I tell them "look, you're living in an air tight home you're getting condensation on your windows, mould in your bathroom. The best solution is to put in an air exchanger." According to Advisor 11, HRV's improve occupant health by improving quality of sleep, reducing instances of illness, and the elimination of places that grow mould in the house and reduction of odours. Advisor 2 mentioned that personal comfort can often be improved by working with ventilation rather than increasing usage of the heating system. Advisor EEE2 mentioned that when an HRV is installed, it signals that a house is really beginning to save energy. All except three advisors discussed HRVs in relation to health and building effects.

5.2.3.2.2 Decisions 2, 3 and 4: Insulation

Decisions 2, 3, and 4, the decision to reduce heat loss through basements, ceiling or attics, and walls, are all achieved by improving levels of insulation. All advisors discussed insulation and the building envelope in some form. Overall, improved insulation was associated with the reduction of heat losses, and some of the advisors explained this connection to improved personal comfort. According to Advisor 1, insulation saves more energy than changing windows. An advisor, who expressed concern for the impact of peak oil, said that even an R-2000 home does not have adequate insulation. Advisor 3's opinion was that to change the furnace in a house without insulation is "kind of dumb". Advisor EEE3 mentioned insulation as second to the furnace as the biggest single improvement to the house's energy performance. Generally, insulation tended to be discussed as whether it is "adequate" or not. Advisor EEE1 mentioned that there can be different types and amounts in different walls, and this can further confuse the process of assessment and renovation. Advisor EEE1 also mentioned that insulation can deteriorate in terms of performance as moisture builds up.

Eight of the 12 advisors specifically discussed the basement and a general consensus was that the basement walls and header[33] are an excellent opportunity to save energy through preventing heat loss. Advisor 4 said that he considers insulation to a completely un-insulated basement an “obvious recommendation”. Advisor 9 said that anything un-insulated is important to address. Advisor EEE1 described insulating the basement as the single biggest area for improvement to energy performance. Advisor 3 mentioned that an improvement to basement insulation could improve a house’s energy rating score by 6 points out of 100. According to Advisor EEE2, to adequately address insulation is to start with a hat (ceiling or attic insulation) and work up in order to reduce a wind tunnel effect. Hence, for Advisor EEE2, the order of priority would be (3) ceiling, then (2) basement insulation, then (4) walls. All other advisors who mentioned the basement insulation discussed the size of the heat losses in and of themselves; hence Advisor EEE2 described a somewhat outlying opinion.

While all home energy advisors mentioned insulation in general, or improvements to the building envelope, insulation to walls was mentioned specifically by 11 of the 12 advisors. Advisors generally agreed that walls represent a large heat loss, especially in pre-1950s houses. A common caveat that was mentioned was that renovating walls internally represents a significant disruption to daily life. Wall insulation was discussed the most often as a challenging renovation. Advisor 2 mentioned the difficulty in tearing down plaster in a 1960s house. Advisors 2, 15 and EEE1 mentioned that siding can be used externally to insulate.

Associated with the guiding principle of quality of information, several advisors, Advisors 1, 11, EEE1 and EEE4, mentioned the difficulty associated with measuring insulation in walls. The methods described were infrared equipment, to drill or smash holes in the wall, or to remove the electrical receptacles to see what there is. Knowledge of insulation in walls was also typically associated with house vintage (Advisors 2, 4, 9, 15, EEE1, EEE4). In the case of a 1930s single brick house, insulation is the most important improvement to make in terms of energy performance (Advisor 15). Advisor 2 clarified that the vintage of the house will give an idea of the type and amount of insulation that exists. But often, they noted, it is an educated guess. According to Advisor 9, because walls cover

[33] The header is in the basement and located where the floor joists meet the foundation.

so much surface area, he described them as “a big deal” in terms of energy savings. Advisor EEE2 mentioned that insulating walls does little if the ceiling and basement are not already insulated as it creates a tunnel effect.

The decision to insulate the ceiling or attic was generally associated with the decision to improve the building envelope. That is, it was not often mentioned in the interviews, but advisors did discuss the building envelope as a high priority in order to improve the energy performance of the house, and the ceiling insulation was understood to make up the building envelope. Insulation to attics was associated with gains in comfort (Advisor 17). It was mentioned as well as the first area to insulate (Advisor EEE2). Advisor 4 said that attics do not always represent the largest heat loss, presumably because attics are generally insulated. However, Advisor 2 and Advisor 11 pointed out that unevenness in insulation to the attic can be problematic and difficult to explain to homeowners. Advisor 2 said:

> For example, when you have an A-frame, like a one and a half story house (draws). And so what you’re pointing out is usually they use the area in here for storage space, so you’re pointing out that if there’s no insulation here, it’s equivalent to the outside, and heat is escaping. So I like to show them those kinds of weak points in the house too. Because those are very difficult renovations to get people to do...there’s no money in it, but it does make a difference. Attic insulation is really important. I have one of those cheap laser thermometers, so I’ll shoot it at the ceiling, it only works in the winter, [in two spots] and I can sometimes show them a 10 degree difference. (Advisor 2)

In terms of measuring insulation, attics were also described as measured by an educated guess (e.g., Advisor EEE4). Advisors 11 and EEE1 mentioned the discomfort in checking attics for insulation. There was agreement that insulating attics makes good economic sense, but there was a divergence in agreement about how much insulation should be put in. For example, Advisor 11 expressed the belief that the payback is too long to add more insulation to an attic after a certain point. Advisor 3 mentioned that he would recommend R-50[34] as adequate to homeowners, while Advisor EEE2 mentioned R-35 as adequate.

5.2.3.2.3 Decision 5: Windows and Doors

[34] R values are the resistance to heat loss, and are inversely related to the u value, amount of heat loss over a surface area.

Windows and doors are modeled jointly in the Hot2000 program. However, only windows were mentioned in the interviews. All but two advisors mentioned the decision to replace windows, and the general consensus amongst these advisors was that windows are very costly to retrofit and do not generate many energy savings compared to other retrofit decisions. Advisors described windows as “not as important” (Advisor 1), a “high cost item” (Advisor 3), “the least efficient upgrade you can do...gives very little energy savings” (Advisor 2), not usually a priority (Advisor 15), and “frankly, expensive” (Advisor EEE3). Advisors estimated window costs as $10,000 (Advisor 1), $15,000 (Advisor EEE2), and $20,000 (Advisor 11). According to Advisor 1 “they really shouldn’t replace windows first because you can spend $10,000 there and save a $150 a year and you do the math. Whereas $500 worth of insulation is going to get you the same returns.” Advisor 17 mentioned that he considered insulation to the ceiling and the basement a higher priority than replacing windows. Advisor EEE1 pointed out that the installation of windows can actually worsen the house’s energy performance as 50 % of the energy loss of a window has to do with how well it is installed, not with the window itself. Advisor EEE2 said that if windows are recommended they should be triple glazed. The opinion of Advisor EEE4 can be considered to be a deviation, in the sense that he did not distinguish windows as less of an energy improvement than the other advisors did. He instead classified it as part of the heating envelope and associated that as a high priority to be done prior to upgrading the heating system.

5.2.3.2.4 Decision 6: Heating Systems

The decision to replace the heating system in the house was mentioned by all advisors. The decision to replace and upgrade (improve the efficiency) of the heating system was typically associated as more likely to be a priority for newer houses, and in the case of an older heating system regardless of house age. A more efficient furnace was associated with improved comfort (Advisor 11), with lowered energy costs (Advisor 3), and large savings in energy (Advisor EEE3). Several advisors discussed the need to replace a fairly old heating system (Advisors 3, 17, 11), and Advisor 17 mentioned the benefit of changing it before it failed, so that through timing the homeowner could get “a much better price”. Several advisors, particularly those from Elora Center for Environmental Excellence, mentioned that while the heating system has very large associated energy savings and a large impact on energy performance, the heating envelope should be addressed first. As Advisor

EEE4 summarized that the building envelope should be done first since that determines the size of the heating system.

5.2.3.2.5 Decision 7: Hot Water Systems

Hot water systems were rarely mentioned by home energy advisors. Only four advisors mentioned them. Advisor 17 mentioned maintenance of hot water systems and Advisor 11 mentioned checking for safety issues, such as leaking. Advisor 9 mentioned that while tankless hot water heaters improve energy efficiency, there is a loss of comfort due to waiting a few minutes for hot water to arrive. Advisor 15 simply mentioned it in terms of solar assessments. Overall, the hot water heater was never mentioned as a high priority item to be addressed compared to other decisions. This could be due to the nature of the hot water heater market, as hot water heaters are typically rented.

5.2.3.2.6 House as a System

One of the largest perceived barriers to giving quality of information as advice in the program is the science of how houses work: a house operates as a system. In light of the guiding principle of quality of information, the fact that a house operates as a system complicates the ease with which advice can be given. This is because the programs were based on giving homeowners a combination of up to eight decisions without necessarily acknowledging the interactions between the decisions made. In particular, behaviour interacts with other elements of the house—how air tight it is combined with occupant behaviour as it affects the operation of heating and cooling systems and ventilation (windows and HRV). Hence, the advisors discussed the recognized interaction between behavior, and renovation decisions. Advisor EEE4 explained this concept: “all the different components work together as a system and how they can affect each other. If we change this thing they can have a positive or negative effect on this thing. So you really have to make them aware that we are not just changing one thing. When we change one thing we could be changing multiple things so it’s important that they really get a handle on the house as a living creature almost.” Advisor 9 summarized why selecting advice is complicated by this reality:

> So to come up with a very simple statement I find is misleading. One of my biggest beefs with this whole industry is that I find simple truths come very rarely as true statements. I can very easily create a scenario where you’ve come up with an upgrade strategy for a house and a family moves in and is happily living in it ever after. Then you put a different family into it and the concept fails because they

> pumped so much more humidity into the house that all of a sudden you are dealing with mould. Worked fine for one family, it doesn't for the other. So, my approach is, you really kind of have to look at the situation and analyze what factors are the drivers when it comes to risks and potential issues. .... And quite frankly I find limited tools at my disposal to limit that impact because all I can do, as far as I am concerned anyways, is make them aware of these connections and the feedback that exists between one measure and maybe other issues that arise so that they are prepared for it and can take that into consideration but that certainly seems to frustrate them. (Advisor 9)

5.3 Patterns of Communication

The interviews revealed that the patterns of communication between advisors and homeowners were affected by the interaction of four factors: the advisor's perceived purpose of the evaluation, the process of delivering the evaluation, the advisor's perception of the receptiveness of the homeowner, and the selected message framing. These elements affect the advice delivery of all home energy advisors, but each advisor has a unique combination of these. This section summarizes each of the four factors, and how they affect the process of advice-giving.

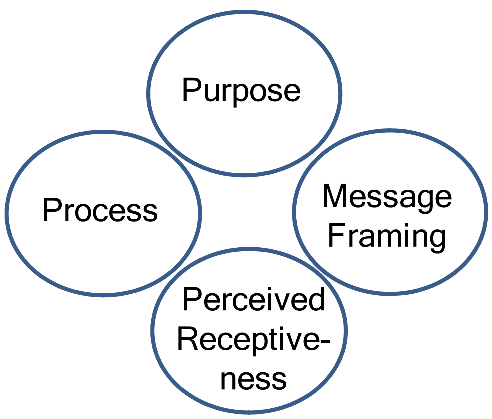


Figure 5.2 Components Underlying Patterns of Communication

5.3.1 Purpose of the Process

The interviews revealed that the home energy evaluation had various perceived purposes that were emphasized to different extents by different advisors. These purposes were a) to provide information so that the homeowner can make a decision regarding the eight decisions; b) to troubleshoot problems related to energy usage in the house; c) to provoke and promote learning by the homeowner about how their house works in relation to energy usage or retrofits; and d) to compile the necessary information to provide a report detailing recommendations. Purposes a) and d) were formal components of each of the EnerGuide for Houses and ecoEnergy programs, while purposes b) and c) were attributed to the advisor's preference and decisions.

As previously discussed, quality of information was found to be the main metric of success of a home energy evaluation. When asked about what constitutes a successful home energy evaluation, Advisor 3 responded if he was able to collect all of the data and the house was properly measured. Advisor 4's response was similar, that he wanted the files to reflect the house accurately. Advisor EEE1 described spending long periods of time in a larger, more complex, house with many additions from different periods to take measurements. He would then spend a long time trying to model the house with the Hot2000 modeling program with the different additions.

Some advisors self-described as an energy problem trouble shooter. They described trying to solve an energy related problem, whether or not it was directly related to the program. Advisor 17 identified that when the price of an initial evaluation was higher in Period 1, that homeowners outside REEP service territory, who paid higher prices, sought an evaluation in order to solve a particular problem that they encountered. Advisor EEE2 discussed the possibility of compartmentalizing the house to only heat and use spaces as needed. Advisor EEE1 discussed the placement of the thermostat as it affected the internal temperature (too hot or too cold depending on the room it is in). Advisor 9 described focusing on a specific problem, such as managing energy bills, and described suggesting a variety of solutions to address the issue. Advisor 17 described lifestyle as one of the biggest issues. He originally worked with the Green Communities Initiative that was oriented towards lifestyle solutions and addressed a broader number of environmental factors. He discussed disappointment with homeowners who left the air conditioner running on a cool day, or asked him for advice on how to obtain a hot tub.

Many advisors described the value of using the evaluation to teach homeowners about their house. Advisor 17 argued that selling energy upgrades is not as good as doing education on how the house works. But other advisors mentioned that taking the time to educate may lengthen the process of gathering information to input into the model. Further, most advisors described a desire to teach, but they did not feel that they were necessarily met with a desire to learn. This will be discussed further in the section about advisor perceptions of homeowners.

Some advisors viewed the advice given within the timeline of the program, and others viewed the report as a place to recommend all the retrofits homeowners can make over the years, something they can go back to as a work plan or blueprint. Advisor EEE1 described the report as roadmap to which he would add every possible energy saving opportunity. Advisor EEE3 viewed the report as a work plan. Advisors 9 and 15 described the report as a blueprint. At one point Advisor 11 discussed selecting advice to give in the context of the timing of decisions, and when prompted, explained that from the perspective of the homeowner, the only decisions that counted were the ones for which the homeowner obtained a grant. Advisor 11 also described adding recommendations into the report so that homeowners might get to it in a few months as money permitted. Advisor 2 reported giving information in the hope that maybe they will do it down the line. Advisor 3 described the report as an important piece of information and the primary way of communicating. His goal was to describe in the report how to bring the house to a modern efficiency of an energy rating of 75. Advisor 3 summarized some of the conflicts between the four potential purposes, and the inability to do everything, in terms of how he thinks the program can be improved:

> we've achieved that sort of a… quick and dirty evaluation but I don't think that's the ideal energy evaluation for a house....I think that a better energy evaluation would pay more attention to health and safety issues; that a better evaluation would actually provide more specific advice on how to carry out the energy evaluations; and that a better energy evaluation would actually probably be a longer more expensive evaluation like spending more time at the house or more time in follow-up with the homeowner; that the energy evaluation wouldn't just be a report that gets delivered but it would actually be a process where the report is just one step in a process that ends with a house being a more energy efficient, healthier, comfortable home. (Advisor 3)

The view of the report and how it relates to the amount of advice given is summarized in Table 5.12.

5.3.2 Process and Involvement

The interviews also revealed variations in the process of delivering the home energy evaluation. The combination of the potential ways in which advisors focused their attention are outlined in Figure 5.3 as: ask questions at the beginning; ask questions throughout/ point things out throughout/ focus on take measurements; run the blower door test with a leak hunt with homeowners/ point things out at the end of the visit to homeowners; discuss potential report recommendations; deliver report. Advisor interviews were coded for which elements of this process they emphasized or expressed preference for.

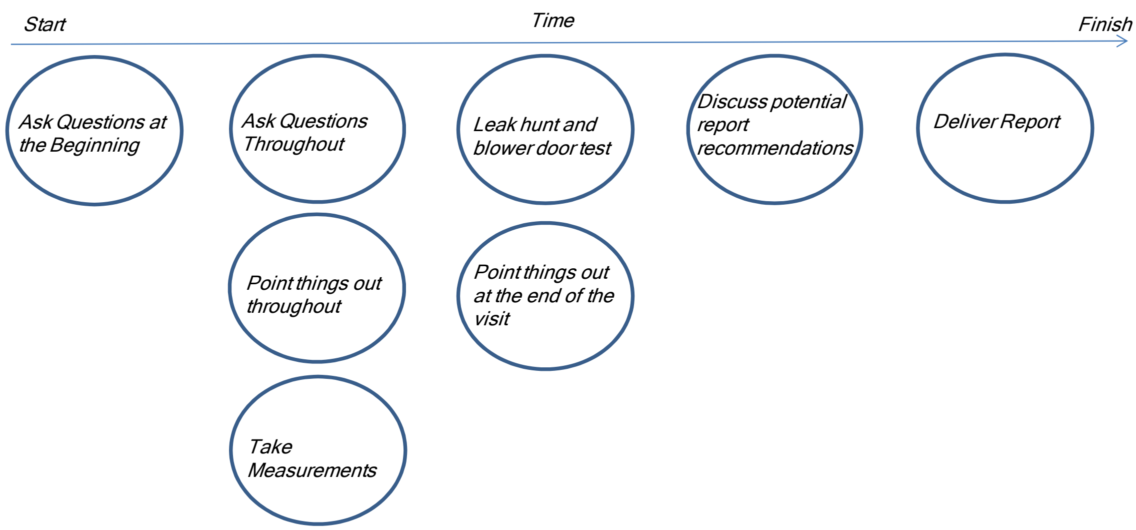


Figure 5.3 Process of Delivering the Home Energy Evaluation

The process of delivering the home energy evaluation depended on the balance between the perceived purposes: balancing the need to collect measurements for quality of information for the report, the interest in teaching homeowners about their house, and the interests of the homeowner. All advisors reported learning about the homeowner's concerns as much as possible. However, some advisors described that they would ask questions at the beginning of the evaluation and then prefer to take measurements of the house alone. The rationales behind this approach were to make sure that they had the correct measurements, to avoid distraction, or simply due to personal preference. Some advisors invited or encouraged homeowners to come along on the evaluation as they took measurements. Within this group, some asked questions of the homeowners about specific issues they found in the house, others pointed things out to homeowners. Within these, several advisors incorporated techniques that conveyed information vividly into the following portion. "We would walk around. It was very much theatre in play. Every window was measured. I did everything so that people would not phone back and say I wasn't happy with the auditor. I was always making sure that they were able to observe that I was thinking the whole time! (laughs) it was kind of important." (Advisor EEE2). Several advisors mentioned that the appearance of cobwebs is associated with air leakage, so they would advise homeowners to look for cobwebs. Advisor 2 said, “Or the other thing that I got excited about was in the basements where you can show the cobwebs flying to show the energy, where the air is coming in and people are mortified by that. It’s really funny, but it’s like, “that’s great!” Spiders are our friend. So that’s my level of excitement, though.”

At one point in the evaluation, a blower door test was performed in which all windows and doors were shut and a blower door contraption filled an exterior door. Several advisors reported asking homeowners to participate in the process by shutting windows and doors, and then by having a “leak hunt”. Techniques associated with the availability heuristic (vividness) were reported as being used at this point. For example, homeowners were encouraged to feel the leaks with their hands. In some cases, the advisor reported that the “leak hunt” became a family game with the involvement of all family members encouraged (A11). One advisor, however, pointed out that an air leak hunt is only instructive for some types of houses (A3). Some advisors who reported that they generally did not point things out throughout might have instead pointed out issues to homeowners at the end of the evaluation. Finally, some advisors discussed their potential recommendations with homeowners before leaving. In the case of the three REEP advisors who worked in Period 1, they typically did the modeling and the report onsite with the homeowner there. A more complete description of all of the Advisors’ following patterns is presented in Table 5.7 and Figure 5.4.

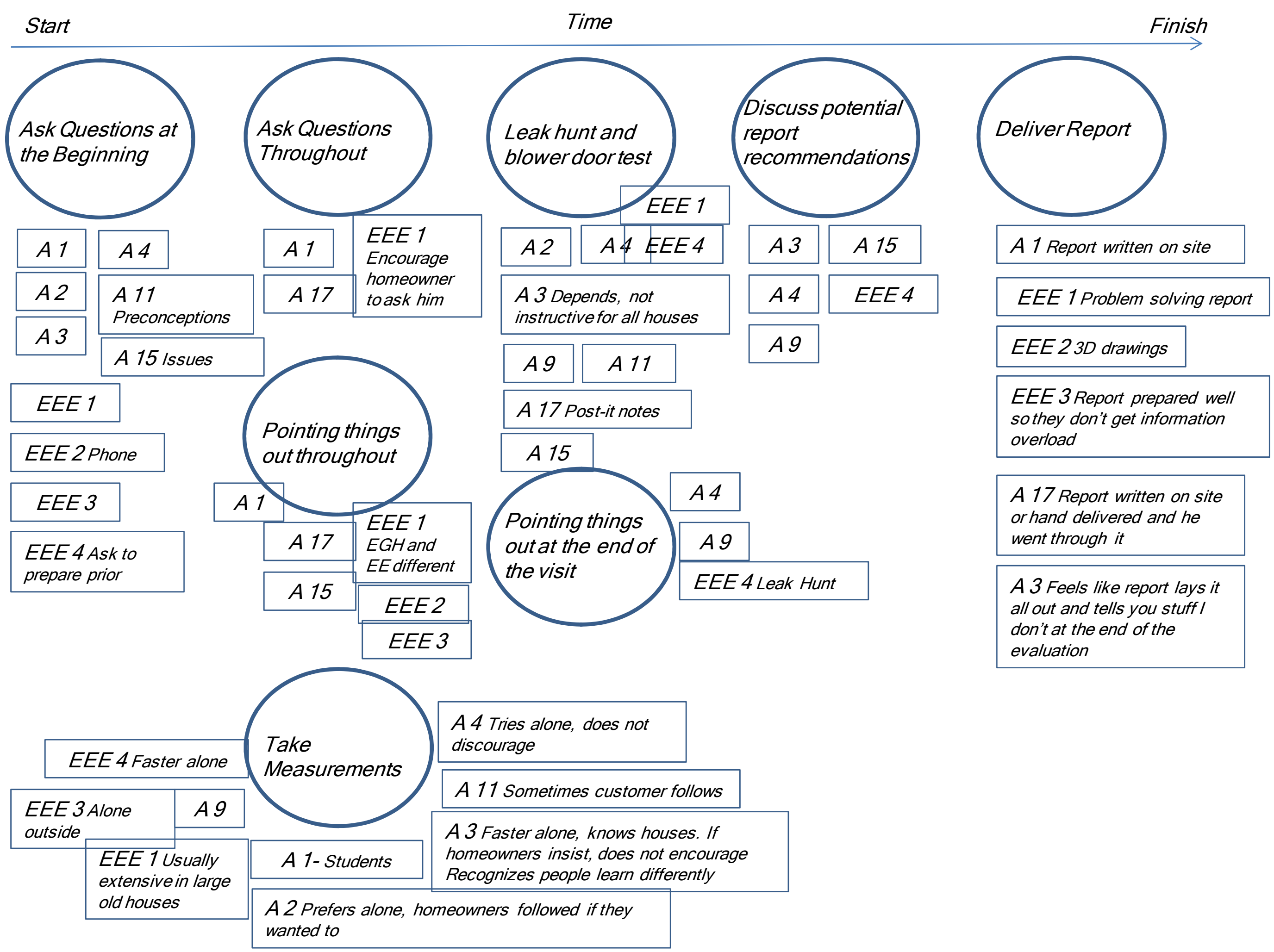


Figure 5.4 Initial Home Energy Evaluation Process

Advisor	Asking questions at the beginning	Asking questions throughout	Pointing things out throughout	Take Measurements	Pointing out things at end	Leak Hunt with Blower door test	Discuss potential recommendations	Deliver report
Advisor 1	x	x	x Flashlight	xStudents				
Advisor 11	xPreconceptions of work			x Sometimes customer follows		x		
Advisor 15	x		xUsually invite			xEncourages to feel with hands	xExplains what to expect in report	X Tries to prepare homeowner for report
Advisor 17		xAsk questions	x "And pointing out things, that was basically the way you did it."			xEncourages to track with post-it notes		x We always went through the information with them.
Advisor 2	x		xHomeowners can follow, but prefers alone to not miss measurements	x Focus on accuracy of measurements		x		
Advisor 3	X Questions on history of house		If homeowners insist, but does not invite them.	x Faster to take measurements alone. Already knows where things are.		x Depends. Not instructive for all houses	x	
Advisor 4	X Asks about situation			X Tries to gather data alone	xFull walk around with comments		x	
Advisor 9				x	x Detailed tour with the homeowner		x	

x: included in the evaluation process

Table 5.7 Description of Following Process by Advisor

Advisor	Asking questions at the beginning	Asking questions throughout	Pointing things out throughout	Take Measurements	Pointing out things at end	Leak Hunt with Blower door test	Discuss potential recommen d-dations	Deliver report
Advisor EEE1	x normally started the process with that discussion	x They were always made aware that he would take questions (left questions to them)	x Differences between EnerGuide and ecoEnergy	xUsually quite long		x have them put the back of their hand against drafts as it is sensitive		x Problem solving report
Advisor EEE2	x Confirm concerns on phone prior		xDid not want to be implicated in theft. Basements scary alone.	x			x	x I did everything as a 3 D drawing.
Advisor EEE3	x Asks questions about their concerns describes prioritization of recommendations		x Inside of house. Liability and learning	x Homeowners don't follow on the outside since he's just taking measurements			Tries not to give information overload	
Advisor EEE4	x Asks them to prepare prior to evaluation by giving access to attic or fireplace etc and questions at the beginning			x There are some time constraints. It’s quicker to do that alone because it slows the process down.	x With leak hunt	x	x	

x: included in the evaluation process

Table 5.7 Description of Following Process by Advisor (continued)

Some of the differences among advisors that came up were conflicting views about the perceived purpose of the evaluation. For example, Advisor 15 acknowledged that having homeowners follow slowed the process down, but he understood the evaluation to be a learning experience for homeowners, and so encouraged them to come along if they wished. Other advisors reported that they did not encourage homeowners to get involved in the evaluation (e.g., Advisors 2, 3, 4 and EEE4). Some of these advisors mentioned that they would invite the homeowner for a detailed tour afterwards of the findings (e.g., Advisors 4 and 9), sometimes combined with the blower door test.

Another issue that advisors discussed was that of trust. In some cases, an advisor expressed their preference to have homeowners follow them. In other cases, advisors described homeowners who insisted on following them. Advisor EEE2 mentioned that some parts of the house are scary (basements) and gave reasons to have homeowners follow: “For instance, if somebody said something was stolen, [I] did not want to be implicated in that type of stuff. Basically, [they] always had opportunity to monitor me.” Advisor EEE3 described wanting to avoid issues of liability; he implied in the interview that he wanted to ensure that there was no possibility for him to be accused of damages or theft.

> Just for protections sake, because we don’t know sometimes what situations we are getting into. So I always like to have the homeowner with me inside the house. Sometimes, as you can appreciate, the bedrooms, the bathrooms and those sorts of things, you go through them, so that way is for protection I don’t want to have any liability issues as you can appreciate. (Advisor EEE3)

Advisors 15, 2 and 3 also discussed the issue of trust on the homeowner’s part as a driver for involvement in the evaluation process. When asked about homeowner involvement, Advisor 2 mentioned “there are some people who do not want to leave your side; they are uncomfortable with you going through their house which is understandable too.” According to Advisor 3, “there will be others who simply don’t trust you. They are not keen as in “I would like to absorb as much information as I can.” They follow you on the heels because they simply don’t trust you alone in their basement, which is fair enough.” Advisor 15 described how this can become uncomfortable for the home energy advisor:

> I think there’s been the odd time, I mean they’re not explicitly saying this, but I’ve wondered if they really trusted me, I mean, you’ve got a strange guy wandering around your whole house. That takes a level of faith, right? I try to build that trust, and usually that works, but of course, sometimes there are homeowners who just follow you down the stairs. When I turn off the hot water tank I always leave my keys on the hot water tank so I don’t forget to turn it back on, so I run down to turn it back on so they’ll follow me to go down, and they don’t have to follow me, I’m just getting my keys and turning on their equipment, right? But the odd one will do that. (Advisor 15)

Many advisors described the blower door test as the highlight of the evaluation, and how this part of the process incorporates vividness for the homeowner. The process is described as follows by Advisor 15:

> Then I do the blower door test. I set up my blower door; I explain what I'm doing. I will then ask them while I'm sitting at the door, I just ask them to go around and make sure all the windows are closed, the inside doors are open, including the doors to the basement. Then I set up my blower door, I usually like to run the blower door, take my readings from the blower door, then leave the blower door running at about 30/35 Pascals and I then go through the house with the homeowner and look for air leakage through the cracks and holes that are in the house. Since I've had a lot of experience with this, I know to predict where they are, although there are times when you're sort of surprised that these things are there, but as you do this more and more you become less surprised because these things, you know about how the house works and where the air leakages are. Then I explain how they can be fixed and the impact that air leakage has to the homeowner. And I take the homeowner to put their hand where they can feel the air leakage and often they're really surprised and shocked that this is actually the case so I talk to them about ways of fixing their problem. (Advisor 15)

Advisors 3, 17, 11, 4 and 2 described the excitement that the blower door test generated. Advisor 2 also pointed out that this was commonly a moment when homeowners liked to point out their accomplishments in the house.

> And actually if I find a big draft, I'll say come you have to see this I have to show you something. And some homeowners are just like "oh cool!'" Once I set up the fan, and they'll be there hanging around anyway, so I'll be like "okay now I'm going to be leaving the fan running and checking for air leakage if you want to come around with me." So that without question is the part that has the most interest. (Advisor 3)

> The blower-door was always fantastic in the fact that it was usually the last thing you did. But you just walked around; you talked about there'd be some leakage in this area and here and there. And once you start the blower-door up and got the first couple a lot of them would dash around ahead of you. I had people who took sticky notes and they were putting sticky notes where they felt the biggest drafts, and they were running around the house doing that. (Advisor 17)

> I set the door up and ...then I get hold of the customer and they usually come around, not always, and we go around the house looking for the major air leaks. "Most of them get right into it you know. If they have kids the kids get right into that. I get the kids to help out and try and find leaks, but you can feel the air coming in and sometimes you hear it, and if there's cobwebs you can see it. And you go around the house and a lot of times you'll see some really amazing leaks that you would never expect, that the homeowner would never expect, so they're amazed a lot

of the times. So make a list of the big leaks and give advice on how to eliminate those leaks or cut them down at least. (Advisor 11)

> I do always explain because sometimes I see people kind of… they are not that impressed by air leakage. Other times you see people they feel a leak and "wow, I can't believe this!" And at times where I do see people not so impressed by the fact that there is air leakage I say "this may seem small here but", I reiterate this as we are doing the walk through, we've now seen this 20-30 times and when you add these up they end up being a significant amount of heat loss. (Advisor 4)

> People are very interested in the blower door test because it's impressive, right? You know, it's a big hazmat sort of sign. And they like …well no yeah…they probably don't like to feel all the drafts because that's a bit overwhelming to them, but if they have a specific concern, that's what they want to. If they have done their own renovations or something like that, they like to point that out. (Advisor 2)

5.3.3 Perceived Receptiveness of Homeowners

The interviews revealed that the perceived receptiveness of homeowners affected the advice given and the delivery of the evaluation for some of the advisors. This was true in two ways: receptiveness affected the level of involvement of homeowners in the process of the evaluation, but it also at times affected the selection of advice. Advisors' perceptions of homeowners was found to have a strong impact on guiding their decisions, and also revealed more information about each advisor's norms and motivations. One area of strong agreement between advisors about homeowners was around the effects of the financial reward on the type of homeowner who participated. There was less cohesiveness about whether homeowners were economically rational and motivated economically.

This section discusses the relationship between advisor and homeowner, including the differences in: level of importance of comfort, knowledge, financial savings, environmental improvement, financial rewards, and improvement in occupant health. Figure 5.5 displays a summary of the differences between the advisor's perceptions of homeowners' motivations and the advisor's own motivations for various outcomes related to a home energy evaluation.

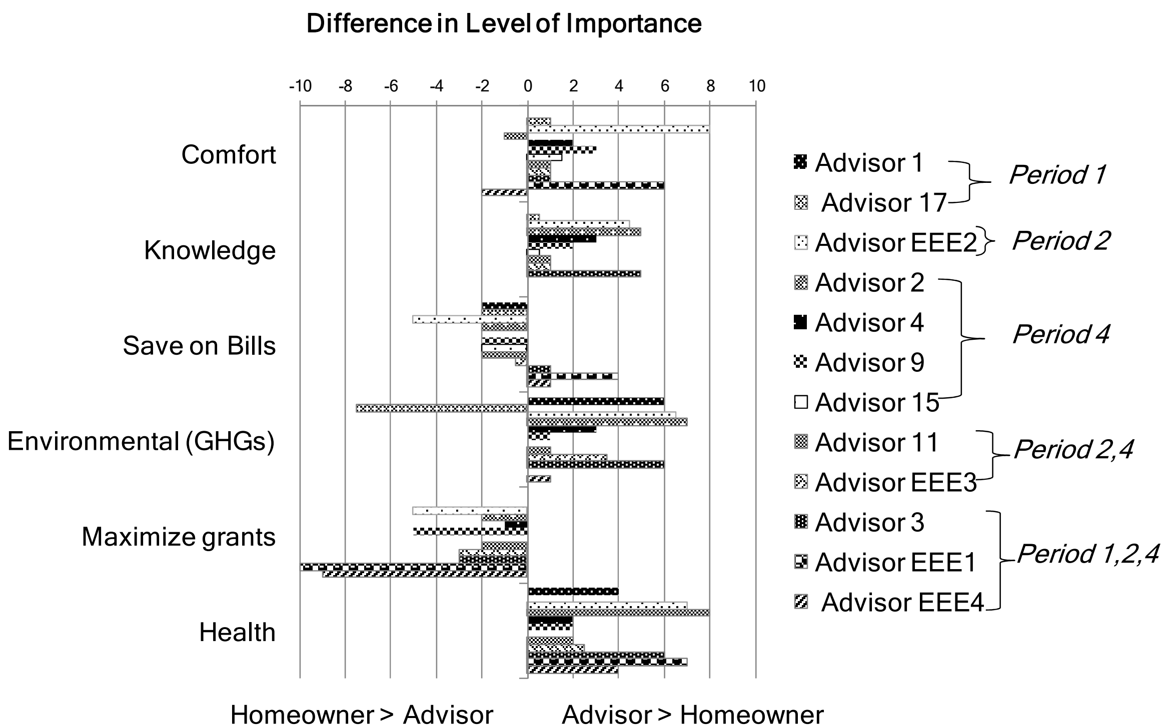
As previously discussed, advisors were motivated to improve the comfort and the health of occupants of the houses they evaluated. Some described being genuinely motivated to teach homeowners. For example,

> A successful home energy audit is when I've come into a house that's older than 1980 and people are very interested to know what's going on with their house, they're very eager to learn, they listen very well, they ask good questions, and then the feedback is in which they express understanding of the information and how it makes sense. They understood what I've explained to them and they're eager to get started

and make those improvements and that they really appreciate that my visit, and they tell me how much they've learned and are grateful. (Advisor 15)

Advisor 2 explained high points of being a home energy advisor:

> My favourite time is engaging with the homeowner who wants to learn and has very little knowledge about how their house works. And you can take them through the house and I can educate them a lot about it, about their basic house stuff. And so that, I love doing that. That's great.... Building science is so fascinating! You know, the house as a system is so fascinating and there are always things where you're just like "wow"! Health? That is up there too… And there is just this sense of "oh, if you understand this then you might change your behaviour this way and wouldn't that be great..... There's two ways they can save energy, change the house, but also sometimes people can change their behaviour, and stuff like that. (Advisor 2)



*Advisor 15 did not respond to Environmental, Maximize Grants or Health, and was removed for these categories

Figure 5.5 Differences in Level of Importance Between Advisor and Advisor's Perception of Homeowner*

Despite high levels of enthusiasm displayed for teaching, advisors perceived that many homeowners were not responsive. For example, Advisor 3 discussed that sometimes the first difficulty in a homeowner's responsiveness occurred upon arrival:

> I've had, you know, homeowners who have…I've shown up at the door and they've said "why are you here?" you know. .And I've had to spend half an hour talking with them to convince them to actually go ahead with the evaluation. And you know… Or homeowners who stand there with their arms closed and… "I already know everything there is to know about my house, what can you tell me?" So, or, there is sometimes you know you've got homeowners who are very receptive and other times they are less receptive. (Advisor 3)

It stands out in Figure 5.5 that advisors perceived that homeowners were far more interested than advisors in maximizing grants. The most extreme difference between ratings was reported by Advisor EEE1. The existence of a financial reward was perceived by advisors as having a strong impact on the motivations of participating homeowners. For example, Advisor EEE2 described homeowners' focus on financial rewards: "By the way, most people would spend five dollars on a caulking gun to fill up some holes you know just with the hope that they can get $1000 back. You can see it in their eyes when you're talking to them."

Most of the advisors who worked in Period 1 described homeowners who were interested in knowledge about how their house worked and who were very environmentally aware and motivated to address climate change (Advisors 1, 3, 17, EEE1). Discussing the inclusion of a grant brought up feelings of conflict for advisors, some stronger than others. For example, some advisors who worked in both Periods 1 and 2 mentioned quitting soon after the grants came about, one reason being that the grants caused a sense of conflict (Advisors 17, EEE2). Advisor 3 described the shift in focus due to grants:

> I feel like in a way our role has changed a bit from pre-grants to grants where we're now the grant provider. That's how people see us as. So they want to know "how much of a grant can I expect?" and "what do I need to do to get the grant? And everything seems to revolve around the grant.....I just had a lady today, I did an evaluation, I said to her "you know you can add insulation here in your attic but just so you know it doesn't qualify for a grant." and she was like "well then it's not going to be worth doing."(Advisor 3)

Advisors also described that during the periods in which grants were offered, homeowners generally had pre-conceived decisions in mind. The two most commonly discussed decisions that were mentioned as pre-conceived were replacements of windows and changes to heating systems. Several advisors who worked during Period 4 discussed the attitude from homeowners that it was only worth doing if was eligible for a grant. Advisor 9 mentioned these conflicting feelings about the grant, but also that it was obvious that when the grant dried up, so did work, so he was aware of its importance.

Period 2 provided the same information that was given in Period 1, but with a performance based grant. There are mixed perceptions of participants in Period 2. Advisors 17 and EEE2 mentioned homeowners being very grant focused once EnerGuide for Houses included them, and both stopped advising soon after the beginning of the program. Advisor EEE1 did not see much difference between Periods 1 and 2, saying they were both environmentally and knowledge motivated. Overall, as summarized in Figure 5.5, advisors for the most part (except Advisor 1 from Period 1, and Advisor EEE1 and EEE4, all of whom worked in Period 1) reported being very interested that homeowners gain knowledge, more so than they perceived homeowners to be.

A very common perception that was expressed, except from Advisors 9 and 17, was that homeowners were generally motivated to save on their energy bills, as shown in Figure 5.5. Related to this, some advisors perceived that homeowners were motivated to make economically rational investments. "I think most people are just looking for what's most practical, what's most cost-effective, what's going to give them the greatest pay back and not always in money but comfort improvements." (Advisor 4) Several advisors (Advisor EEE2, 9, 11) mentioned paying attention to clues of socio-economic status and the ability to invest in various retrofits: the car in the driveway (Advisor 11), the clothes that they wear and the general condition of the house (Advisor EEE2) and whether they are baby boomers, on fixed income or not (Advisor 9). In some cases, the difference between ability to pay and willingness to pay was used as a gauge of other homeowner motivations. For example, many advisors spoke of homeowners' reluctance to pay for a heat recovery ventilator. Advisor 11 mentioned that as soon as the homeowner heard "two thousand dollars", they said "no", but, he also mentioned that he would noticed their expensive car in the driveway. Advisors seemed perplexed about the values where homeowners choose to spend their money. Figure 5.5 displays that all advisors perceived that they were more interested in improving homeowners' health than homeowners were. Most advisors perceived themselves to be more interested in comfort than homeowners as well. However, it could also be that homeowners simply did not understand the house as a system and the interactions of behaviour, air quality and comfort. Advisor EEE3 described that

> The hardest thing for people to understand has mainly to do with indoor air quality issues. How do we get around that? Try to come up with strategies that make sense for them. As an example, maybe I can relate it as a situation. I went to a house, relatively new; it had an old furnace in the house. I come back on the second visit, and then a brand new furnace in the house. Which is what I recommended and that's what she did. I asked the lady, "How do you like your new furnace?" She said "I hate

> it." I was like, "well, what's wrong? It's a nice furnace, it's a good brand, what's going on?" She said, "Now I've got a whole bunch of condensation on my windows which never happened before." I said "Ahh, it's not the fault of the furnace, what's happened is that you've now changed the whole dynamic to the house". And all of a sudden the eyes glaze over, because she doesn't understand ... how one thing can have a big impact on the other aspects of the home, because we try to work on the home as a system. And so because of that, I'm trying to relate to her as far as indoor air quality and ventilation systems, and that, and that is hard to get across. They can definitely see the symptoms: condensation on windows and people getting congested and it's always humid in the house and things like that. But they don't understand how putting in an HRV or an air exchange unit can have a benefit to the home because all they see are extra costs.

Advisors 17 and 9 expressed a different opinion than the other advisors, and expressed that they did not believe that homeowners were economically rational. Advisor 9 expressed the opinion that the baby boomers do not see saving money on energy bills as an important driver.

> Also we hear it often that "my energy bills are too high". That's not really the highest level of motivation, though, because if you look at it demographically and look at the baby boomers, they actually generally seem to feel kind of comfortable with their energy bills..... You'd think everybody would want to save on their energy bills. Some people do, and certainly if you go into, say, the low-income housing area you would, except a lot of those situations are actually skewing results because those people don't actually pay their own utilities. It's either government institution or the way it's all set up. Somehow the co-op handles the payment so they have a different relationship to the utility cost as well. (Advisor 9)

Advisor 17 pointed out that lifestyle choices were responsible for negating the improvement to energy savings: "The highest bills I've ever had had nothing to do with the house, they were driven by the homeowners."

Another commonly held perception of homeowners, regardless of program period, was that they generally had little knowledge about how their house worked in relation to energy usage, as well as little procedural knowledge on how to go about doing renovations. Advisor EEE3 reported "I think there's a big lack of knowledge, homeowners just don't know. It's amazing the lack of knowledge people have about how the house works. They're willing to live with un-insulated houses or old furnaces, and different issues on the way and they're just paying the bills month by month and they just really don't know, and there's a real lack of knowledge out there." Several advisors pointed out that this was particularly the case in terms of maintenance of mechanical systems (Advisors 1, 17) and insulation (Advisors 2, 3, 9, 11, EEE3). Advisor 2 and Advisor 9 discussed the insecurity that homeowners display in carrying out work.

“And they’re looking for that advice on ‘how should I do this? If this was your house, how would you do this?’” (Advisor 2). “I think in some instances it’s not actually necessarily information they are after. They are looking for assurance and for somebody to take responsibility for something that won’t be taken on by somebody else. But they’d love to have somebody who says ‘I will do this for you and I will take responsibility for your renovation and it will work out fine.’” (Advisor 9). Advisors 11 and 3 expressed opinions in agreement with Advisor 9 that homeowners were not necessarily interested in the information, but they also expressed views that homeowners are economically motivated to save on energy bills. For example, according to Advisor 11, “Well, gaining knowledge on how their house uses energy is sort of an intellectual thing and they’re not into that. Kind of trying to cut back on their bills. They do it by cutting back on their energy usage. But it’s why, like, if I talk them in too scientific a way, it’s just “phew!” (shooting noise). They don’t get it. You know? .... Most homeowners don’t have any good idea how their house works. ” Advisor 3 expressed a view that concurred with this:

> I’ve done over 2,500 evaluations. I haven’t had a single homeowner ask me “so, how much does my water heater use energy, how much does my space heating use” as opposed to…, you know, “how much does my fridge use in electricity per year.” Not a single homeowner has asked me. No one cares. They care about their bill, they care about the total amount. ....and when people look at the report afterwards and maybe have some questions for me, I never have anyone who looks at “oh, that’s an interesting bar graph, it breaks down my energy use about...” No one cares! You know? (Advisor 3)

Hence, there is friction that can arise due to conflicting interests and values between homeowners and advisors. However, with persistence, sometimes this friction can be overcome. The one female advisor of the group described her most successful evaluation as:

> The most successful evaluation that I had was to show up at the door and at the end of it, the homeowner said “when you showed up at the door,” he said “I thought to myself, “what’s this little girl gonna teach me, why did they send me this?” Right, and he was very polite, and he said, “You taught me something about my house.” And I was so touched about that. That was the most successful one because…yeah… So, I really enjoyed that because he had…right away he was like “This is gonna be useless, this is gonna be a waste of time.” But he somehow, through our engagement,… and I could see his interest level going through, you know, getting deeper, and so, that was really good because I know I handled it really well in terms of obviously, not making him feel threatened. So that was the most successful one. I loved that one.

Advisor 15 described a situation where the homeowner was interested in his feedback despite a negative perception towards the program:

> I had one homeowner who told me that he figured it was a complete and total waste of time, and a big sham. He was dead serious, and he was a very aggressive kind of individual. I tried to explain to him that this program was designed more for houses that were older than his. That it was more than just the furnace and the AC [air conditioner]. So, and ironically, this guy, when I went back and did the follow up audit, and was going through his attic, and the guy had thrown the insulation up there, probably could have added a little bit more. So, when I started to make that noise, he was quite interested in this. I mean it was okay, the insulation was okay. I mean he was quite interested in my feedback, yet, he was telling me the whole thing was a sham. (Advisor 15)

5.3.4 Scientific and Accurate Versus Message Framing

The interview explicitly probed advisors as to how they framed messages when communicating with homeowners. Advisors were presented with different types of messages, and asked if they commonly would say something similar to homeowners. When advisors responded that they did not use a particular type of statement or message, they were asked to give examples of alternate statements they would use. It was in this way that an advisor's preferences for message framing were revealed. The main finding of this section of the interview is that advisors prefer accurate statements and measurements, most expressed a preference for scientific framing and explanations. Most advisors also expressed a preference for gain-framed messages (that emphasize desirable consequences), over loss-framed messages (that explain consequences of inaction), or comparative/normative or vivid messages (that tell homeowners what other homeowners are doing). Amongst the advisors interviews, deviations were as follows: those who used loss-framed messages; those who did not use gain-framed messages; those who used comparative or normative messages; those who used vivid statements. Accuracy and perceived receptiveness of the homeowner as they were described were generally related to concerns of some advisors over liability related to information given: avoidance of guarantees regarding energy and monetary savings or grants was common.

A general reaction towards loss-framed messages was that they were not the way to motivate. They were seen as being based on poor language, or being threatening, or being judgmental. However, one advisor mentioned he was "attracted to the bluntness" of the message (Advisor 4). The two advisors who reported using loss-framed messages said that they used it in a humorous or banter like manner. One used an alternate statement of "You're just heating up [this city][35] for free!" while the other mentioned the important point is to make it humorous or provoking, not mean. When asked for an alternate statement, several advisors offered a scientific or economically driven statement. For example, Advisor 11 gave the alternate statement: "Say when it comes to furnaces I'll say "Look, this furnace is 80% efficient but 20%

[35] The city's name has been removed to retain the advisor's anonymity.

of the heat generated is going up the chimney, if you go to a new furnace you can reduce that to just a 5% loss so you end up burning less gas" so that's how I present it to them." Advisor 3's statement was "for every dollar spent, 25 cents is going up the chimney. If you got a high efficiency furnace, that would be reduced to 5 cents." Advisors 9 and EEE4, who used loss-framed messages, were considered deviations.

Uses Loss-Framed Statements	Versions	Aggressive statement	No
Advisor 9: "yes, but don't want to be combative, accusatory, or miss the mark, want it to be banter", make it humorous or provoking	Advisor 1 "cut losses"	Advisor 15	Advisor 17: "not the way to motivate"
Advisor EEE4: yes, not aggressively " Sometimes "what do you want to do? You're just heating up Burlington for free!" Look, you're heating up Burlington, the heats leaving your house and heating up the town. A very dry humour."	A3 "for every dollar spent, 25 cents is going up the chimney. If you got a high efficiency furnace, that would be reduced to 5 cents"	Advisor 2 "judgmental"	Advisor EEE3: would use better language to say the same thing
Advisor 4:In the case of structural danger	Advisor 4: no, scientific statement, "attracted to the bluntness"	Advisor EEE1: science driven statements, not to threaten	
		Advisor EEE2: does not want to criticize the individual	

Table 5.8 Summary of Responses to Loss-Framed Statements

Most advisors said that they used some version of the gain-framed statements. Advisor 9 said that he sometimes used these, but it really depended on the homeowner he was speaking with. Advisor 2 described that she did not use gain-framed statements, and expressed being very uncomfortable with guarantees such as saving energy or money on their energy bills. Advisor EEE1 also described feeling most comfortable using scientific statements, and did not use gain frame statements. Most advisors accepted the use of a gain-framed statement about savings. However, they were usually quite specific. Advisors 1 and EEE2 would only discuss energy savings, never money savings, whereas Advisor 11 would say "decrease energy use, save money". Advisor 3 reported that he generally discussed saving energy, and sometimes saving money. The rest of the advisors acknowledged often using this type of statement, several mentioning that this was all part of the conversation. The advisors who did not use gain-framed statements were considered deviations.

Does not use	Likes this	Likes this	Likes this
Advisor 2: "I can't guarantee...“by doing this, most people would experience”" or a scientific statement about keeping the heat in, does not like definitive	Advisor 1: "save energy"	Advisor EEE2: but does not equate money, only energy savings (80 to 90%)	Advisor 17: focused on saving dollars
Advisor 9--depends on type of person	Advisor 11 "decrease energy use, save money"	Advisor EEE3, probably about 50% of time	Advisor 3: finds it uninteresting but does talk about saving energy (always), sometimes money
EEE1--still leans towards scientific	Advisor 15 "it's all part of the conversation"	Advisor EEE4, money and energy savings, very common, not just energy savings. Likes to outline lots of benefits	Advisor 4: "100% of the time" also mentions comfort gains

Table 5.9 Summary of Responses to Gain-Framed Statements

Advisors reacted in a variety of ways to comparative statements, and overall, comparative statements yielded information about the limits of advisors' knowledge and revealed more information about their perceptions of homeowners. The two statements were: "I just finished the second evaluation on a home similar to yours." Or "I've seen some homeowners of these types of houses put a lot of effort into [x measures]: and when they did that, they really reduced their energy bills and saved a lot of greenhouse gases." Advisors used comparative statements or statements about other homeowners in a variety of ways, but many also explained the difficulty in using the comparative statements given. Two advisors, Advisors 2 and EEE1, described that they absolutely would not use comparative statements between houses or homeowners. In the case of Advisor EEE1, the housing stock that he described that he evaluated was the most diverse, so this in particular it made sense that these were difficult to compare. For example, Advisor EEE1 described the houses that he evaluated as mainly old homes with many additions from different time periods. Many advisors said that they used some form of comparative statement, but they did not emphasize or generally discuss greenhouse gas emissions as they did not think homeowners would be very responsive. Advisor 11 was very specific as to when he used comparative statements: he sometimes used them in the case of convincing a homeowner about the benefits of an HRV. He did this often when explaining the health benefits that other homeowners had told him about.

Advisor 17 pointed out an issue that came up for many advisors, which was that he did not have the data to compare. This relates to the guiding principle of the quality of information. Advisor 15's point of view agreed with this, and he related the problem with comparing to the house as a system concept: "That would be very tricky to do because there are so many other variables in the equation, you know how many people live there, did they change did they use the thermostat, and you know behaviour change and that could come in, so many variables, so that would be a big scientific experiment to do that."

Uses	Uses	Does not use	sort of uses
Advisor 1--no problem, seemed that he could quote a lot from past experience prior to Period 1	Advisor 9-yes, first is limited, second does not reference greenhouse gas emissions	Advisor 2	Advisor 11--neither statement, but sometimes describes benefits to other homeowners of installing HRVs
Advisor 15--does discuss other homes	Advisor EEE2, no numbers but referred to other people	Advisor EEE1	Advisor 17 did not have the data to compare, did not like first statement, gives lifestyle anecdotes of what not to do
Advisor 3--not often, never promises large energy savings	Advisor EEE3 but without GHGs, and houses can be quite different		
Advisor 4-not often, does not emphasize greenhouse gas emissions	Advisor EEE4, specifies situations, not too often		

Table 5.10 Summary of Responses to Comparative and Vivid Statements

The concern about quality of information and using comparative and vivid statements stood out for advisors depending on their experience. It appears that those who had done follow-up evaluations on the same houses as where they had done initial evaluations generally felt more comfortable with this type of statement, or said that it came out more naturally because they had actually seen and remembered the before and after. This applied more generally to the advisors who worked in their own service territories through the Elora Centre for Environmental Excellence and had worked during periods when there were a large number of follow-up evaluations. In the case of REEP advisors, as REEP operates as an organization, the advisors did not necessarily follow-up in the same houses and felt less comfortable making these types of statements. "Well, part of it is that we do have limited feedback from homeowners from a real life perspective."(Advisor 9) Again, returning to the complexity of a house as system and the quality of information:

> If anybody in this context would present me personally with a statement like and they've saved x % of their energy bills I'd be very suspicious how that's been determined. Because we are finding that unless you almost lay it out like a lab experiment and make these people aware that

> they should try and keep their lifestyle the same, any of those saving measures seem to have fairly high error bars attached to them. (Advisor 9)

Advisor 2 expressed a more emotional reaction, saying:

> I don't think so, I don't like to compare houses, I don't like to. Maybe I need to look at things. This doesn't sound encouraging it sounds guilty, it sounds guilt-making. Although someone could say by saying something like this you're giving someone hope. I wonder what homeowners would like to hear. This is interesting. (Advisor 2)

Many advisors mentioned using techniques of doing the home energy evaluation that incorporated vividness or the potential to access the availability heuristic. About half of the advisors reported using vivid statements, such as metaphor or similes for comparison. The other half of the advisors described a preference for a scientific statement. For example, they described the equivalent air leakage area purely as a measurement that was contained in the report. Advisor 11 said that he would not use the equivalent air leakage as the air changes are more precise (this relates to house volume), again confirming interest in scientific statements.

Object as Equivalent Air Leakage Area	Measurements	No	Other Vivid Statements
Advisor 1 to a good leaky house	Advisor 15, Advisor 17 equivalent air leakage in report	Advisor 11 says air changes are more precise	Advisor 4 refers to a water tight problem, like leaks in a bucket
Advisor 9	Advisor 2 explains the number will appear in report when doing blower door test		Advisor 9 -boat is the lead in
Advisor EEE2, but also mentions spider webs (so does Advisor 2)	Advisor 4 yes, but does not reference something concrete like window		Advisor EEE4–"ghostly thing"
Advisor EEE3 says "beach ball, soccer ball etc. all the time"	Advisor 3 yes, gives measurements in inches		Advisor 2 and EEE2 spider webs
	Advisor EEE1		
	Advisor EEE4, but compares to volume of house		

Table 5.11 Summary of Response to Vivid Statements

5.4 Advice

So far it has been described that in giving advice, the advisors were primarily motivated by quality of information. The interviews revealed that advisors developed different styles of giving advice. The pattern of communication was influenced by the four interacting elements of purpose, process, message framing and the perceived receptiveness of the homeowner. Figure 5.6 illustrates the interactions between the four elements of the pattern of communication and the guiding principle of quality of information and how these affected the resulting recommendations. This figure illustrates that the recommendations were influenced by the purpose and the perceived receptiveness of homeowners; hence these are shown as a filter between the quality of information and recommendations. Further, how the recommendations were communicated depended on the process and the selected message framing, and these are also illustrated as filters between recommendations and decisions taken by homeowners. Due to the influence of the four factors, when giving advice, some advisors self-contradicted their knowledge of what measures affect a houses energy performance. For example, they reported choice-editing for the homeowner due to perceptions of the homeowner's interest and knowledge levels. Other advisors' rationales were that everything in the report was there for a reason. However, homeowners often did not react as the advisors hoped. This section discusses more specifically the advice that was given to homeowners, and the underlying rationale.

Broadly, advisors can be divided into the two groups of "choice-editing", considered to be keeping the recommended list of improvements to an achievable list, and those who gave all possible improvements, whether or not they thought the homeowner would accomplish them all during the program. The advisors who gave all possible improvements in the report were also often the same advisors who viewed the report as a "roadmap". Between these two extremes, there was sometimes negotiation between homeowners and advisors over the recommendations made. These positions are summarized in Table 5.12.

In this section the qualitative strand, the discussion of how the recommendations were made, is merged with the quantitative strand, an analysis of recommendations and decisions made by homeowners by advisor. The five decisions that stood out in terms of negotiation with the home energy advisor were: the replacement of the heating system, basement and wall insulation, air leakage, and replacement of windows. These are summarized as the five D's: heating systems as "drivers", basement insulation as "determined", wall insulation as "discouraged", window replacement as "distraction" and reduction of air leakage as "duo". These descriptors summarize the underlying issues associated with these decisions, and are described briefly in Table 5.13. The frequency of these recommendations by advisor and within the various vintage groups is described in Figure 5.8, Figure 5.9, Figure 5.10, Figure 5.11 and Figure 5.7.

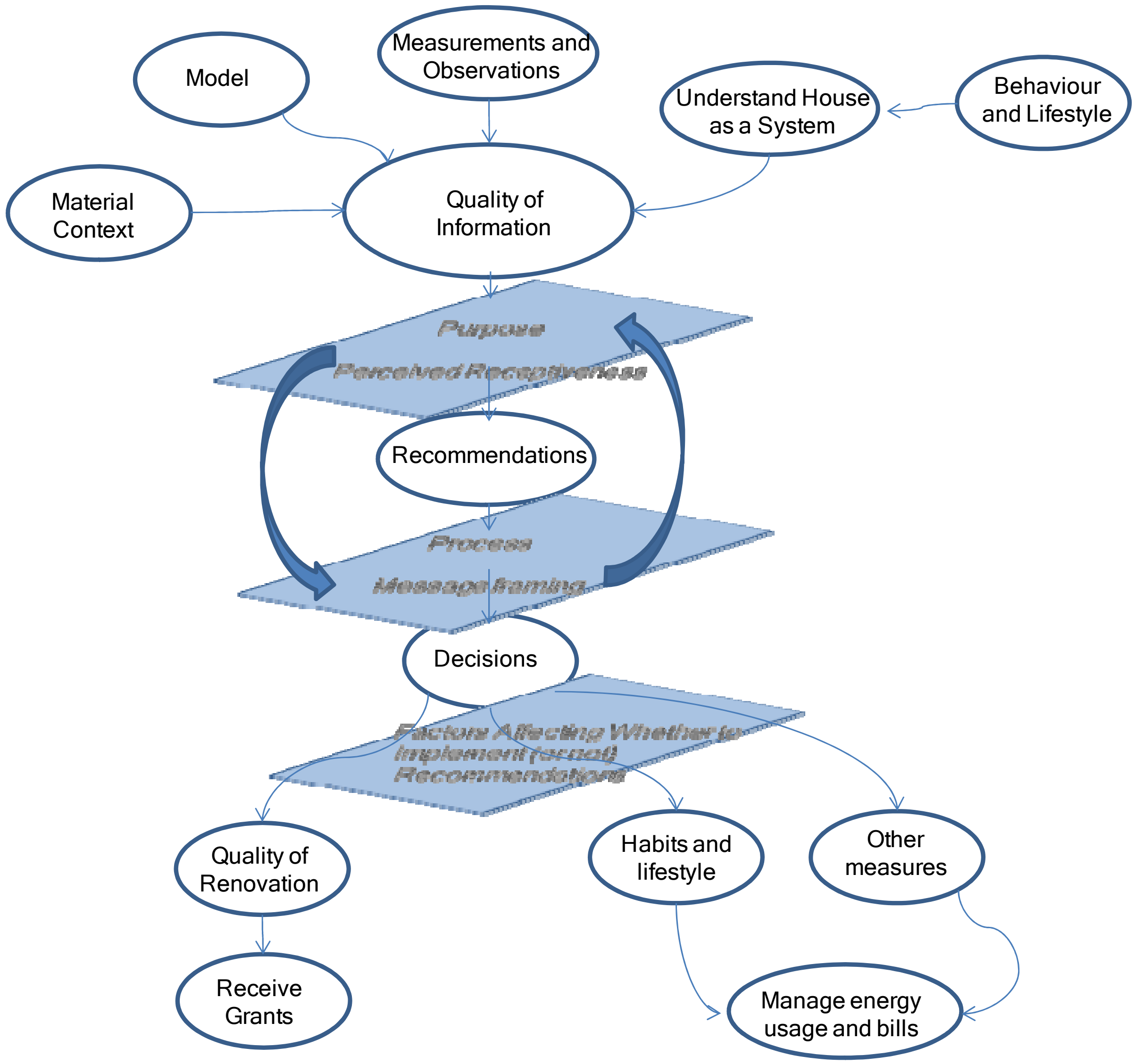


Figure 5.6 Interaction of the Four Elements of Communicating Advice and Quality of Information in the Advice-giving Process

Advisor	Scope of Recommendations	Recommend savings in your report which you don't think are important, or only for information?
1	All possible improvements	Yes, does not specify
2	Focused on achievable list	Everything has its importance in there
3	Focused on achievable list	Windows
4	All possible improvements if receptive, focused on achievable list if low interest	Keep the report to what I think is important
9	Focused on achievable list	Even if not high priority but has to make sense
11	Focused on achievable list	Lifestyle type choices, like drain heat recovery
15	All possible improvements	Will model more difficult things, such as insulation added to existing insulation.
17	All possible improvements	Only what is important
EEE1	All possible improvements	Every change that could bring each component of the home to current standards
EEE2	All possible improvements	I actually spelled out that they weren't worth pursuing.
EEE3	All possible improvements	If it's applicable for things to do in the future
EEE4	All possible improvements	Everything is important and prioritized as well.

Table 5.12 Advisor Responses to Report Recommendations

Decision	D	Description
Heating system	Driver	Replacement of the heating system is commonly reported as a driver into the program.
Basement insulation	Determined	Agreement among advisors that this renovation can greatly improve energy performance.
Wall insulation	Discouraged	Some advisors choice edit the recommendation of walls to help homeowners focus on the recommendation of basements.
Window replacement	Distraction	Advisors reported that homeowners believe that the windows are an important way to reduce energy losses, when the opposite is true, and they are not cost effective.
Air leakage	Duo	Air leakage is difficult to reduce perfectly, but is a "staple" of advice recommended in combination with other recommendations. Air leakage also interacts with other building envelope retrofits.

Table 5.13 Description of Five Decisions

5.4.1.1 Driver

The replacement of the heating system was considered by many advisors to be a driver that encouraged homeowners to participate in the program. However, many advisors discussed that homeowners typically did not want to install a higher efficiency furnace. Advisors also noted that some homeowners were hesitant to replace their heating system due to the cost. As previously mentioned, the introduction of the reward was associated with a focus on pre-conceived decisions. For example, Advisor EEE1 gave the estimation that in Period 4 at least 80% of participating homeowners wanted to change their furnace, and that many were referred to the program by a furnace installer. Advisor 17 expressed the belief that a strong interest in furnace replacement began with the introduction of a grant in Period 2. Advisor 11 summarized this situation: “They’re getting the furnace installed next week so do your thing and get out. So, those are the ones that are unpleasant for me.” Advisors 4 and EEE3 both mentioned that when they would ask homeowners about their concerns, a typical response was the desire for a new furnace. Both Advisors 2 and 3 mentioned that homeowners participated in order to get a furnace grant, Advisor 2 specified that some homeowners felt forced into the program since they wanted a furnace grant, and could only get it by participating. Advisor EEE3 discussed that, while the heating envelope is important, people can more readily understand the importance of improving an “old clunker” of low efficiency to a modern technology high efficiency furnace.

As discussed in Section 5.2.3.2.4, advisors generally agreed that the recommendation to change the heating system is typically the single biggest opportunity to improve energy performance in a newer house. Further, furnaces should be replaced particularly if they are older and closer to failure. And finally, low- or mid-efficiency furnaces should be replaced with high efficiency furnaces. Several advisors, such as Advisors 3 and 11, mentioned that if a homeowner wanted to have a recommendation of a furnace, they would include it in the report. On the other hand, some advisors, such as Advisors 11 and 17, pointed out that sometimes homeowners were hesitant to change an old furnace, even though it was close to failure. Even though most advisors said that they only put recommendations into the report that were important (see Table 5.12), many would make recommendations that were consistent with homeowners’ pre-conceived decisions.

Turning to an examination of recommendations, as discussed in Chapter 4, what is interesting in examining Figure 5.7 is that heating system recommendations were generally made less than 50% of the time in Period 1, but between 50% and over 80% of the time during Periods 2 and 4. Recommendations do not appear to have varied by vintage, even though the importance in relation to energy performance increases in newer houses.

In Period 2, it appears, for each vintage group, that Advisor 10 recommended heating systems to the smallest percentage of homeowners, while Advisor 14 recommended them to the largest percentage.

In Period 4, it appears for every vintage group that Advisor 2 recommended furnaces the least often, while Advisors 4 and 12 appeared to recommend furnaces the most often.

5.4.1.2 Determined, Discouraged and Distracted

The main negotiation that occurred between homeowners and advisors was about the windows ("distraction"), wall insulation ("discouraged") and basement insulation ("determined").

Starting with a discussion of walls, overall, most advisors said that for older houses, the building envelope, including wall insulation, is an important measure to improve energy performance. However, Advisor 4 indicated there was disagreement amongst REEP advisors on what to recommend for a partially insulated wall; some recommended more insulation and some did not recommend more. The following are some examples of these divisions. For example, Advisor 2 said:

> I also let them know that we don't tend to recommend something that is ridiculous. Not ridiculous but that most people wouldn't consider. For example, in a 1960s bungalow there is a little bit of insulation on the walls and… but not nearly enough and it's usually a very poor quality, right, it's old fiber glass. So, it's not doing that much good. But at the same time, is a homeowner gonna tear out all the plaster and put in new insulation or new siding for that? No, they are not gonna do that, right? I mean, that's gutting your house. The people with Victorian double brick homes they are just not going to tear out the plaster, and they are not going to put siding on the outside. So, I have chosen, I guess, all the way along to just not even bother with that and focus when where they can make a difference like basement insulation, attic insulation, and other things.(Advisor 2)

However, Advisor 2 also explained that effective insulation is the measure that will most improve energy performance in a house.

According to Figure 5.10, Advisor 2 recommended wall insulation in nearly 60% of evaluations of the oldest houses. This percentage was closer to 5% for the newest houses.

On the other hand, Advisor 9 said: "Basically anything un-insulated, as far as wall cavities or surface areas are concerned would be high priority to get into....I will point out to people who are say, living in a particular home with double brick construction and only a very small cavity between the lath and plaster and the brick to upgrade who are basically saying "is it even gonna be worth it?" I will basically point out to them that I've had two clients contact me after they've done it and share their positive results with me." As summarized in Figure 5.10 , Advisor 9 recommended wall insulation to over 80% of the owners of the oldest group of houses, and to over 10% of those with newer houses. Advisor 9 recommended insulation to walls more often than the other advisors did.

Advisor 15 discussed that even though it is difficult to add insulation to existing insulation, he still made this recommendation. According to Figure 5.10, Advisor 15 recommended insulating walls to close to 60% of those with the oldest houses, and to less than 10% of those with the newest houses. However, Advisor 15 made the recommendation to improve wall insulation less often (by vintage group) than Advisor 9.

Advisor 4 expressed the importance of improving the integrity of the building envelope. According to Figure 5.10, Advisor 4 recommended wall insulation less often than the other advisors. For example, he only recommended wall insulation to nearly 50% of owners of the oldest group of houses, and to less than 5% of owners of the newest houses.

During Period 4, Advisor 11 recommended insulation to walls to the lowest percentage of houses when compared to other advisors. He advised insulation to walls to close to 50% of homeowners with the oldest houses and to less than 5% of homeowners of the newest houses.

Advisor 3 discussed that it is "dumb" to have a new furnace and no insulation in the walls, but also explained that walls can be high cost to insulate and disruptive in most cases. He said that convincing homeowners to insulate the walls required a bigger sales job. He added that improving insulation to walls has the co-benefit of reducing air leakage. According to Figure 5.10, Advisor 3 recommended insulation to homeowners more often than other advisors did during Period 1. He recommended it to over 70% of owners of the oldest houses, and to close to 20% of owners of the newest houses. During Period 2, Advisor 3 recommended wall insulation the second most often to 80% of those with the oldest houses and to over 20% of those with the newest houses. During Period 4, Advisor 3 recommended insulation to walls less often than other advisors did. He recommended it to nearly 60% of those with the oldest houses and to less than 5% of those with the newest houses.

During Period 1, according to Figure 5.10, Advisors 1 and 17 recommended insulation of walls to a similar percentage of houses as Advisor 3.

In summary, overall, adding insulation to walls was the retrofit that was recommended to homeowners the least often. Furthermore, there were large variations of the percentage of houses to which advisors made this recommendation.

As previously discussed, it was found that advisors generally agree that windows are a very costly retrofit that does not generate enough savings. However, advisors discussed that homeowners were very interested in changing their windows. Advisor 2 described "I would say more than 50%, maybe even higher, would be okay hearing a recommendation “yeah you should get your windows done.”....That’s one of my spiels. Windows are the least efficient upgrades ....I try to appreciate where they’re coming from but say there’s other things too....The most energy efficient house has no windows in it. We like windows, we do.” (Advisor 2) Advisor 4 mentioned that besides furnaces, windows were also a typical concern mentioned by homeowners. Advisor 15 explained his belief that homeowners wanted to change windows because their neighbours did. Advisor 17 said that the focus on windows was due to convenience: those homeowners wanted to avoid having to paint and maintain their windows, and they used energy to justify the cost. Advisor EEE1’s and Advisor 1’s perceptions were that homeowners thought that windows could do anything for them Advisor EEE1 and Advisor 11 both mentioned homeowners who already had a contractor scheduled to change the windows by the time the advisor had arrived to do the evaluation. All of Advisors EEE1, EEE2 and EEE3 reported homeowners who were annoyed when they found out how low the grant for windows was.

When confronted with a demand for windows, what did advisors do? Advisor 17 said that he only ever really recommended windows twice, and they were for behavioural reasons. In one case, he reported that the homeowners liked to sit by the window and would turn up the heat so he recommended triple glazed windows. Figure 5.11 shows that Advisor 17 recommended changes to windows to the lowest percentage of homeowners compared to any other advisor. He recommended windows to only 10% to 20% of homeowners, depending on the vintage group.

Advisor 11 described that he would recommend replacing windows if they were old, but said that at a cost of $20,000, the chances of windows being replaced were “slim to none”. Hence, Advisor 11 expressed the belief that homeowners behave in an economically rational manner and this affects the decision to replace windows. As shown in Figure 5.11, Advisor 11 recommended the replacement of windows to a fairly high percentage of homeowners, ranging from just under 60% to over 90% of homeowners in Period 2, and ranging from nearly 50% up to close to 90% of homeowners in Period 4.

Several advisors acknowledged homeowners’ interest in windows, and even recommended them, but discussed also trying to encourage homeowners to pay attention to other recommendations. Advisor 2 warned that very little energy savings were associated with changing windows, but also gave permission to homeowners as there were reasons to replace them: “But the windows, people would be very happy because people like windows! You know, we love windows! And as I said, the most energy efficient house has no windows in it. But, you know, we do need some windows, or, we like windows, of course. We do need windows; otherwise we are all sad, right. Seasonal affective disorder.” (Advisor 2). Advisor 2 recommended that close to 60% of homeowners changed their windows during Period 4. This percentage varied little across the vintage groups.

Advisor 15 described the desire to be responsive to homeowner concerns, but also show them the best opportunities. He explained that the priority should be on the building envelope, including walls. He noted that even if homeowners were interested in changing windows, he would explain to them that windows are not usually a priority. He would explain that there are alternative opportunities, including energy savings opportunities by insulating knee walls. If windows were a pressing concern, he would test them in front of the homeowner, and explain the advantages and disadvantages of replacing windows to the homeowner, but leave the decision to them. Advisor 15 recommended windows most often to houses built in 1945 and before, and overall, recommended windows to a lower percentage at less than 20% to less than 40% of the houses he advised.

Advisor 3 explained that he tried to give information to homeowners with the intention of shifting their attention to a different option. Advisor 3 did this by including information in the report that was relevant to making a decision. When asked if he ever included recommendations in the report that was meant for information only, but not necessarily for action, Advisor 3 said:

> Windows might be an example. Cause oftentimes people will say ...that that's the best way to improve the efficiency in their homes. And they'll claim "my windows are so drafty!" …. So, sometimes ...I'll tell people ahead of time, … I'm going to model upgrading your windows and model upgrading your basement you can see them side by side and all brand new windows will raise your rating by 1 point insulating your basement will raise your rating 6 points. … I do like to do that as a way of allowing people to make their own priorities instead of me saying forget about the windows I'm not even going to put it in the report. I'll say no I'll put it in and you can see yourself how little it saves compared to other things you can do.(Advisor 3)

With this rationale in mind, Advisor 3 recommended windows to the largest percentage of houses when compared to other advisors, during Periods 1 and 2. In Period 1, he included windows as a recommendation in 50% to over 90% of reports. In Period 2, he recommended window replacements in 60% to over 95% of reports. In Period 4, he recommended windows in 30% to 70% of reports. Compared to other advisors, he recommended windows the second most often.

Advisors 4 and 9 did not mention a negotiation about windows at all. Broadly, Advisor 9 explained that he tried to focus homeowners on an achievable list where everything made sense. Advisor 9 recommended windows to nearly 30% to nearly 40% of houses, with little variation between vintage groups. Advisor 4 explained that he recommended all possible improvements if the homeowner was receptive. If the homeowner was not receptive, he gave them a more focused list with the goal of keeping the report to what he thinks is important. Advisor 4 recommended windows to nearly 30% to nearly 50% of houses that he advised.

Advisors’ discussions of their recommendations to insulate basements can be considered “determined” in the advice-giving process. This is because not only did advisors agree that basements are an effective opportunity to impact a house’s energy performance, but they generally agreed that this was usually a more achievable opportunity. Advisor 17 mentioned the decision to insulate the basement as a high priority item from an energy standpoint. When asked what the largest improvement to energy performance in a house typically was, Advisor 11 responded that is basement insulation, because the basement is typically not insulated and is quite accessible, and because there is a substantial heat saving associated with insulating the header and the walls. Advisor EEE1 expressed the same opinion. Advisor 4 said that an obvious recommendation is a basement with no insulation. Advisor 3 also gave the opinion that an un-insulated basement would be recommended to insulate, but that homeowners often did not understand the importance of this recommendation as the basement is under the ground. Advisor 3 also explained that he hesitated to recommend insulating the basement if it was finished. While discussing homeowners’ interest in grants, Advisor 15 mentioned that it is often inexpensive to put insulation in the header of the basement, but the energy savings are substantial and go on for years. Overall, advisors agreed that un-insulated basements represent a large reduction in energy use; they are more accessible than other retrofits, less expensive and less disruptive.

Overall, advisors recommended basement insulation more frequently than window replacements or wall insulation; the frequency of recommendations was also consistent amongst advisors. According to Figure 5.9, Advisor 11 recommended basement insulation the least often, from just over 30% to owners of the newest houses to just over 80% to homeowners of the older houses. Advisor 4 also recommended basement insulation less often, to 60% of owners of the oldest houses and to nearly 80% of owners of the newest houses. The rest of the advisors recommended basement insulation from 60% to nearly 90% of homeowners with little variation.

Insulating basements was often recommended due to the advisor’s determination that it is a better option than other decisions, in particular, window replacements. When homeowners expressed interest in windows, Advisor 15 explained that he would discuss windows, but try to shift homeowners’ attention to decisions like basement insulation. Advisor 3 mentioned modeling the information for the relative heat losses of windows and basements to help homeowners make a more rational energy decision. Advisor 2 mentioned choice editing walls out of the recommendations (not putting them in the report) in the hopes that this would allow homeowners to more easily focus on an effective change like the basement. Hence, advisors were determined about basements: they agree that insulating a basement is a relatively inexpensive, accessible and effective option to reduce energy, and they typically tried to shift homeowners’ attention towards this option using various methods.

5.4.1.3 Duo

As previously mentioned, air leakage was the decision most associated with the process of a home energy evaluation. Air leakage was commonly explained to homeowners during the process using techniques that were vivid. This was achieved through pointing out cobwebs, using a flashlight, going on a leak hunt and feeling the leakage with hands and posting sticky notes. As prompted in the interview questions, advisors did use vivid statements to explain how to reduce air leakage and the equivalent leakage area. Air leakage was explained by advisors as non-uniform around the house, and difficult to "get at" well, but still a relatively cost effective decision.

Prior to the evaluation, air leakage was not well understood by homeowners. Advisors reported that homeowners generally complained of drafts, even when air leakage was not the problem. As discussed previously, Advisor 3 mentioned homeowners complaining of drafts by their windows. In another example, Advisor EEE1 explained how drafts have more to do with behaviour:

> Those calls I got from people who had excessive drafts then I did on relatively new homes couldn't figure out why things were so drafty and it could have been anything from the core or just personal comfort, may have to do with the location of the thermostat. You know a thermostat in a sunny room? (Advisor EEE1)

Overall, the recommendation to reduce air leakage was also a fairly uniformly recommended decision amongst advisors. Reduction of air leakage was typically recommended more often for older houses than newer houses. In Period 1, reduction of air leakage was advised to 50% to nearly 90% of houses. In Period 2, reduction of air leakage was advised to 60% to nearly 100% of the oldest group of houses. In Period 4, reduction of air leakage was advised to 50% to nearly 100% of houses.

5.4.1.4 Number of Recommendations

The number of recommendations was another variable examined by this study. Hence the number of recommendations given by advisors was considered in this analysis. Just as there were variations in the frequency of recommending certain retrofits, different advisors also gave different numbers of recommendations at different frequencies, shown in Figure 5.12, Figure 5.13, and Figure 5.14. In Period 1, Advisor 3 gave the most recommendations overall for each vintage group. In Period 2, Advisors 3 and 11 gave the most recommendations overall for each vintage group, and Advisors 5 and 8 the least. In Period 4, Advisor 12 gave the most recommendations overall for each vintage group. Other advisors varied in distribution of number of recommendations by period, however the peak was six recommendations to the oldest houses, five recommendations to houses built between 1946 and 1960, four or five recommendations to houses built between 1961and 1980, and four recommendations to houses built between 1981 and 2010.

5.4.1.5 Depth of Recommendations

As described in Chapter 3, the depth of recommendation was also considered to be an important component of advice-giving. Depth was measured by the recommended change to the energy rating of houses compared to the initial energy rating score. A cross-tabulation of initial and recommended energy ratings was done to compare the depth of advice given by advisors. The results are shown in Figure 5.15, Figure 5.16, and Figure 5.17. In Period 1, Advisors 3 and 10 recommended the deepest improvements. In Period 2, Advisor 14 recommended the deepest reductions for the energy ratings starting at the lower end (less than 74 points). Advisor 11 recommended the deepest reductions to houses that started in the 75 to 79 range of scores. In Period 4, when houses had an initial rating of less than 60 points, most advisors recommended an improvement in the 60-69 range. It appears that Advisors 7 and 9 recommended the largest improvements to the energy rating score of houses. When houses started in the range of 60 to 69 points, Advisor 9 made the most recommendations to improve to an energy rating of 75 to 79. For the same range of initial energy rating score, Advisor 8 made the most recommendations to improve to an energy rating of 80 to 89. For houses that started at 70 to 79 energy rating points, Advisor 4 most often recommended an improvement to 80 to 89 energy rating points.

It is notable that Advisor 3 was the only to express a clear goal that was to bring houses to a modern level of energy performance of close to a 75 energy rating.

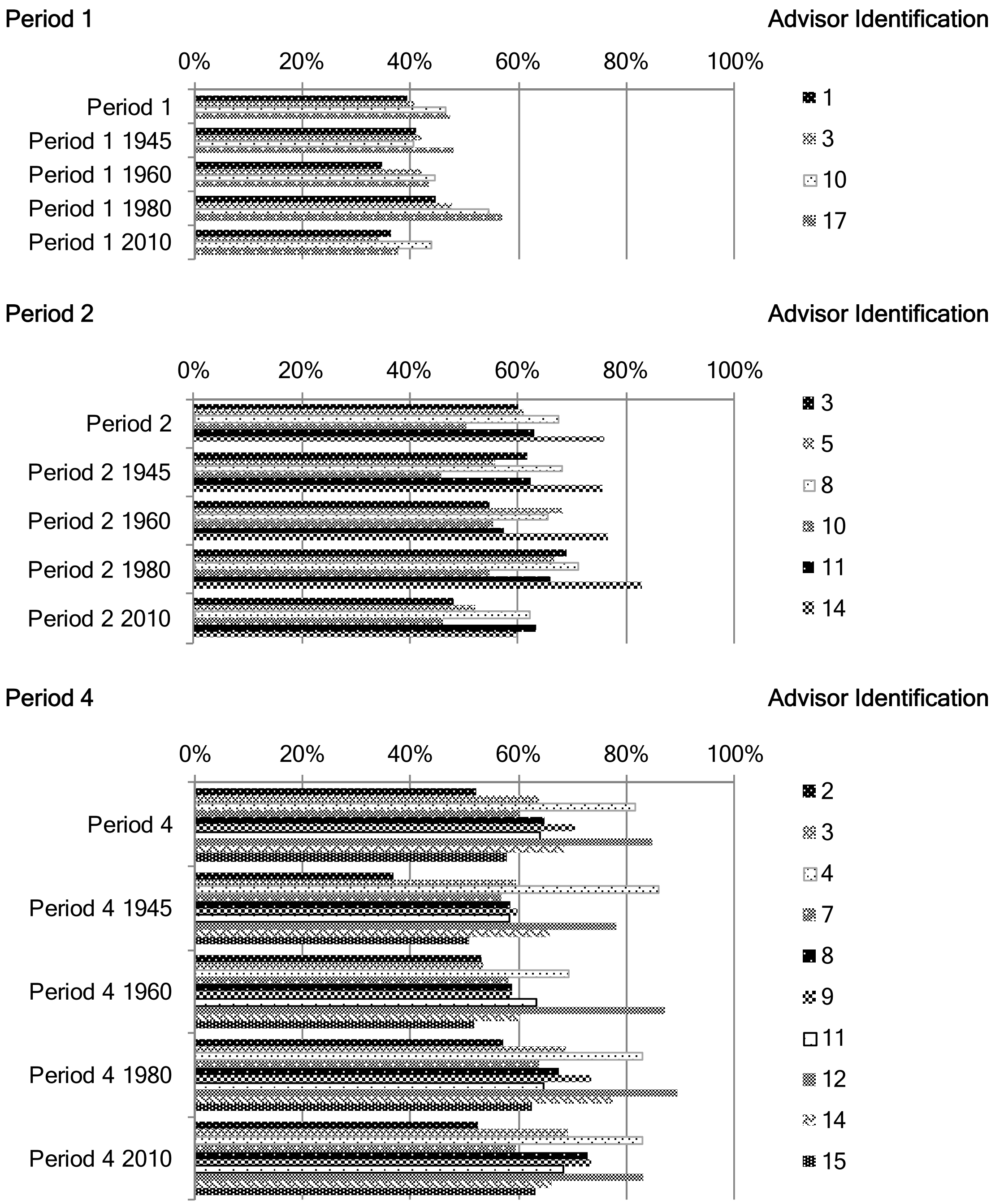


Figure 5.7 Recommendation to Replace Heating System by Advisor, Period and Vintage Group

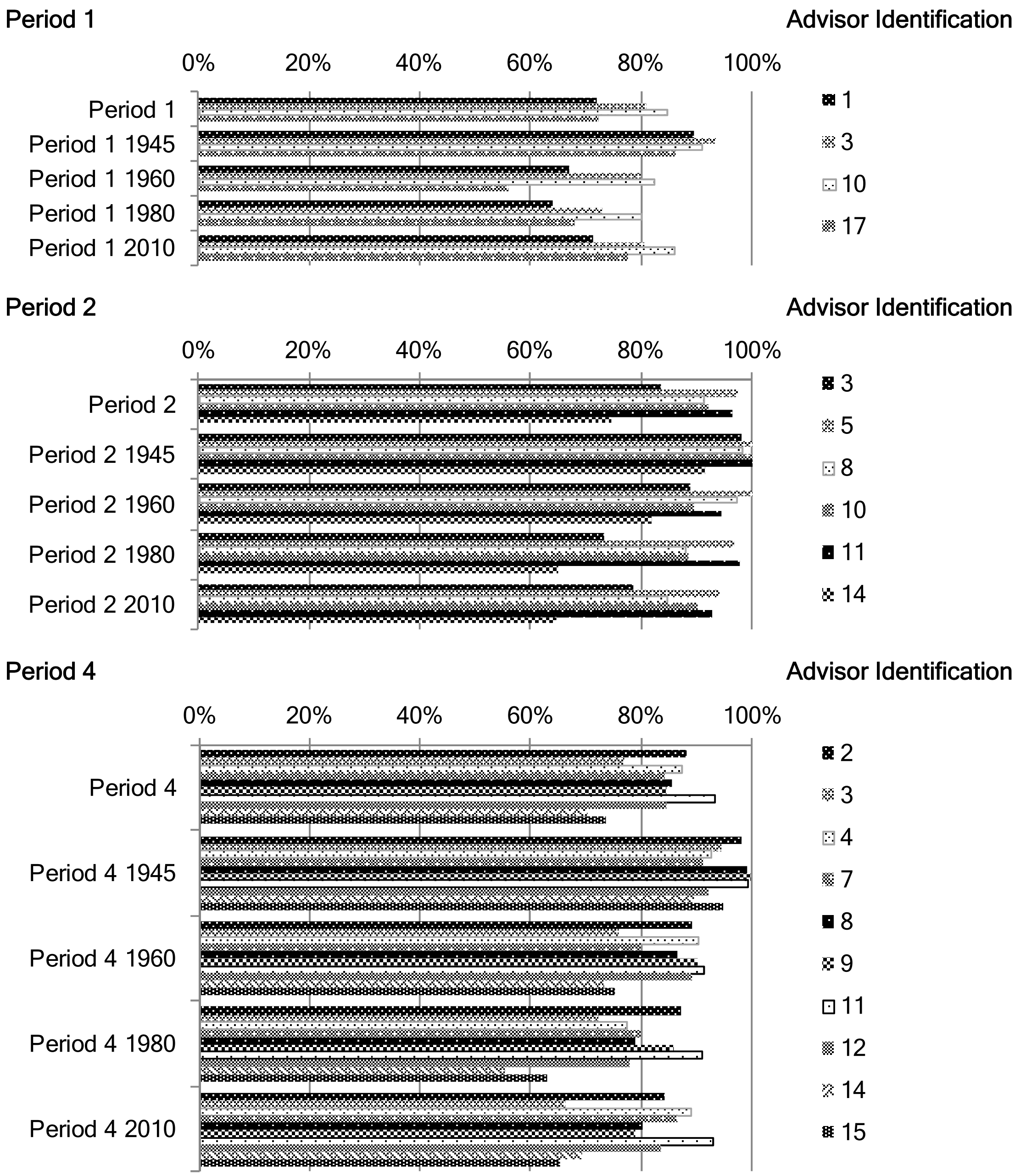


Figure 5.8 Recommendation to Reduce Heat Loss Air Leakage by Advisor, Period and Vintage Group

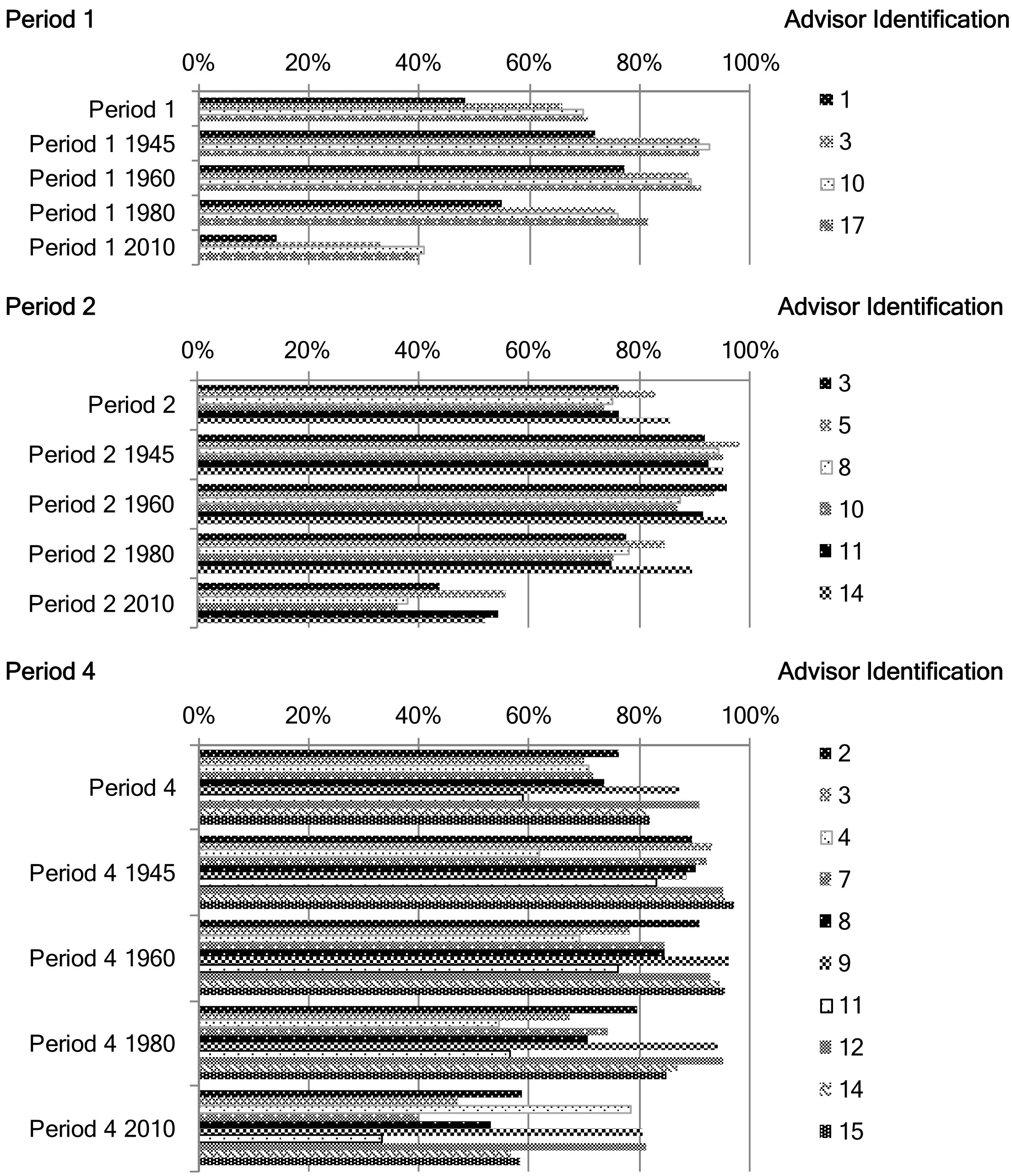


Figure 5.9 Recommendation to Reduce Heat Loss to Basements by Advisor, Period and Vintage Group

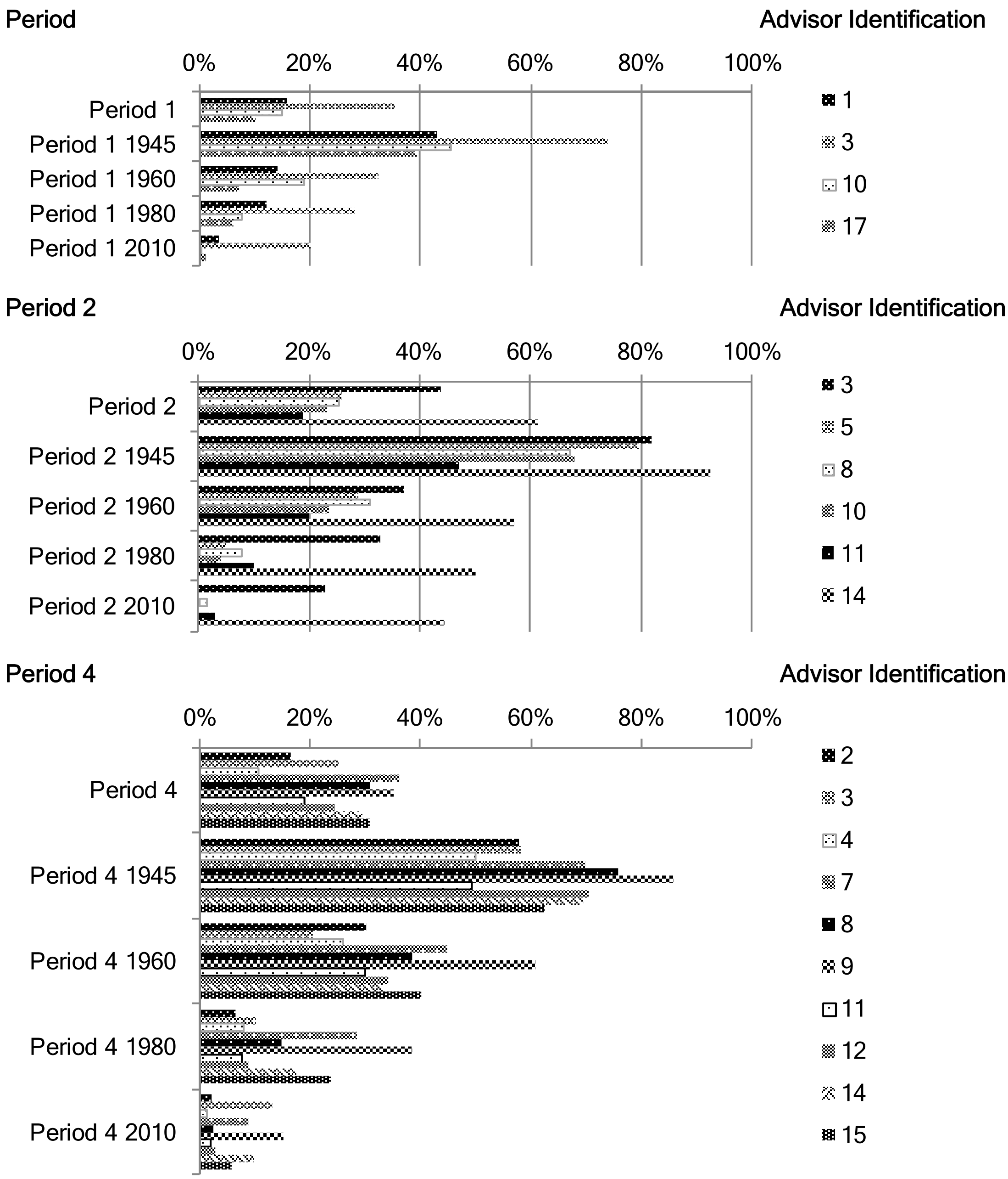


Figure 5.10 Recommendation to Reduce Heat Loss to Walls by Advisor, Period and Vintage Group

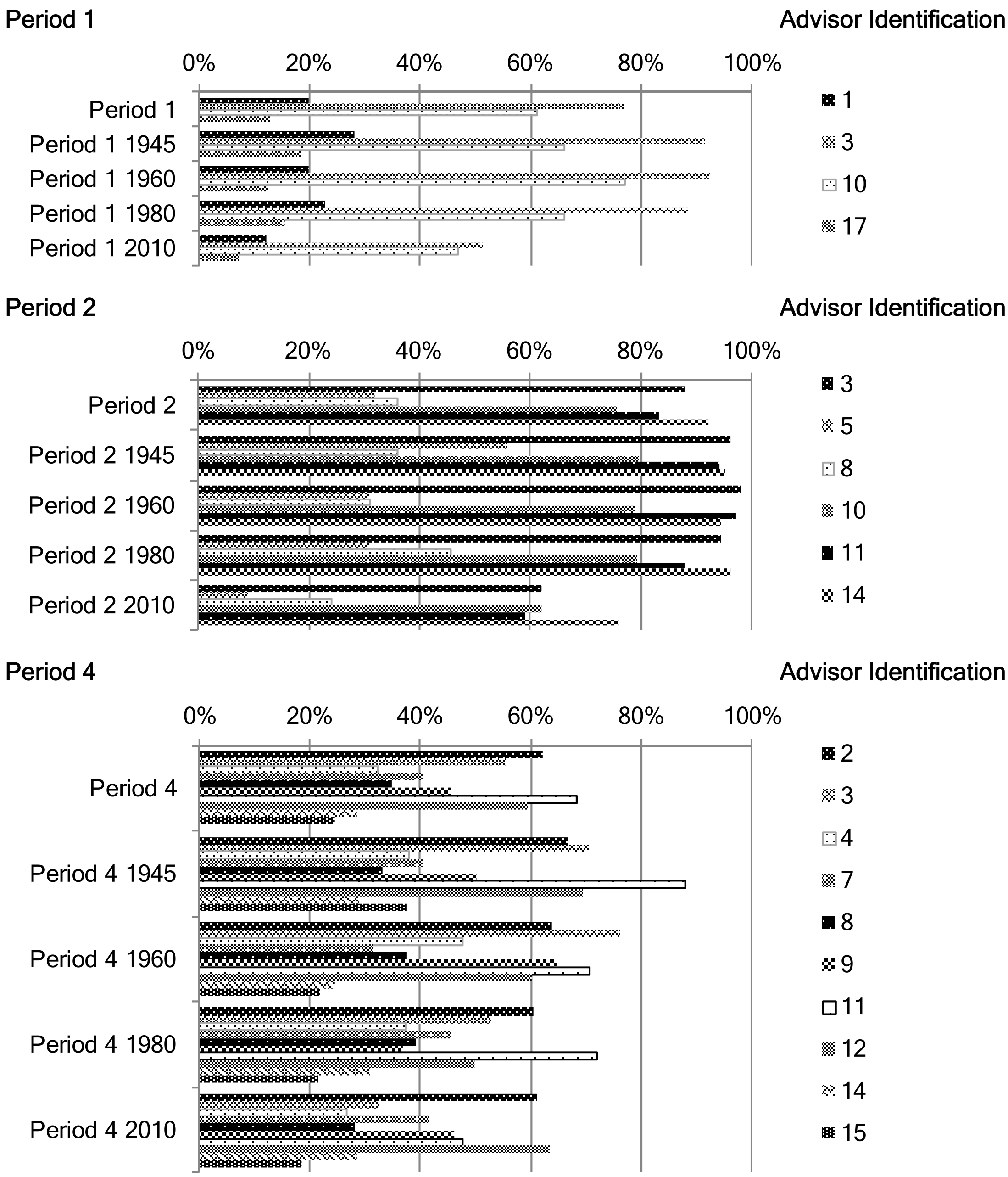


Figure 5.11 Recommendation to Reduce Heat Loss Through Windows and Doors by Advisor, Period and Vintage Group

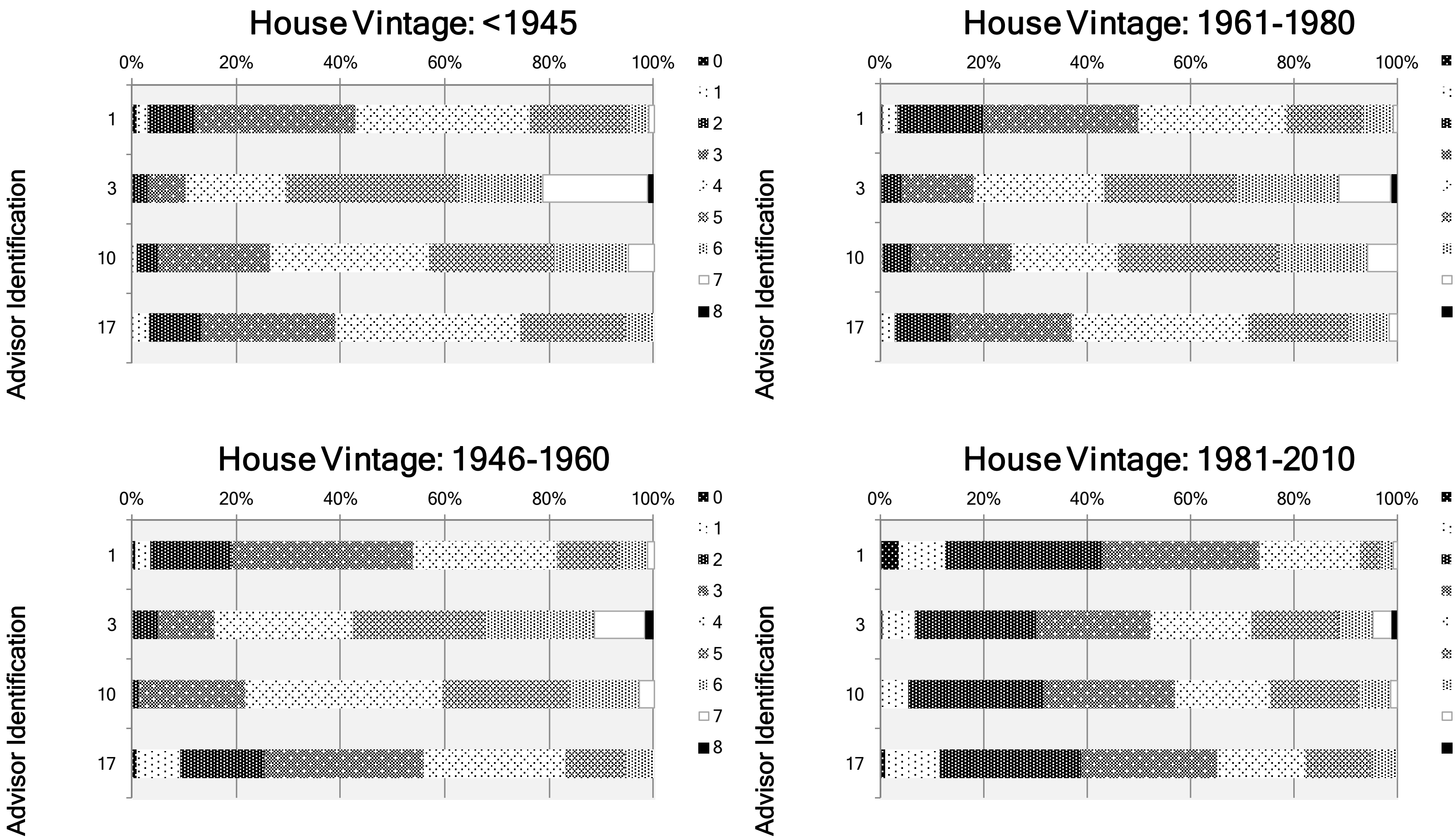
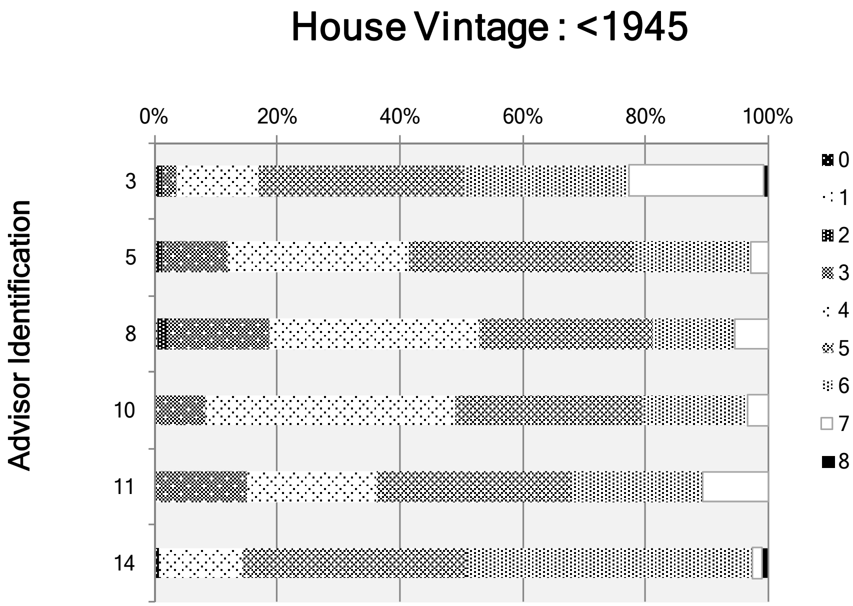


Figure 5.12 Period 1 Number of Recommendations by Advisor



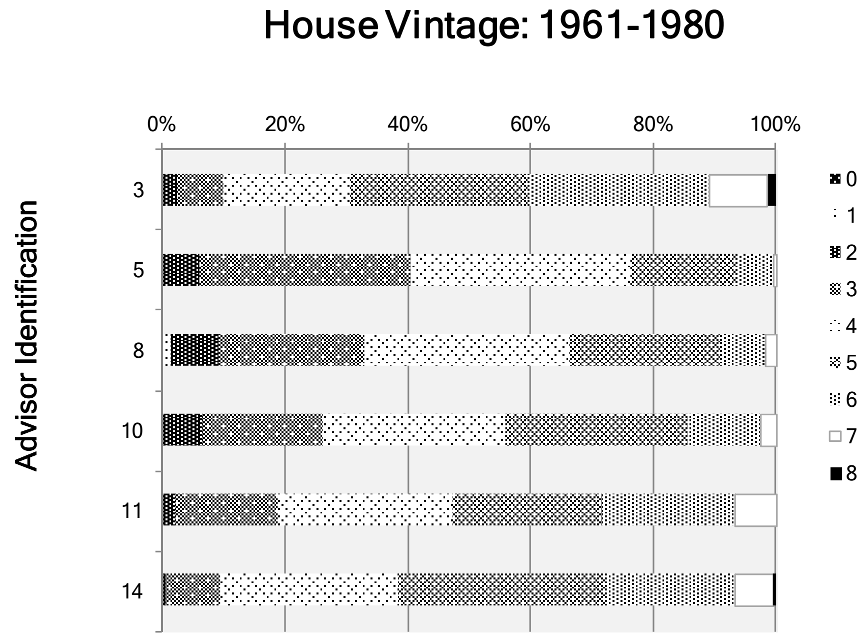
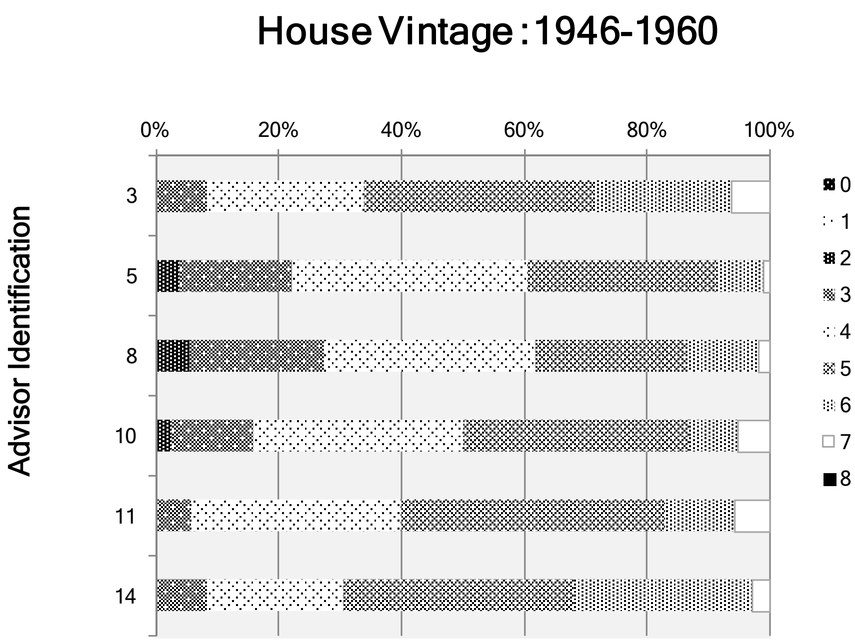


Figure 5.13 Period 2 Number of Recommendations by Advisor



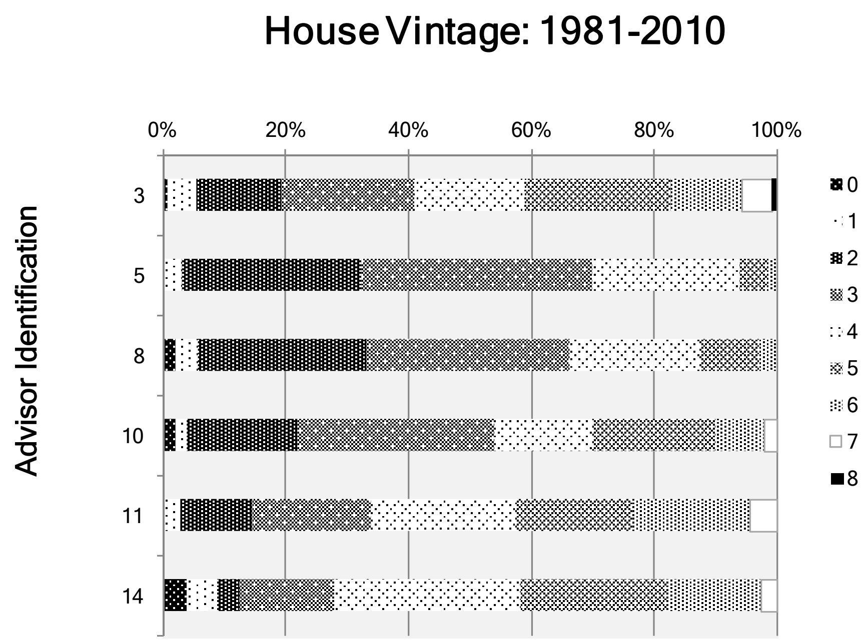
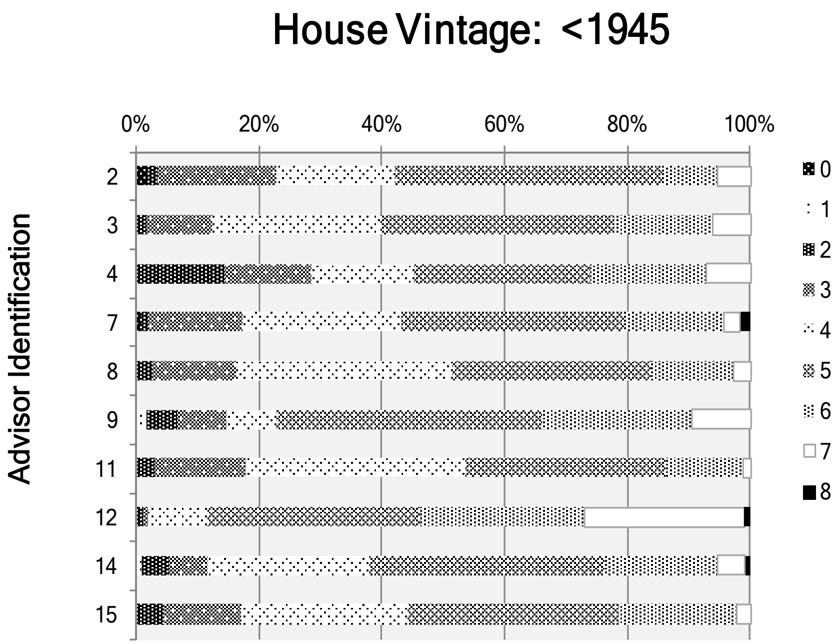


Figure 5.13 Period 2 Number of Recommendations by Advisor (continued)



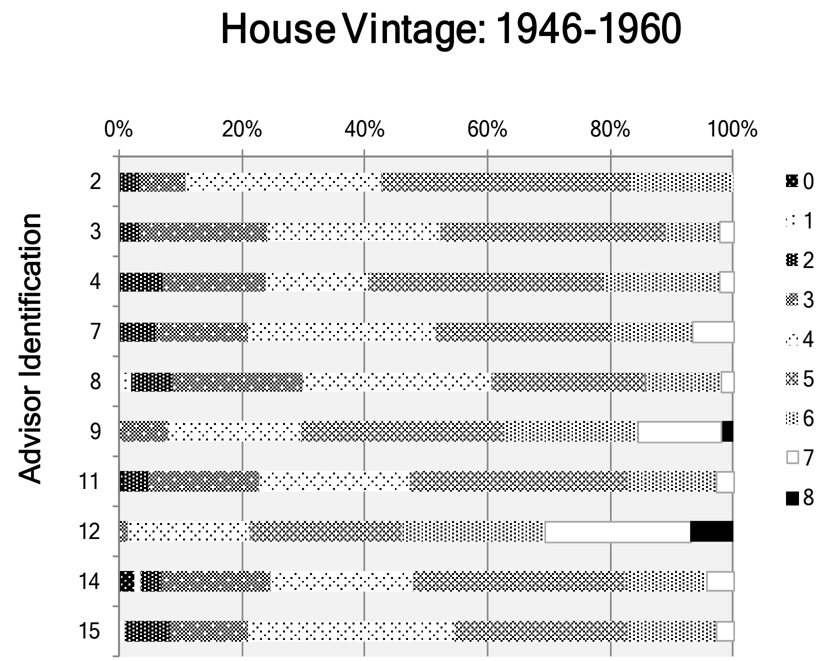
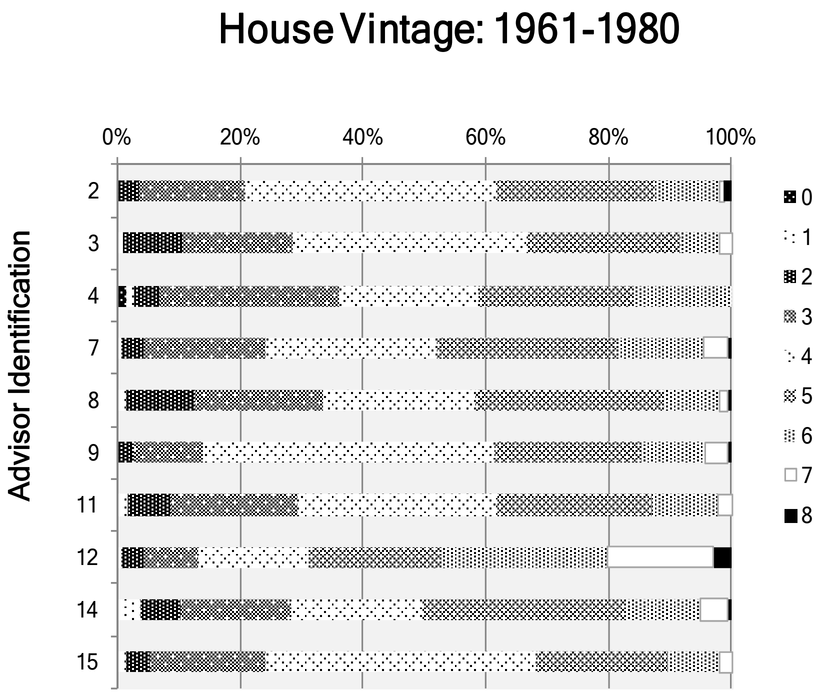


Figure 5.14 Period 4 Number of Recommendations by Advisor



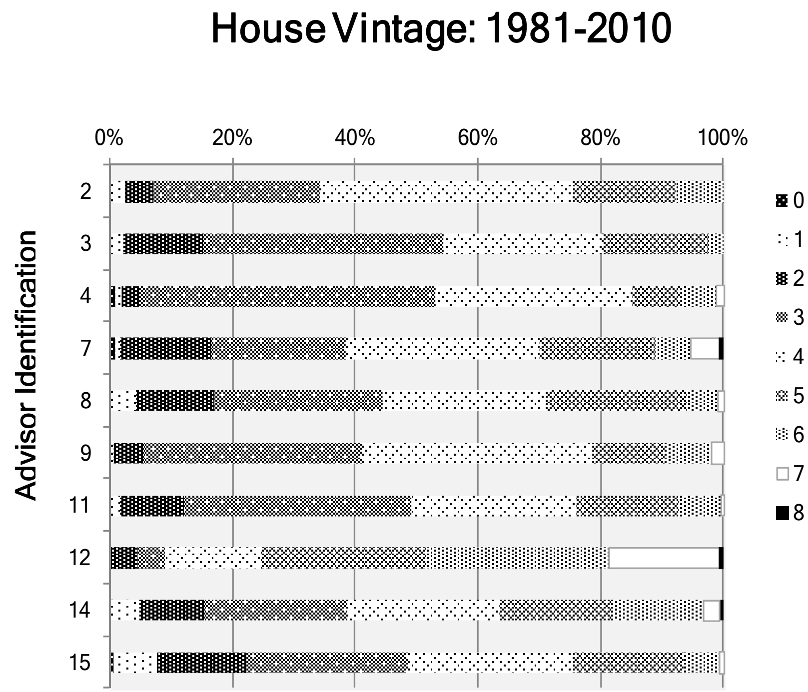


Figure 5.14 Period 4 Number of Recommendations by Advisor (continued)

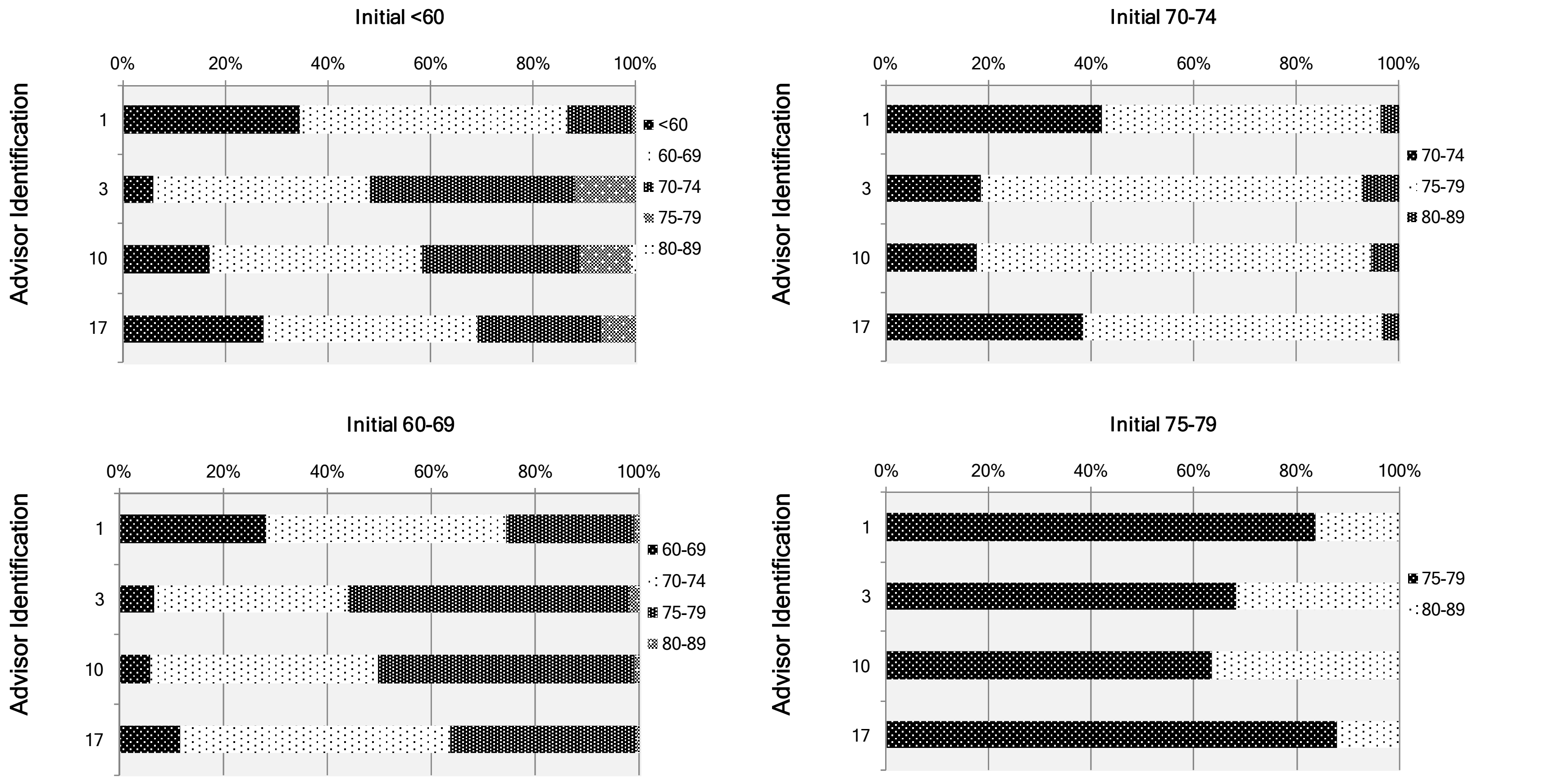


Figure 5.15 Period 1 Depth of Recommendations by Advisor by Range of Initial Energy Rating

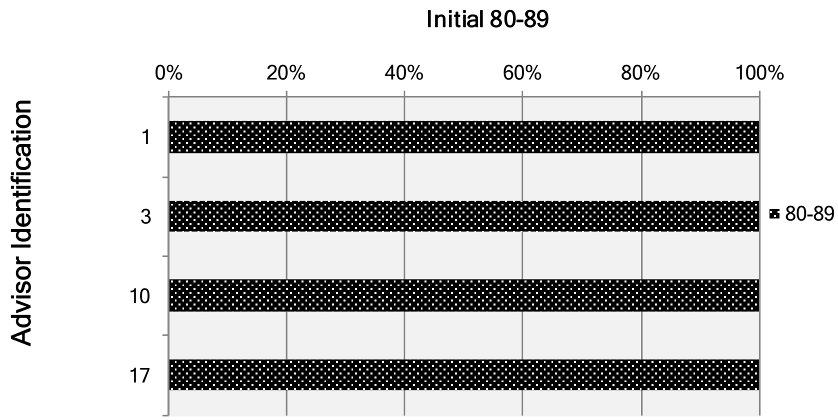


Figure 5.15 Period 1 Depth of Recommendations by Advisor by Range of Initial Energy Rating (continued)

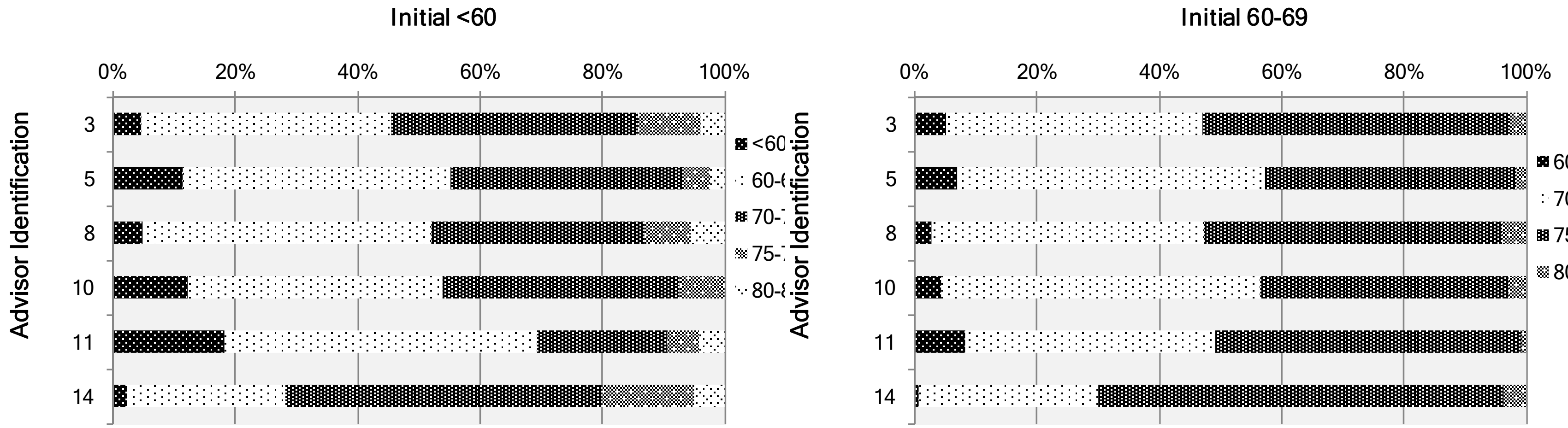


Figure 5.16 Period 2 Depth of Recommendations by Advisor by Range of Initial Energy Rating

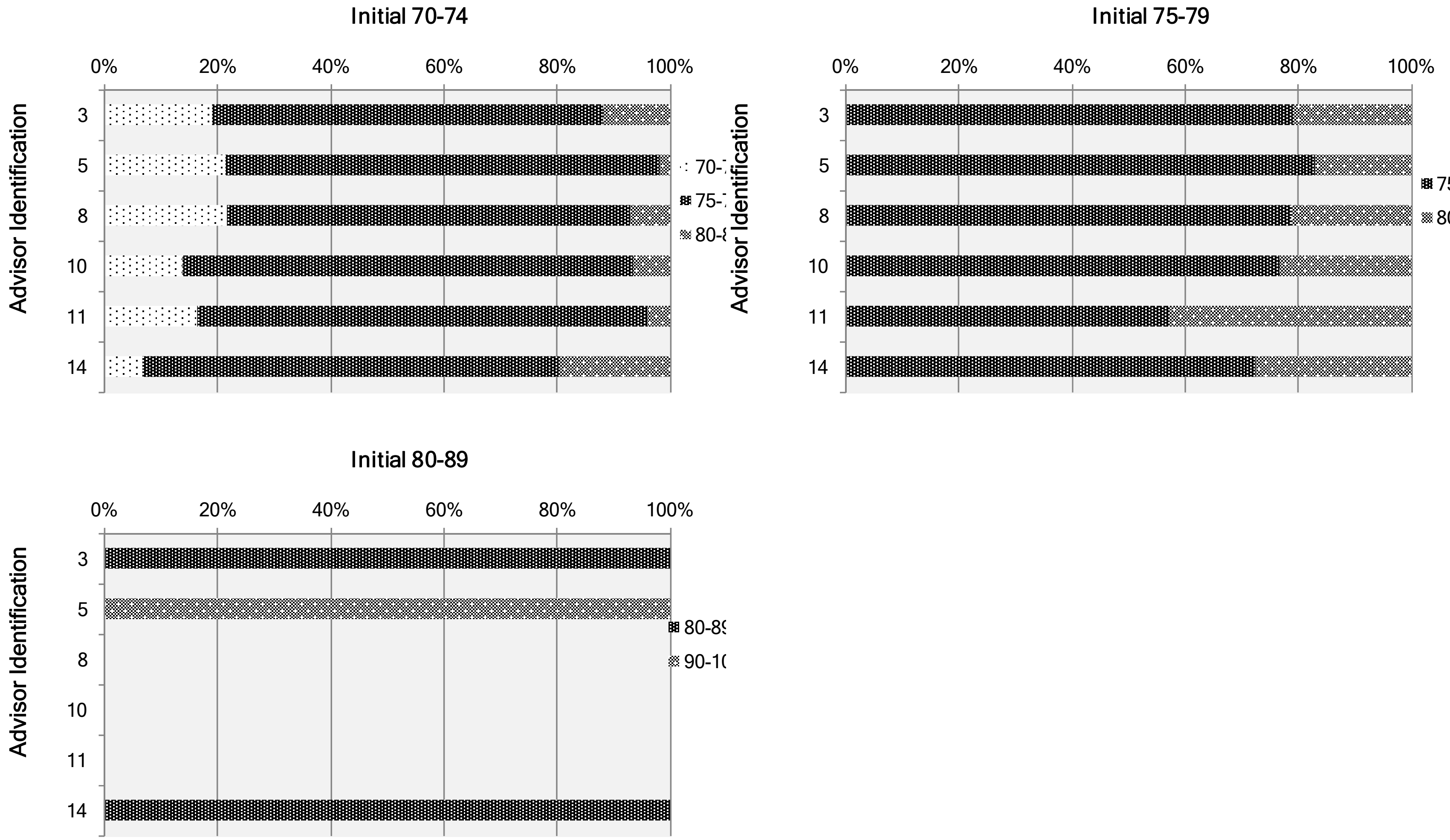
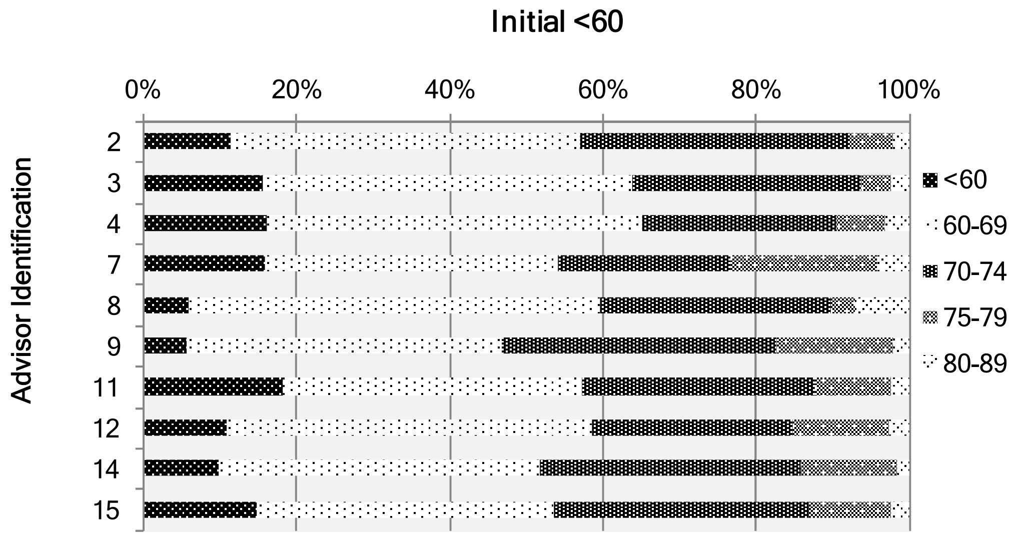


Figure 5.16 Period 2 Depth of Recommendations by Advisor by Range of Initial Energy Rating (continued



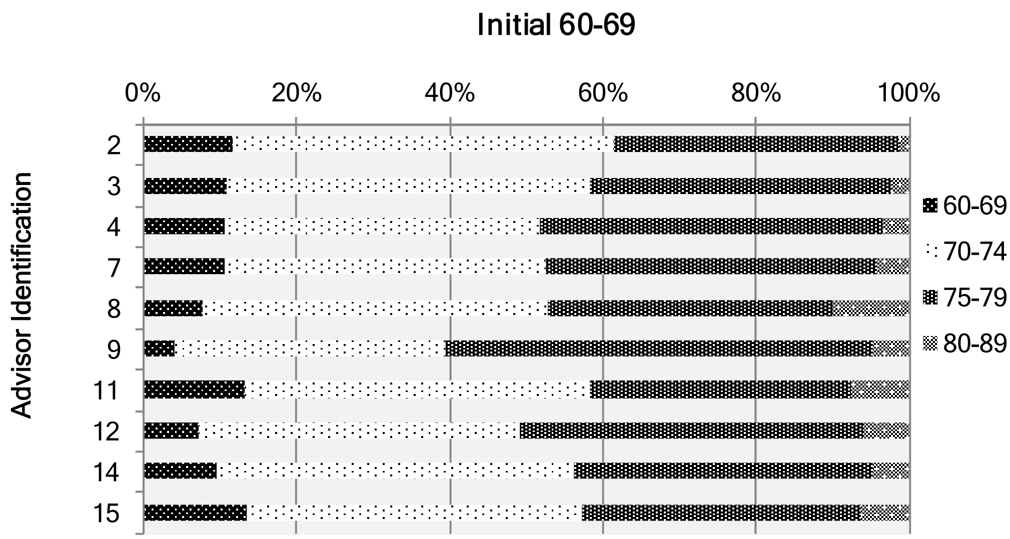
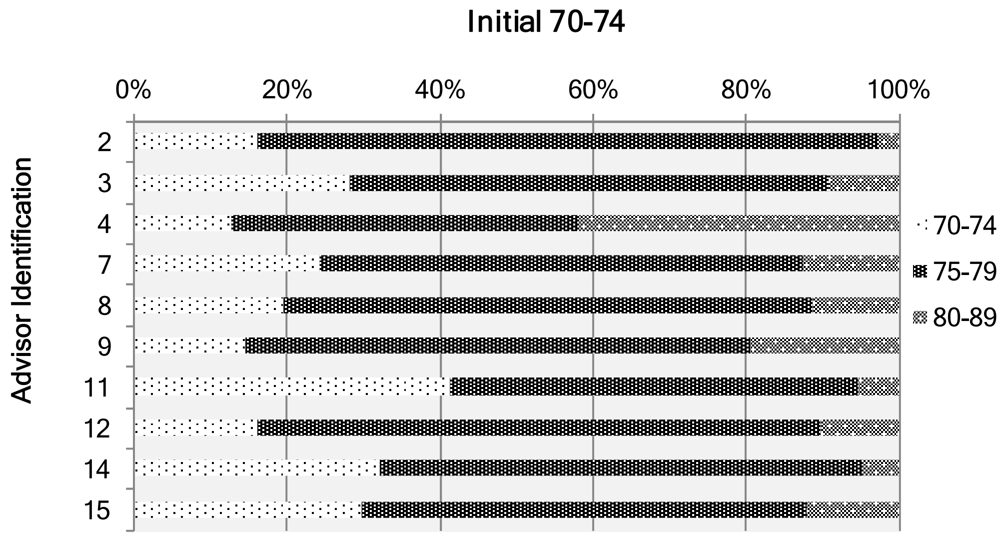


Figure 5.17 Period 4 Depth of Recommendations by Advisor by Range of Initial Energy Rating



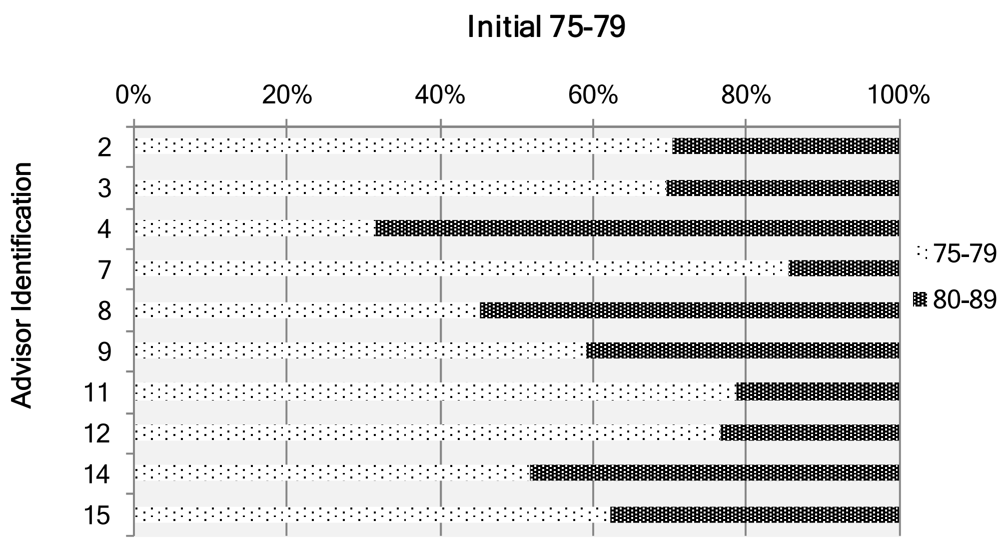


Figure 5.17 Period 4 Depth of Recommendations by Advisor by Range of Initial Energy Rating(continued)

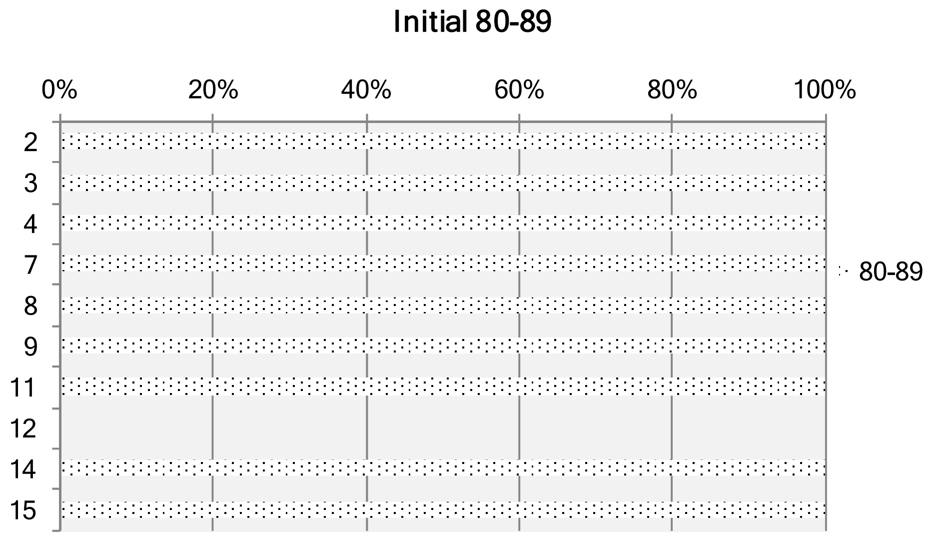


Figure 5.17 Period 4 Depth of Recommendations by Advisor by Range of Initial Energy Rating(continued)

5.5 Homeowner Responses to Advice

This section presents the homeowners' responses to advice strategies as an examination of the decisions they made. This analysis first presents broader outcomes of the advice and presents the depth and the number of decisions taken by homeowners. The next part of the analysis focused on examining homeowner actions taken under the five "D" decisions, while paying close attention to the previous discussion about prioritization and recommendations of these retrofits by the advisors.

The results of depth of achievement are shown in Figure 5.18. In Period 1.1, houses that had an initial energy rating score of less than 60 up to 69 points made up the majority of houses that returned. It appears that a larger share of houses that were advised by Advisor 3 achieved deeper changes than the changes achieved by other advisors.

In Period 2 (see Figure 5.19), for the houses that had an initial energy rating score of less than 60 points, Advisor 14 was associated with houses from this group achieving the most depth by as they improved to 60 to 69 points. For the group of houses starting at 60 to 69 points, the houses that were advised by Advisor 8 more often achieved 70 to 89 points than the houses advised by other advisors. For the houses that started at 70 to 74 points, the houses advised by Advisors 10 and 14 often reached 75 to 79 points, while those advised by Advisors 8 and 3 often achieved 80 to 89 points. During

Period 2, Advisors 3 and 8 were associated with a larger share of houses that achieved 80 to 89 points than houses associated with other advisors.

In Period 4 (see Figure 5.20), for the group of houses that started at less than 60 points, the houses advised by Advisor 9 tended to make deeper gains, except that a larger percentage of houses achieved 80 to 89 points that were advised by Advisor 8. For the group of houses that started at 60 to 69 points, those advised by Advisors 8 and 9 achieved the highest gains in energy points. For houses starting at 70 to 74 points, Advisor 8 and Advisor 15 advised houses that achieved the deepest improvements.

The next analysis was to examine the number of changes achieved associated with each advisor. The results are shown in Figure 5.21. During Period 1.1 Advisor 10 was associated with more changes in his group of houses. However, for houses in the vintage group of 1961 to 1980, the group advised by Advisor 3 had the highest percentage of houses that made 6 or more changes.

During Period 2 (see Figure 5.22), for houses older than 1945 and the houses built between 1961 and 1980, the group advised by Advisor 8 generally made more changes than groups that were advised by other advisors. For the houses that were built between 1946 and 1960, those advised by Advisor 14 made more changes compared to those advised by other advisors. For the houses that were built between 1981 and 2010, Advisor 11 is associated with the most changes made compared to other advisors.

During Period 4 (see Figure 5.23), for all vintage groups, the group advised by Advisor 15 made more changes than groups advised by the other advisors.

In this section, the advice-following of the specific retrofits is described and compared to the discussion about advice-giving in Section 5.4. In Period 1.1, advice-following is shown in Figure 5.24. A few observations can be made. For example, Advisor 3 recommended changes to heat loss walls to a higher percentage of homeowners than the other advisors, even 15% up to 25% more often than other advisors, particularly Advisor 10. Despite this difference between advisors in how often this recommendation was made, when grouped according to advisor who gave advice, a similar percentage of houses made changes to walls across the groups, In the case of basements, the percentage of houses that were recommended to insulate the basement, but did not, is similar across advisors. According to Figure 5.24, Advisor 1 appears to have recommended insulation to basements the least often, and the houses that he advised that returned had the largest percentage returning houses that were "*not recommended and not changed*" when compared to other advisors. The group of houses that Advisor 1 advised also had the smallest percentage of homeowners who insulated basements. It appears that if basements were not recommended to be insulated, basements were not insulated. Meanwhile, while Advisors 3, 10, and 17 recommended basements to similar percentages of homeowners, the advisor whose group returned with the largest percentage that took action was Advisor 3.

Section 5.4.1.2 summarized the wide variations of the percentage of houses to which windows were recommended. Analysis of the decisions to replace windows presents another interesting trend. Advisors 10 and 17 recommended window replacements to 25% of homeowners or less, and on the other hand, Advisor 3 recommended window replacements to nearly 80% of homeowners.

Advisor 17 recommended windows the least often and had the highest percentage compared to other advisors of households that took the decision "*not recommended and not changed*". Advisor 10 had the next highest percentage of households in the category "*not recommended and not changed*". However, for each of these advisors, approximately 20% of returnees changed the windows when not recommended to do so. Overall though, a smaller percentage of the homeowners who were advised by Advisors 10 and 17 and returned and changed the windows compared to other advisors. About 25% of homeowners advised by Advisor 3 had been recommended to make a change but did not. In this case, Advisor 3 had convinced them to change their minds with the information given in the report about the windows. On the other hand, close to 70% of homeowners advised by Advisor 3 changed windows. If trying to avoid investment in windows, it appears that not recommending windows is a better option than recommending them as information. This will be further explored in analysis of other periods.

In the case of the heating system during Period 1.1, close to 60% of returning houses advised by Advisor 10 were not recommended to change their heating system. That is, those who were recommended the heating system by Advisor 10 did not return as often. A larger percentage of homeowners that Advisor 10 advised and who had returned added insulation to walls, basements, and reduced air leaks more often than the homeowners advised by other advisors. For Advisor 10, it appears that the returning group of homeowners was less focused on heating systems.

Finally, in the case of the reduction of air leaks, overall, it was recommended often, and overall it was achieved by a high percentage of returnees. All advisors were associated with a relatively high percentage of homeowners who returned for each Advisor had made changes to air leaks that were not recommended. However, this could have been because of synergies with other insulation recommendations, or, because the recommendations were below the threshold of 1GJ and homeowners made changes that surpassed this, or because homeowners made changes even though it had not been recommended. However, in this analysis, air leakage was the most common second decision, typically combined with changes to the heating system as the first decision, so the second two options mentioned are more likely to have occurred. The homeowners who returned and were advised by Advisor 10 generally achieved greater savings associated with air leakage compared to what was recommended. Advisors 1 and 17 discussed participation in the blower door test as a common occurrence. Advisor 3 mentioned encouraging participation in the blower door test only when it was instructive. Hence, all three used vivid techniques associated with air leakage.

Period 2 was a bit difficult to analyse the impact of advice-giving as only two advisors of the six were interviewed. Results of Period 2 are summarized in Figure 5.25, Figure 5.26, Figure 5.27, Figure 5.28, and Figure 5.29. In Chapter 4 it was discussed that houses that returned in Period 2 tended to be older than in other periods, and used more energy overall.

During Period 2, heating systems were the most widely achieved recommendation and homeowners usually achieved over 100% of the recommended depth of improvement (see Figure 5.25). However, Advisor 10 recommended heating systems less often, and this was the advisor for which a smaller percentage of returning homeowners changed their heating systems in all vintage groups except 1946 to 1960. Advisor 11 was associated with the lowest percentage of returning homeowners changing their heating systems in the 1946 to 1960 vintage group.

Examining windows, a similar pattern to Period 1 is seen. As seen in Figure 5.28, for each vintage, either Advisor 8 or 5 recommended windows to the lowest percentage of homeowners, and Advisor 3, in the hopes of changing minds, to the highest percentage. For each vintage, a significant percentage of the returning homeowners advised by Advisors 5 and 8 had replaced windows even though they were not a recommendation ("*not recommended and changed*"). Advisor 3 had a relatively large percentage of homeowners who changed their minds, for whom windows were "*recommended and not changed*". Overall, though, it is seen that for the advisors who recommended windows to a smaller percentage of homeowners, overall a smaller percentage of those who returned changed windows, compared to when windows were recommended often, they were often changed. This is despite the large percentage of homeowners who appeared to have been convinced that this is not a wise energy investment. Interestingly, in the vintage group of 1981 to 2010, a large percentage of returning houses advised by Advisor 11 were "*not recommended and not changed*", even though he recommended windows to a similar percentage as Advisor 10. Meanwhile, Advisors 5 and 8 recommended windows far less often.

During Period 2, advisors widely agreed to recommend basements (see Figure 5.26). This can even been seen in the data of the advisors who were not interviewed, as basements were recommended at a fairly even frequency by advisors, and often. Despite the evenness in recommendations, there was unevenness in decisions made. Homeowners did not often insulate their basements, and when they did, they tended to achieve less than 50% of the recommended heat loss reduction. For the vintage group of 1981 to 2010, more of the homeowners advised by Advisor 5 made changes to the basement compared to those advised by other advisors. At least 90% of the owners of older houses who had been advised by Advisors 3, 5 and 14, insulated their basements, but over half of homeowners from this group who returned achieved less than 50% of what was recommended. For the vintage group of 1946 to 1960, a larger percentage of houses overall did not make a change when recommended. However, a similar percentage of the owners of houses advised by Advisors 3 and 14 addressed heat loss in their basements. A similar percentage of the owners of houses advised by Advisors 5 and 8 addressed heat loss in their basements. For houses of vintage group 1961 to 1980, Advisors 5, 8 and 14 had similar results with levels of achievement that were higher than the houses advised by Advisor 3. Advisor 5 was not interviewed, however, from Figure 5.26 it can be seen that they did not recommend windows very often. From analysing Advisor 5, it can be seen that recommending basements often and not recommending windows often appears to have been an effective strategy.

As previously discussed, the recommendation to insulate walls (see Figure 5.27) was recommended unevenly among advisors. Advisor 14 recommended wall insulation the most often (45% to over 90% of houses depending on the vintage group), whereas Advisor 11 recommended wall insulation the least often (5% to nearly 50% depending on the vintage group). Overall, it can be seen that high frequency recommendations were matched with high frequencies of "*recommended and not changed*" for Advisor 14, and other advisors. However, for all houses in vintage groups older than 1980, but particularly for 1945 and older, the advisors who frequently recommended insulation to walls had a higher percentage of returning homeowners address walls, however poorly it may have been done.

Obviously, wall insulation was not a preferred item for homeowners to change. However, in Period 2 it can be seen that if recommended enough, some homeowners took action.

For the decision to reduce air leakage (see Figure 5.29), it is difficult to see a discernible pattern. For example, Advisor 14 advised this decision less often, but homeowners appear to have achieved reductions to air leakage just as frequently as for other advisors.

Period 4 was easier to analyse for strategies than Period 2 as five advisors that worked in Period 4 were interviewed. The decisions taken by homeowners during Period 4 are described in Figure 5.30, Figure 5.31, Figure 5.32, Figure 5.33, and Figure 5.34. During Period 4, many advisors complained that homeowners were very focused on changing their heating systems. According to Figure 5.30, Advisors 12 and 4 recommended heating systems to homeowners most often. Advisor 2 recommended heating systems the least often for the oldest and newest vintage groups. Advisors 7, 14 and 15 recommended heating systems in similar proportions, as did Advisors 3, 8 and 9. Advisors typically said that a heating system would be the most significant improvement for newer houses. Across all vintages, the homeowners advised by Advisors 12 and 4 generally made the highest percentage of "*recommended and not changed*". For of the houses that were 1945 and older, Advisor 2 recommended heating systems the least often and nearly 60% of the homeowners that returned from this group had not been recommended to change the heating system and had not changed it. Advisor 11 did not recommend a change to the heating system the most often nor the least often. Of the houses that returned that had been advised by Advisor 11, a higher percentage in the category of "*not recommended and not changed*" than other advisors who had given a similar frequency of recommendations. Other advisors who had not recommended a change to the heating system the most often nor the least often (Advisors 3, 8, 9 14, 15) commonly had up to 5% of homeowners who returned categorized as "*not recommended and changed*". Advisors 9 and 15 said that they would recommend what they thought was important, hence, might not recommend heating systems when they believed they were not needed, even if the homeowner wanted one. Advisor 11 mentioned that he would recommend things that the homeowner had as pre-conceived ideas. Of the homeowners that returned, Advisor 11 had less "*not recommended and changed*" than other advisors for the oldest vintage and for houses built between 1961 and 1980. Despite advisors' perceptions that homeowners were very focused on changing their heating systems, it is interesting to see that overall, across periods, there was a fairly high percentage of homeowners for whom heating systems were recommended but not changed. Further, within periods but across advisors, homeowners changed heating systems in similar percentages, however, the extent to which they follow advice varied by advisor.

For the decision to add insulation to the walls (Figure 5.32), it can be seen that for the newest group of houses, Advisors 3, 7, 9 and 14 made this recommendation more often than other advisors. In this group, only 10% of homeowners that returned followed advice and they achieved less than 50% of what was recommended. For houses built between 1961 and 1980, Advisors 7, 9 and 15 recommended walls more often than other advisors. However slight, more changes were made for returning houses advised by these advisors. Further, Advisor 9 recommended insulation to walls more often than any other advisor, and in three of the four vintage groups (excluding before 1945), the highest percentage of the houses that returned advised by Advisor 9 had made changes to walls. Overall, it can be seen that the more often insulation to walls was recommended, the more often it was done, even though the percentage was small and the retrofit achieved less than what was recommended. Advisors also generally perceived that it was difficult for homeowners to understand how to insulate walls well, and how to find someone to do the work. This was confirmed in this analysis as even those who addressed walls in greater number did not achieve very much compared to what was recommended.

Windows are perhaps the most interesting story as there are fairly large differences in how often advisors recommended them, and they were indicative of differences in the advisors' advice-giving style (see Figure 5.33). The pattern is clear: Advisor 15 tried to only recommend what was important, and recommended windows the least often, and had the largest percentage of returnees who fell into the category of "*not recommended and changed*". Advisor 7 recommended the next lowest percentage compared to 15, however, also had a similarly large percentage of houses return in the category of "*not recommended and changed*". Interestingly, though, Advisor 3 also had a fairly large proportion of houses return in the category of "*not recommended and changed*" even though he typically gave homeowners the energy information about windows when they were interested. Further, the number of homeowners who changed their mind, that is, "*recommended and not changed*" and advised by Advisor 3, was less than 10% for each vintage group. Advisors 3 and 15 in some ways represent diverging styles in advice-giving. Advisor 15 kept the windows off the list, and

Advisor 3 puts them on for information—a smaller proportion of the returning homeowners for Advisor 15 had changed their windows.

For the decision to reduce air leakage (see Figure 5.34), similar to Period 2, it was difficult to see a discernible pattern. Advisor 2 discussed air leakage as theoretical, and if done properly could be the most effective improvement to energy performance. In nearly all vintages (not 1946 to 1960), Advisor 2 had the largest percentage of returning houses that reduced air leakage. It can also be noted that Advisor 12 was associated with the largest percentage of "*recommended and not changed*" across vintage groups. Overall, air leakage was described as the recommendation associated with vividness due to the inclusion of the blower door test and pointing out of cobwebs during the process of the evaluation. Although many houses did not address walls or basements adequately, air leakage appears to have been addressed adequately; it could be due to the vividness of explaining this decision.

5.6 Summary

These findings are compared to those of other studies and to the findings of the first research question in the discussion. The following presents a brief summary of the findings.

Of loss-framed and gain-framed statements, advisors generally preferred gain-framed. However, overall, advisors most preferred scientific statements. Advisors tended to use vivid techniques rather than vivid statements, mainly during the evaluation process or blower door leak hunt and searching for cobwebs.

While not all advisors have the same set of norms and beliefs related to environment, or the same balance of concerns related to health and comfort, they did generally agree about the importance of the five decisions of insulation to basements, ceiling and attic, replacement of windows and doors, and furnaces to a house's energy performance. There was some disagreement between advisors over the balance between air sealing and installing a heat recovery ventilator. Little information was revealed about their opinions on hot water systems.

There were two main advice strategies that advisors used. These were choice-editing in order to focus homeowners (e.g., leaving out wall insulation), or giving a list of all possible improvements to make, where the report may be considered as a roadmap for the future. In the case of walls, advisors were not in agreement over whether to recommend an improvement, even if there was a benefit to energy performance. The findings for walls are that if they were not recommended to be insulated, then they were not insulated, whereas if they were recommended to be insulated, some achievements were made, even though the percentage who implemented this decision was low, and the level of achievement was also low. In the case of basements, a similar finding is made. If insulation was not recommended, it was not likely to be done, but if it was recommended, some achievements were made, even though the percentage that did this was low, and the level of achievement was also low. In the case of windows, advisors agreed that the impact on energy is quite low and they are costly to install. However, some advisors modeled the energy impact and included them in the recommendations in order to help homeowners change their minds in an informed manner. Others would keep windows off the list and discuss other options with the homeowners. Overall, it appears that keeping windows off the list resulted in less frequency of window replacements. Heating systems were another decision that was often "*not recommended and changed*". This can likely be attributed to advisors' concerns that homeowners were driven to the program for heating system replacements, and in some cases, advisors did not believe it was an important change to be made. A pattern could not be discerned very well with respect to reduction of air leaks, or in many differences in advice styles between Period 2 and other periods.

In terms of depth and number of achievements, the houses advised by Advisor 8 in Period 2 made deep improvements to the energy rating. However, Advisor 8 was not interviewed. Advisors 3 and 11 were also associated with deep changes to energy performance to various groups in Period 2. Advisor 3's strategy was to bring all houses to a modern level of efficiency, and to leave a detailed report as a road map for homeowners. In Period 4, Advisors 9 and 15 appeared to have advised houses which achieved the deepest improvements. The houses advised by Advisor 15 made more changes.

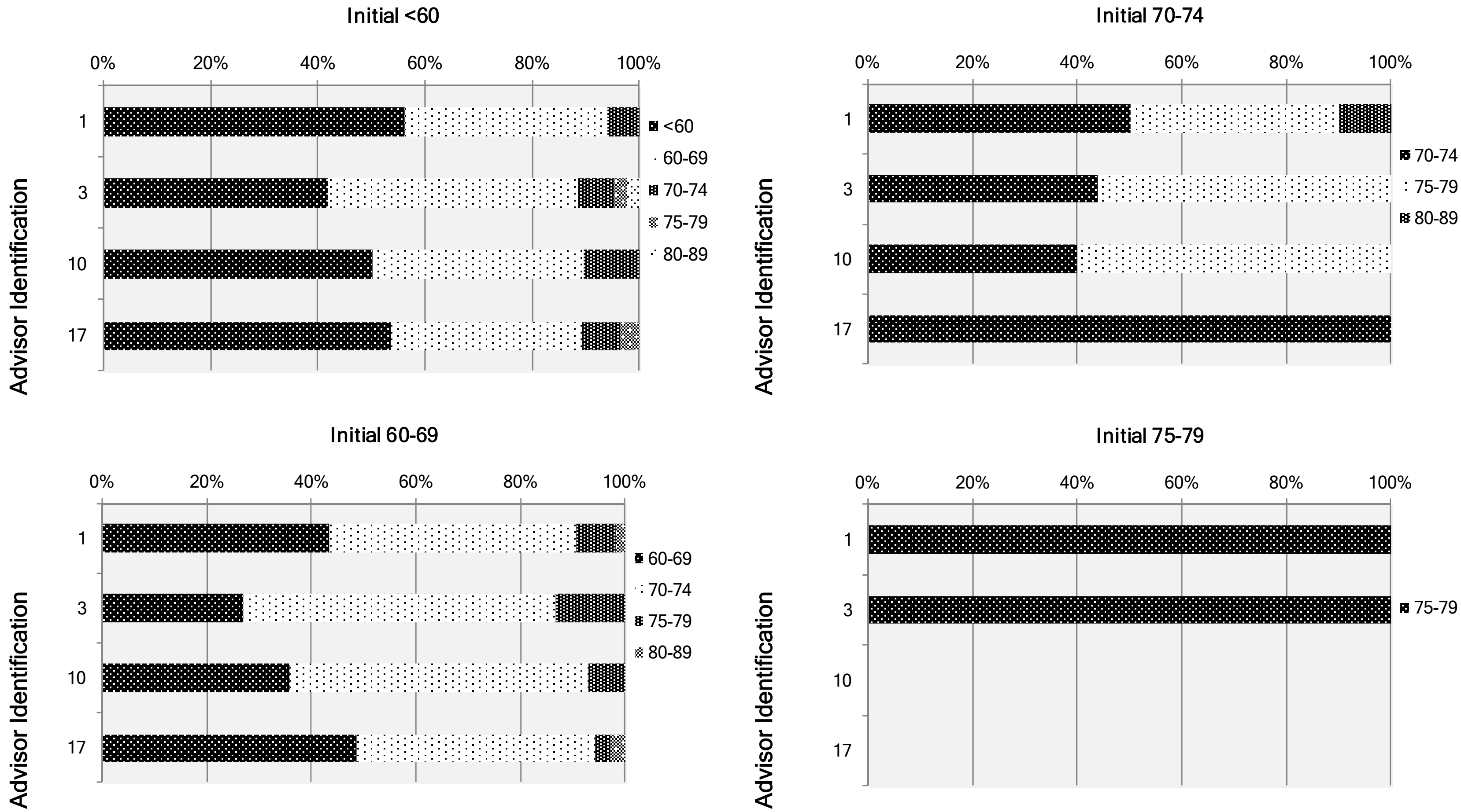


Figure 5.18 Follow-Up Period 1.1 Depth of Decisions by Advisor by Range of Initial Energy Rating

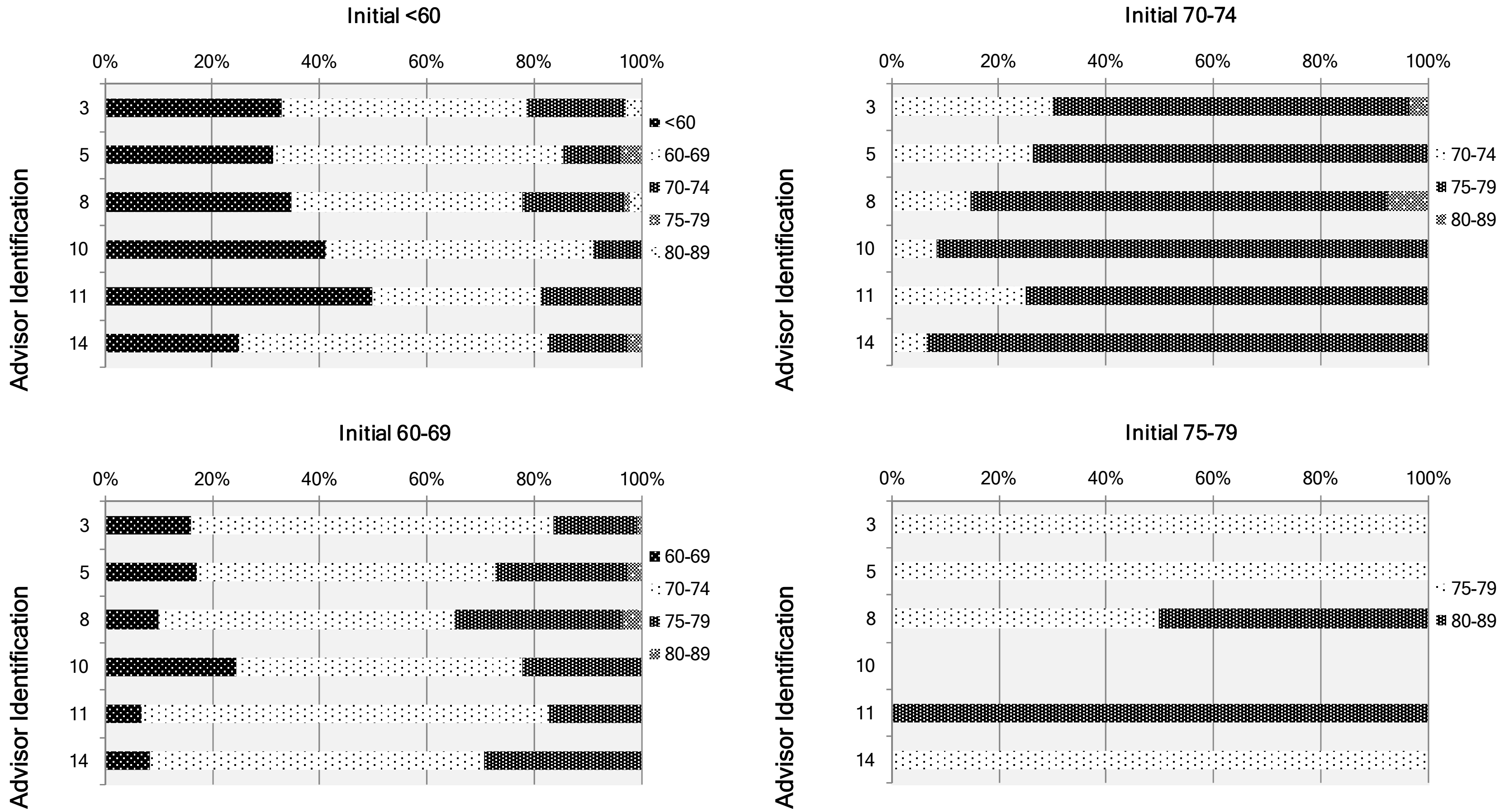


Figure 5.19 Follow-Up Period 2 Depth of Decisions by Advisor by Range of Initial Energy Rating

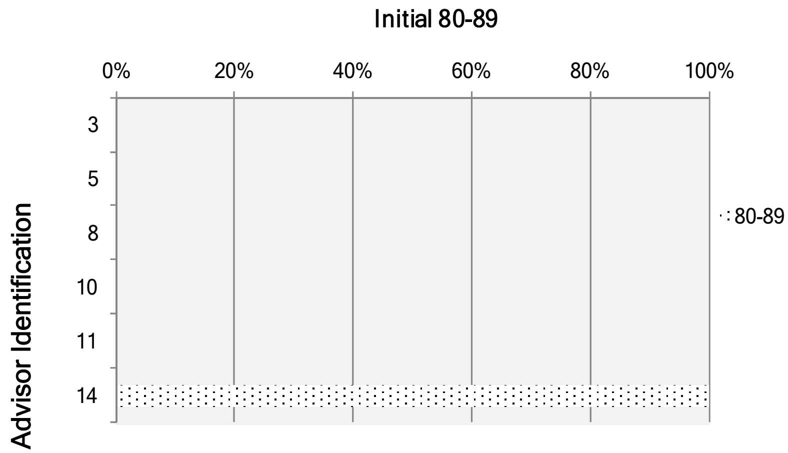


Figure 5.19 Follow-Up Period 2 Depth of Decisions by Advisor by Range of Initial Energy Rating (continued)

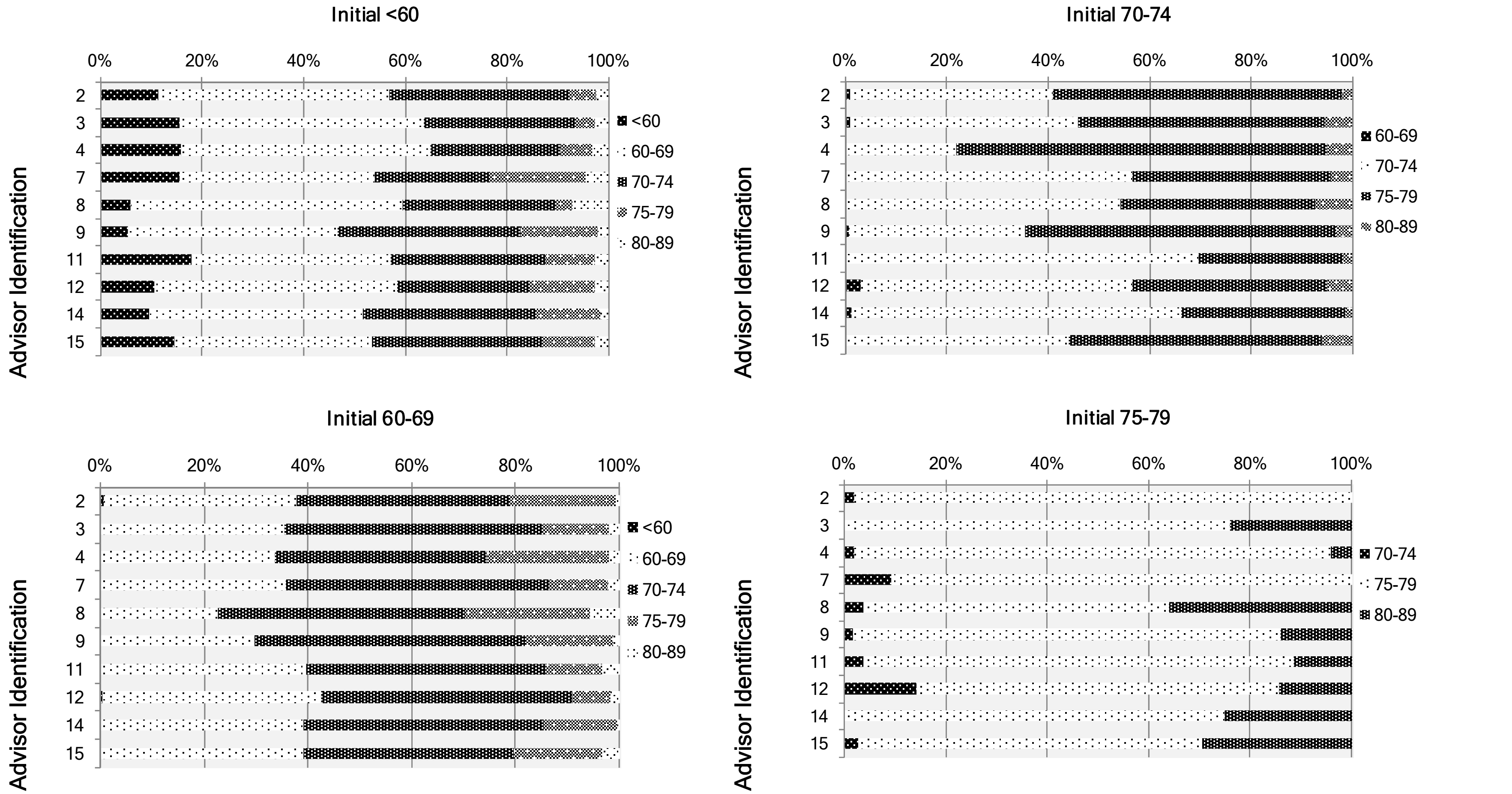


Figure 5.20 Follow-Up Period 4 Depth of Decisions by Advisor by Range of Initial Energy Rating

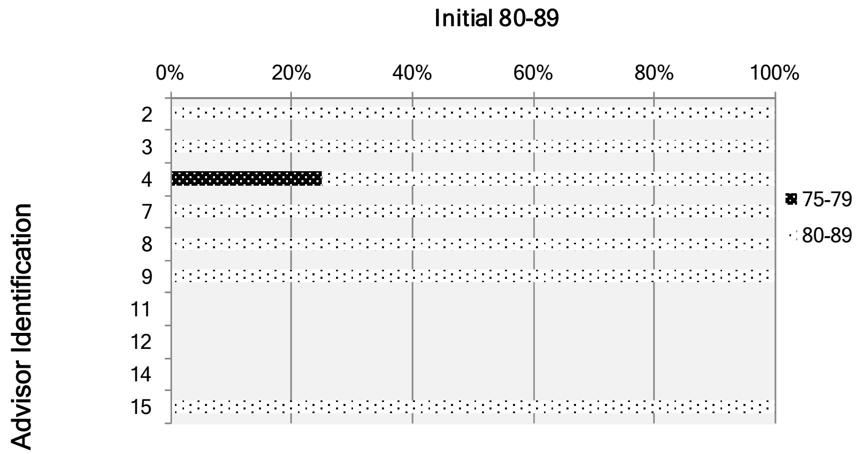


Figure 5.20 Follow-Up Period 4 Depth of Decisions by Advisor by Range of Initial Energy Rating (continued)

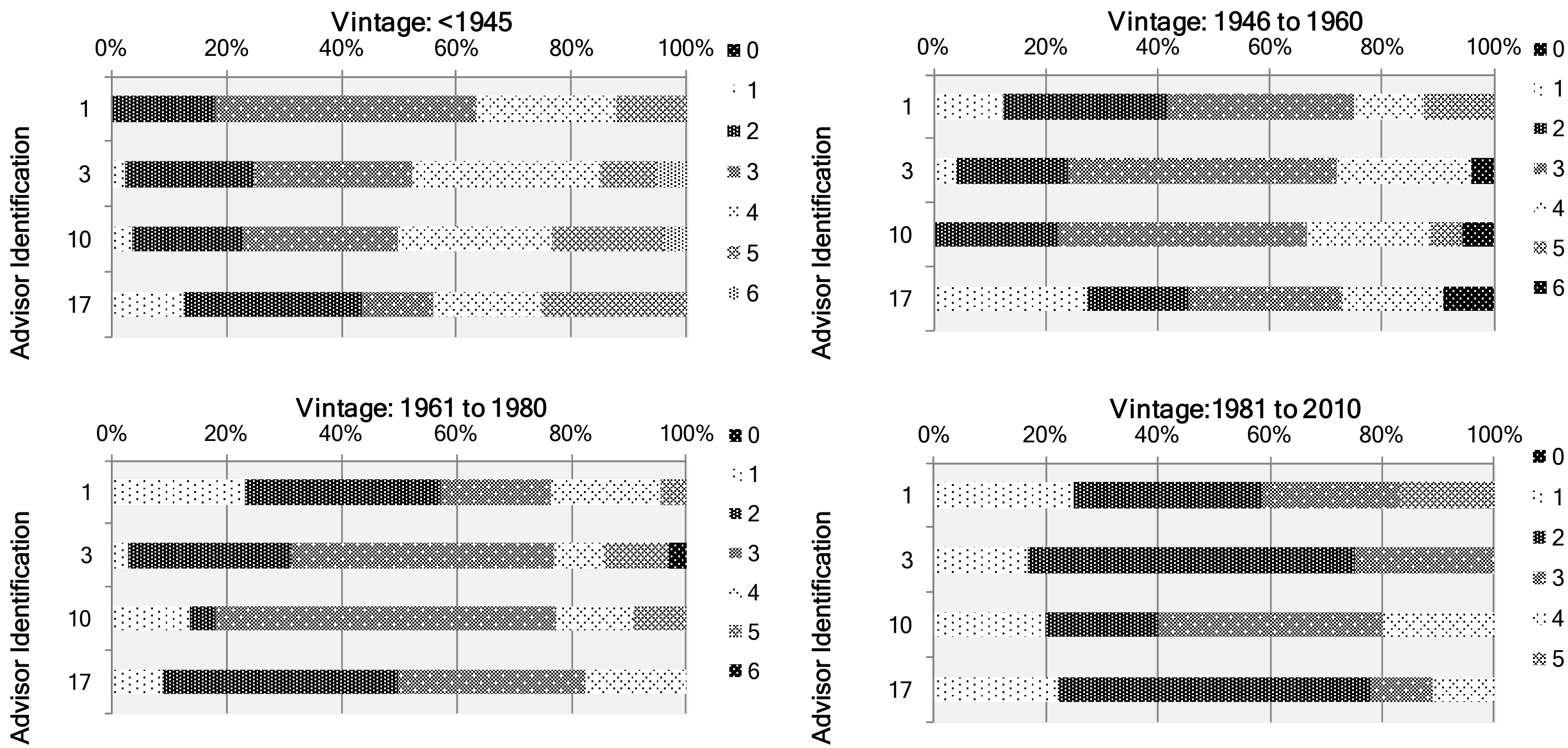


Figure 5.21 Period 1 Number of Changes Achieved by Advisor

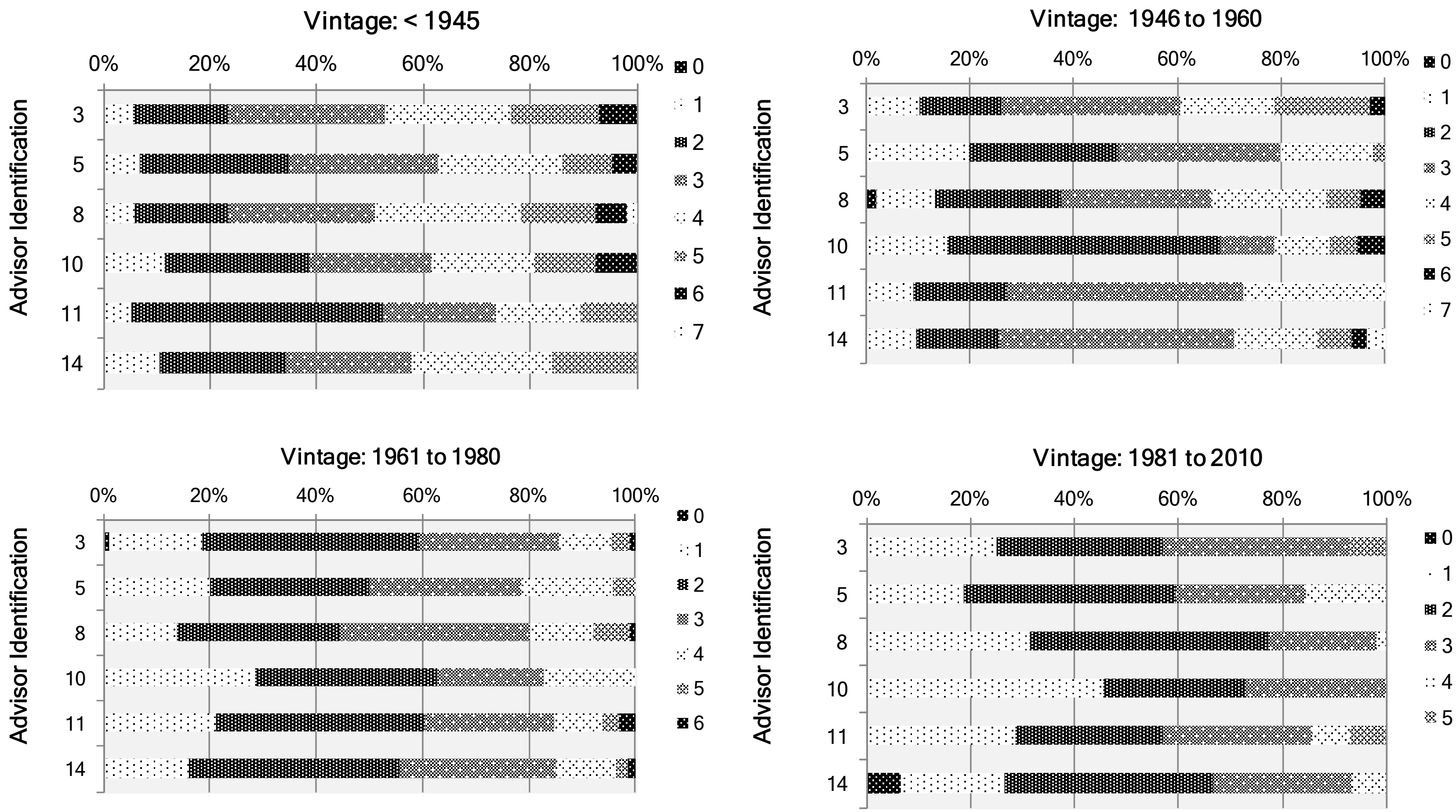
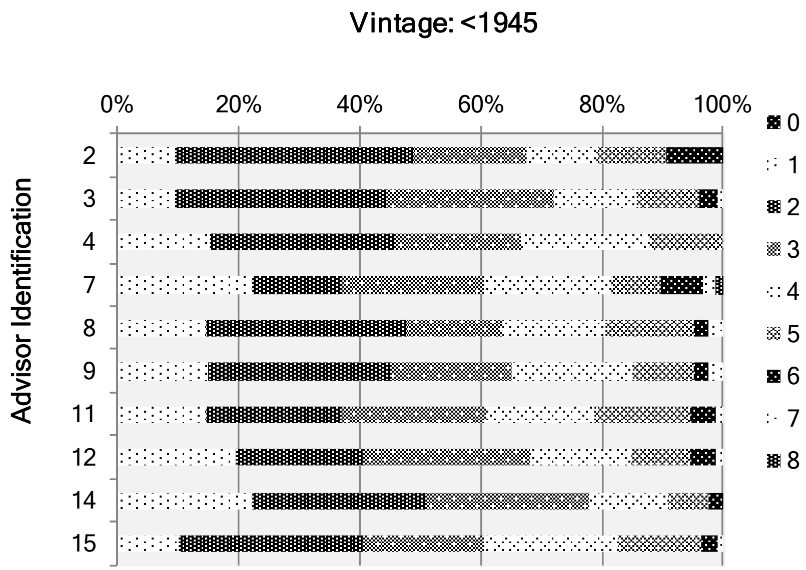


Figure 5.22 Period 2 Number of Changes Achieved by Advisor



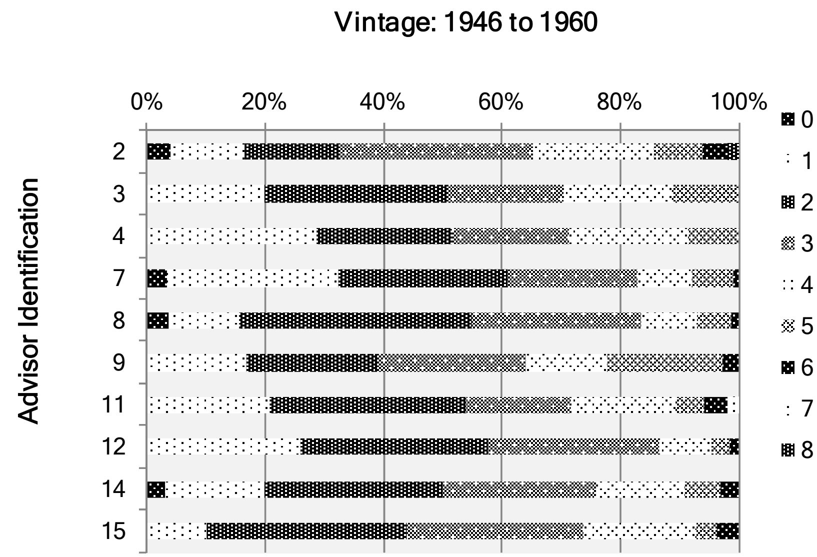
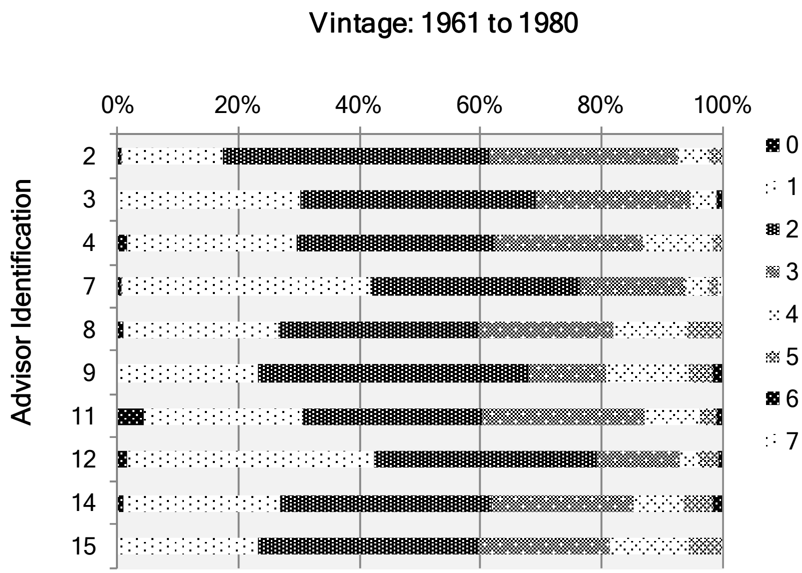


Figure 5.23 Period 4 Number of Changes Achieved by Advisor



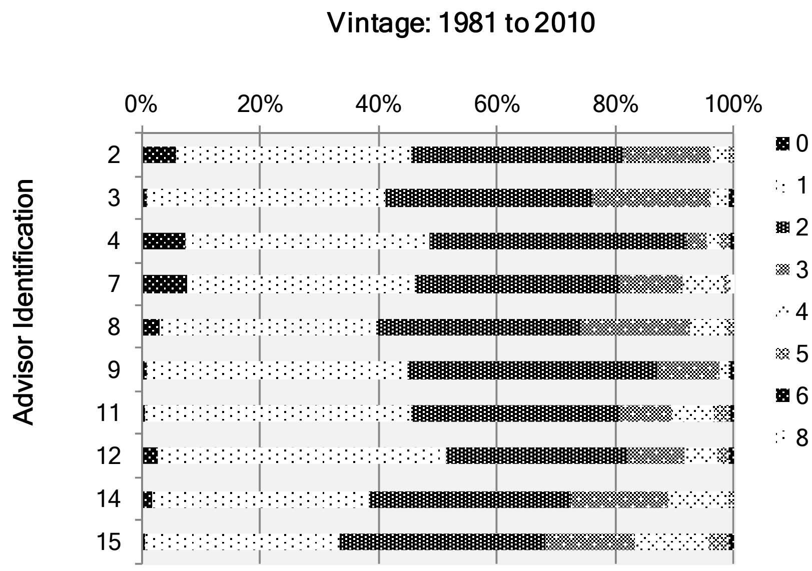


Figure 5.23 Period 4 Number of Changes Achieved by Advisor (continued)

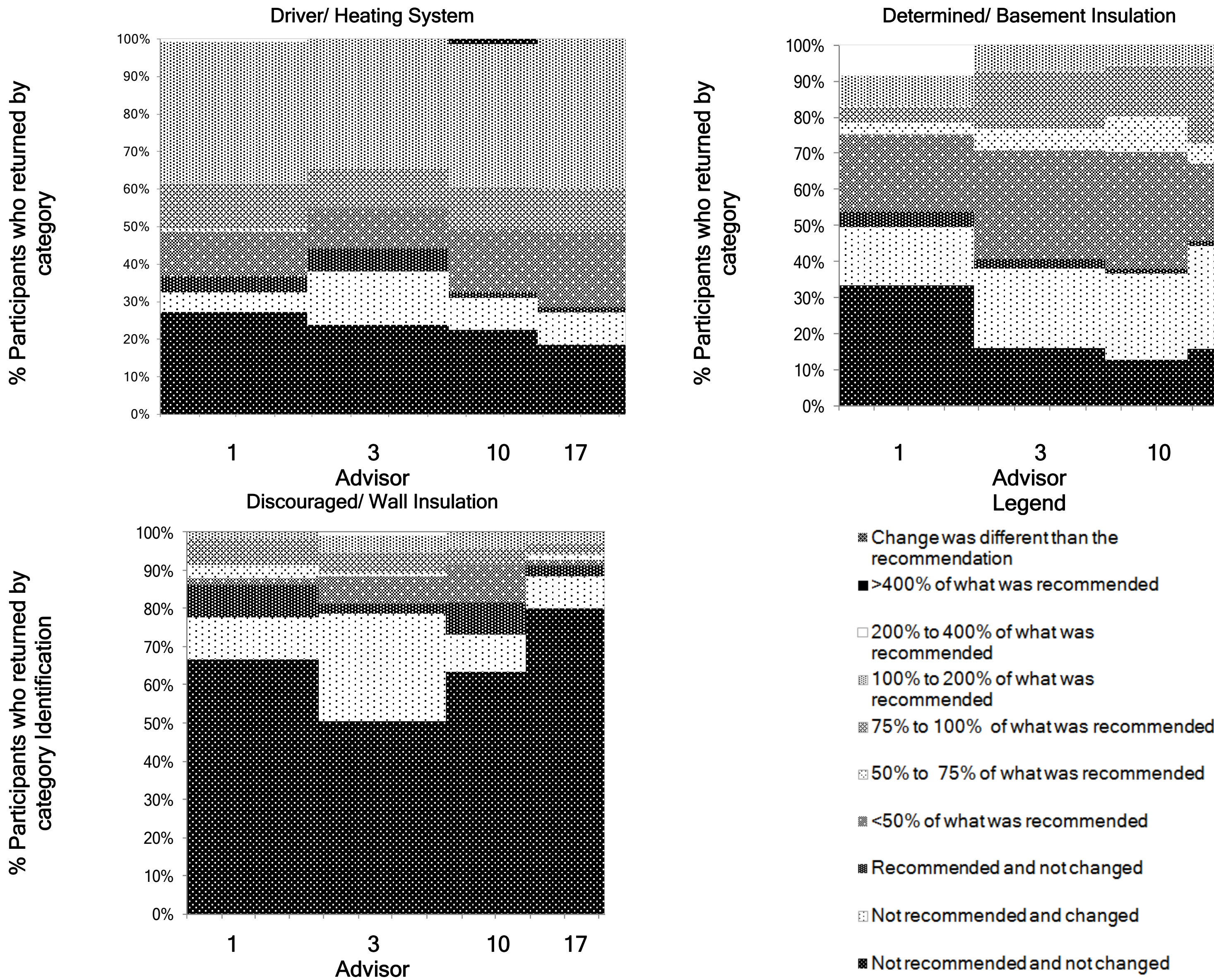


Figure 5.24 Advice-following: Decisions Taken in Period 1.1

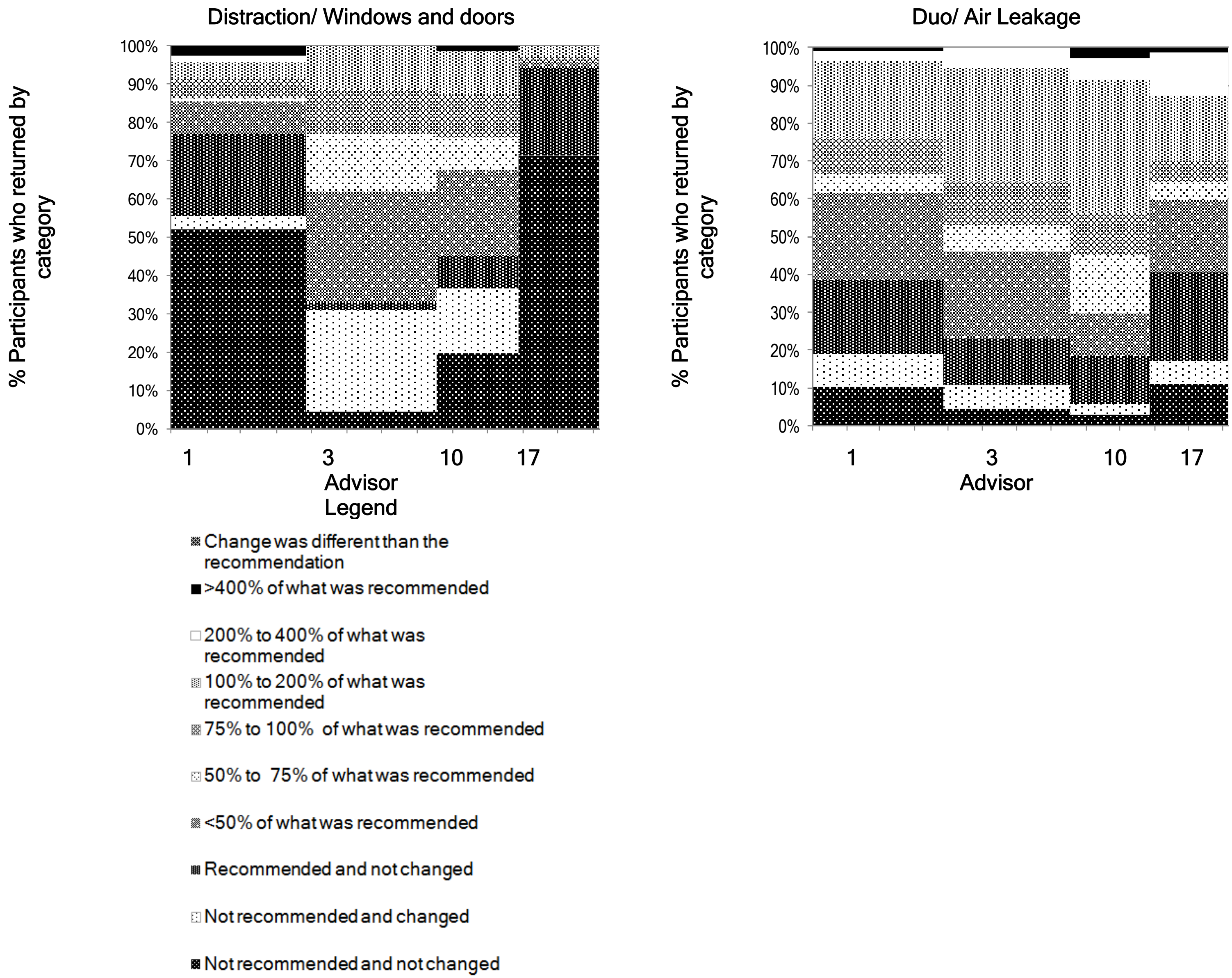


Figure 5.24 Advice-following: Decisions Taken in Period 1.1 (continued)

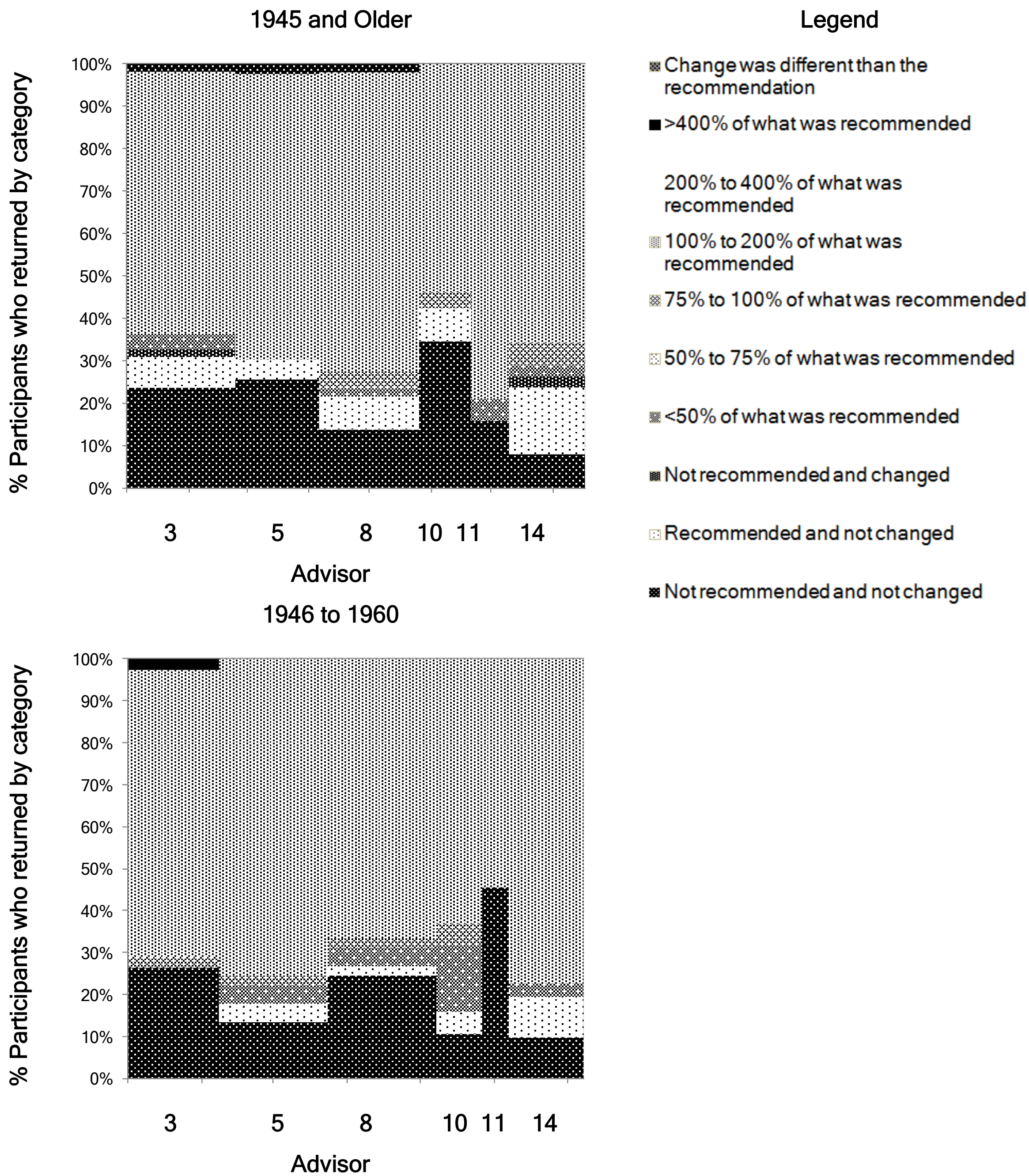


Figure 5.25 Driver: Advice-following of Decision to Replace Heating System in Period 2

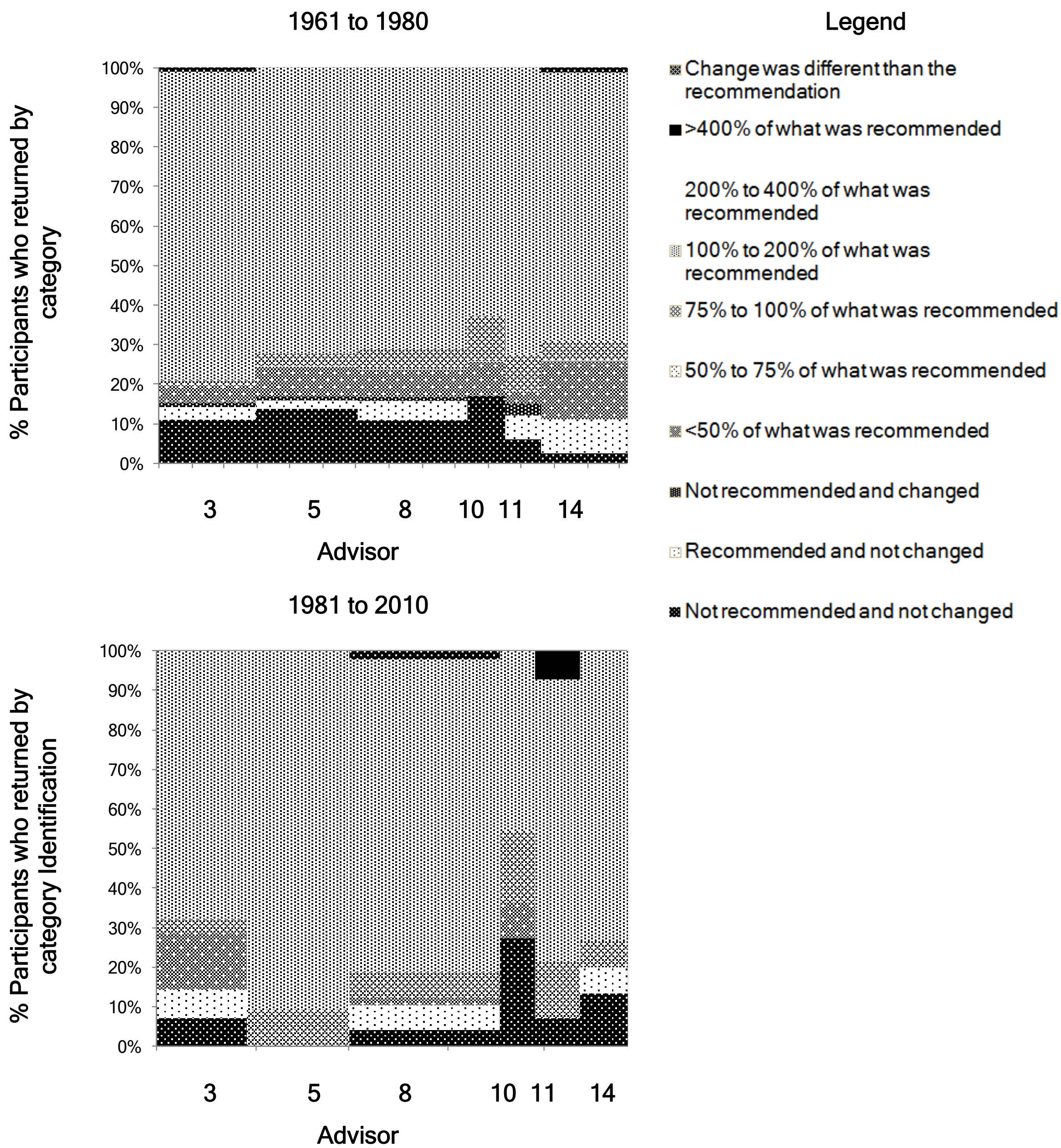


Figure 5.25 Driver: Advice-following of Decision to Replace Heating System in Period 2 (continued)

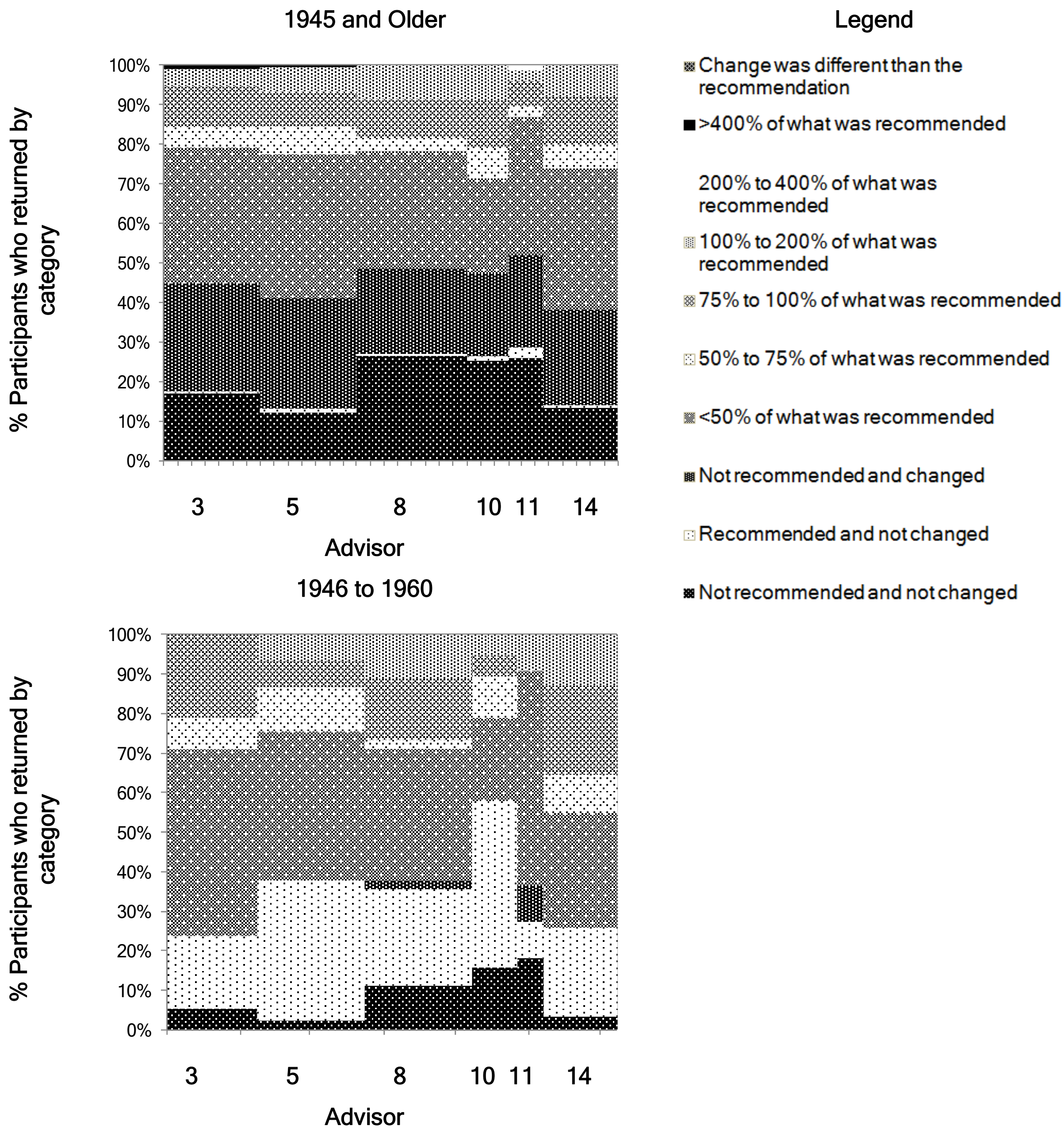


Figure 5.26 Determined: Advice-following to Insulate Basement in Period 2

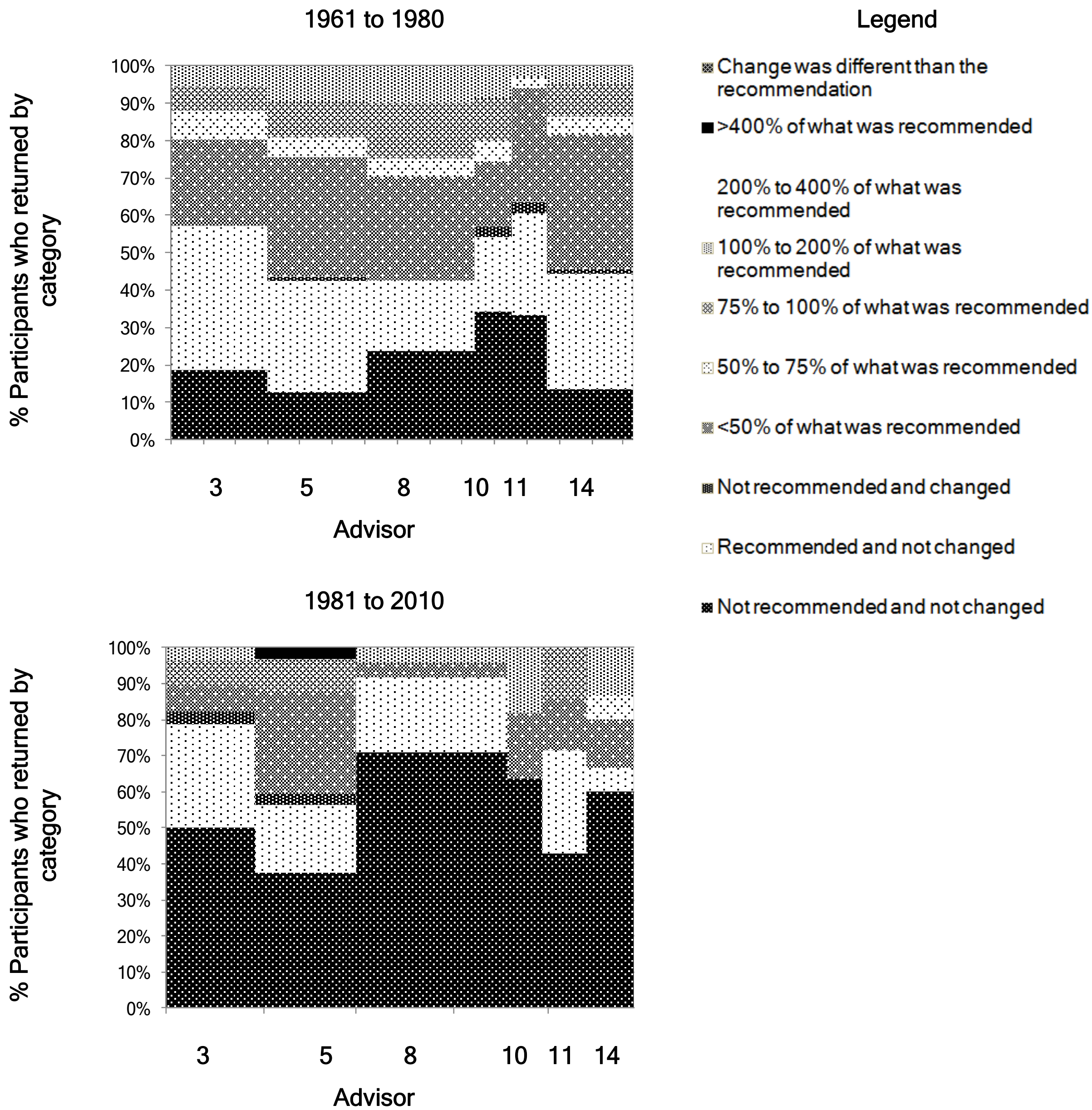


Figure 5.26 Determined: Advice-following to Insulate Basement in Period 2 (continued)

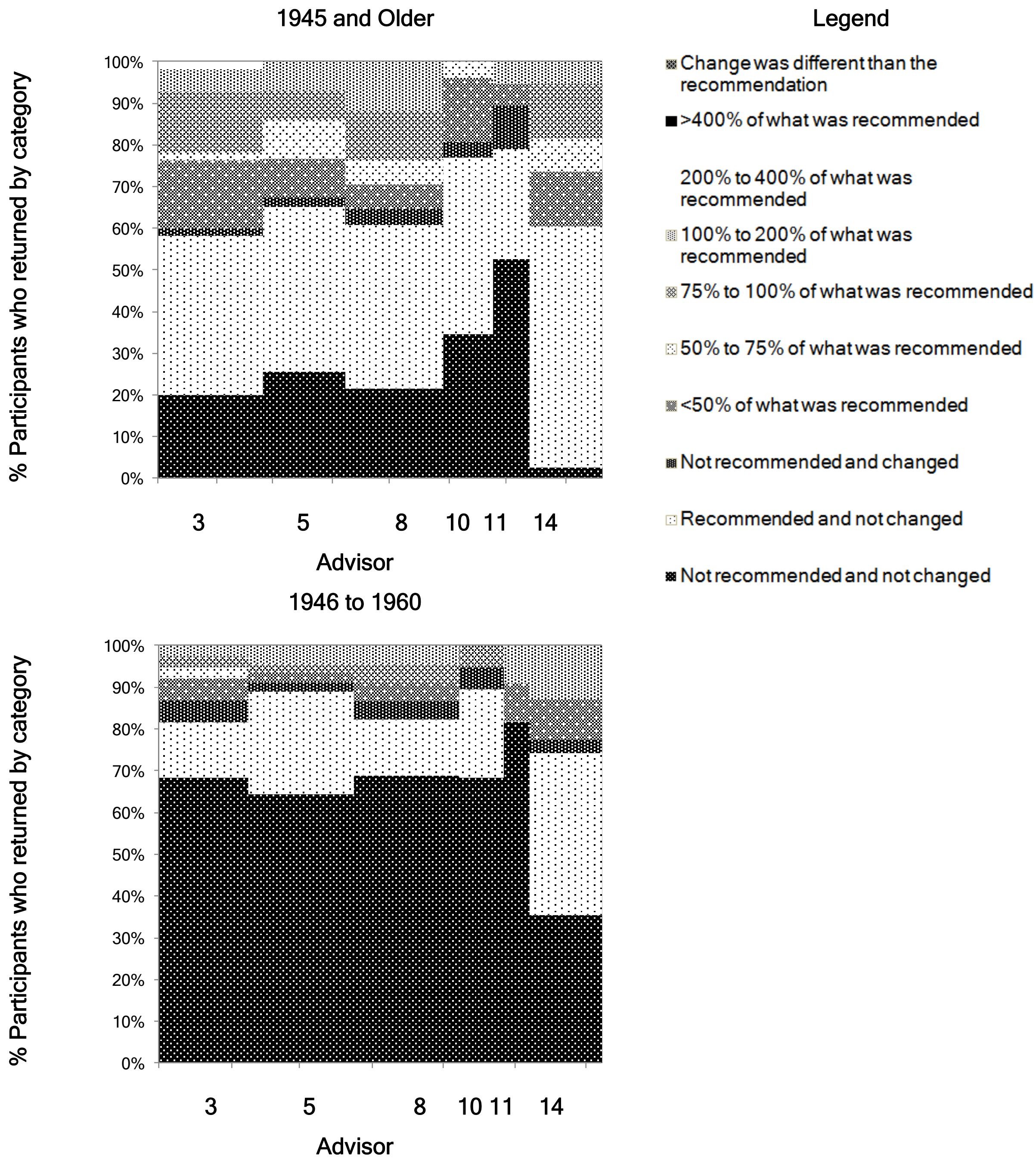


Figure 5.27 Discouraged: Advice-following to Insulate Walls in Period 2

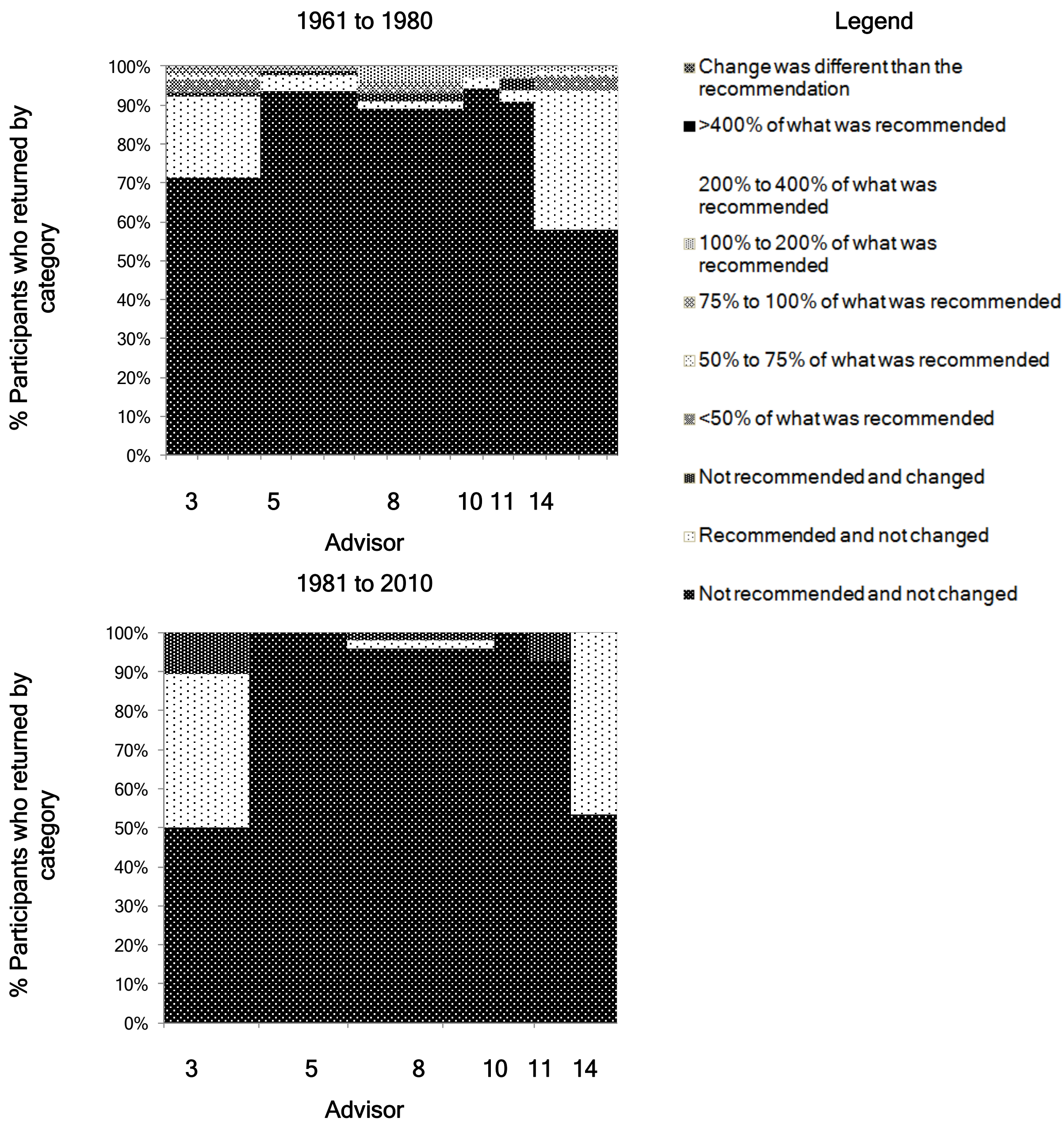


Figure 5.27 Discouraged: Advice-following to Insulate Walls in Period 2 (continued)

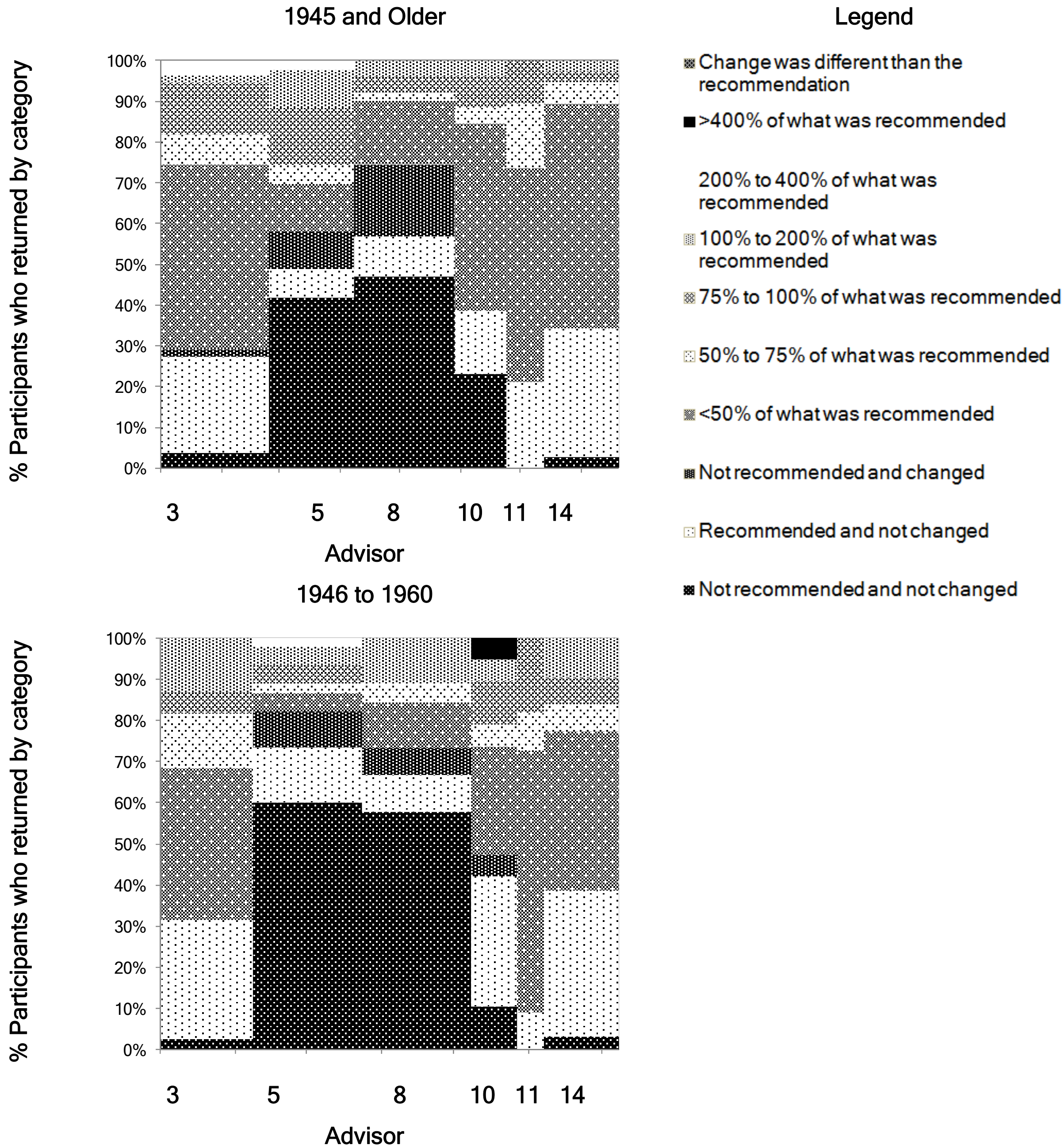


Figure 5.28 Distraction: Advice-following to Replace Windows and doors in Period 2

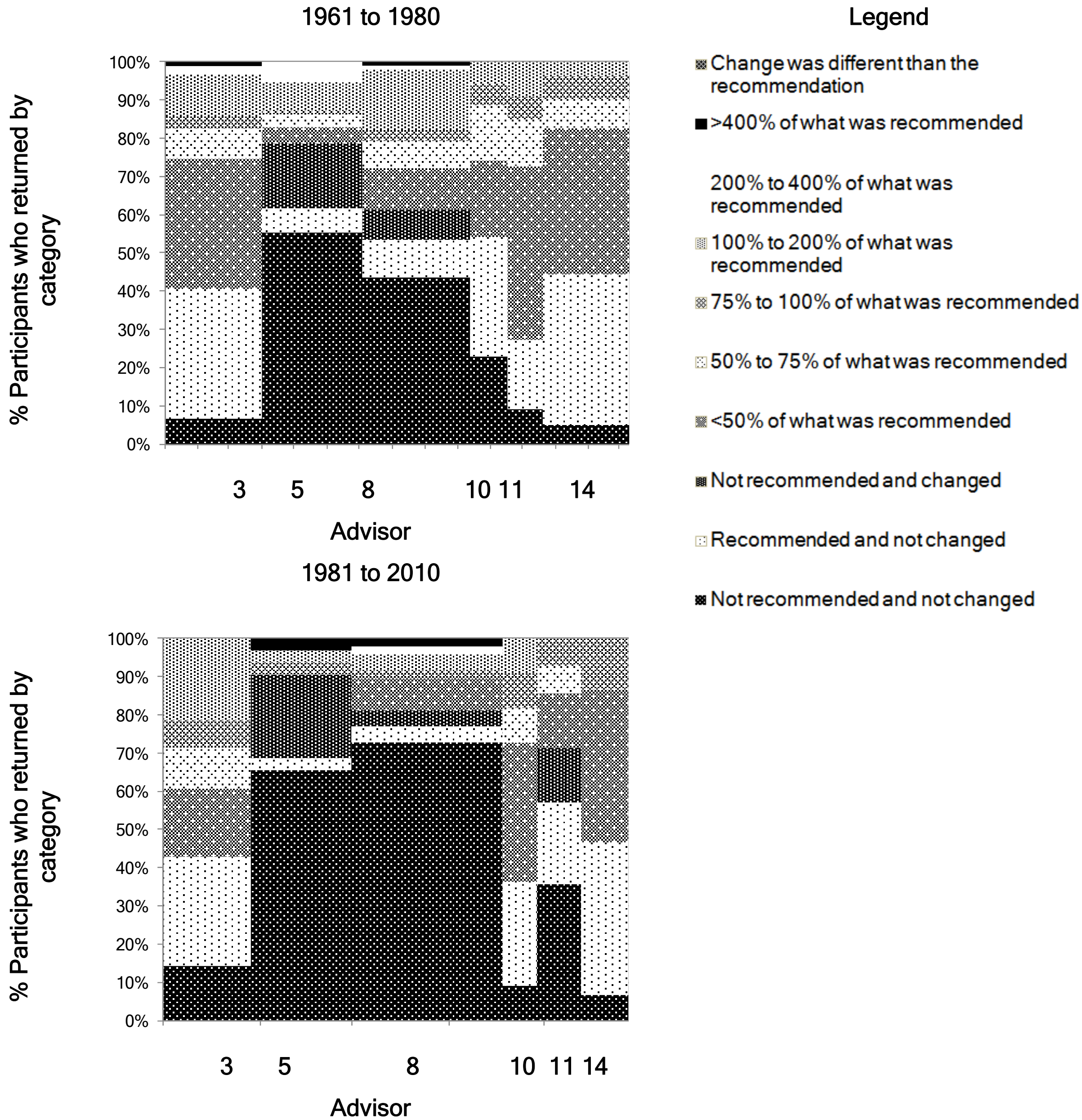


Figure 5.28 Distraction: Advice-following to Replace Windows and doors in Period 2 (continued)

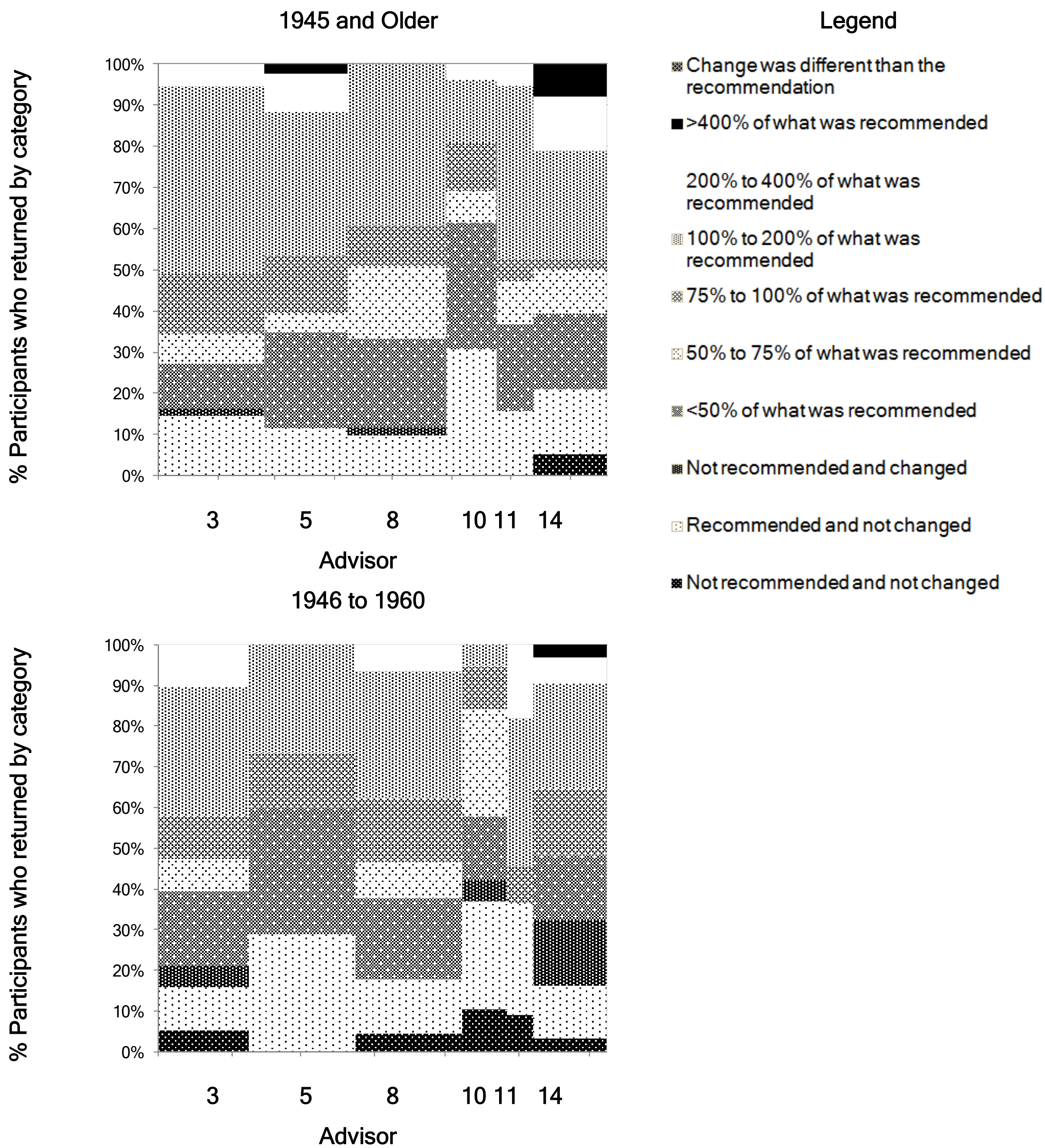


Figure 5.29 Duo: Advice-following to Reduce Air Leaks in Period 2

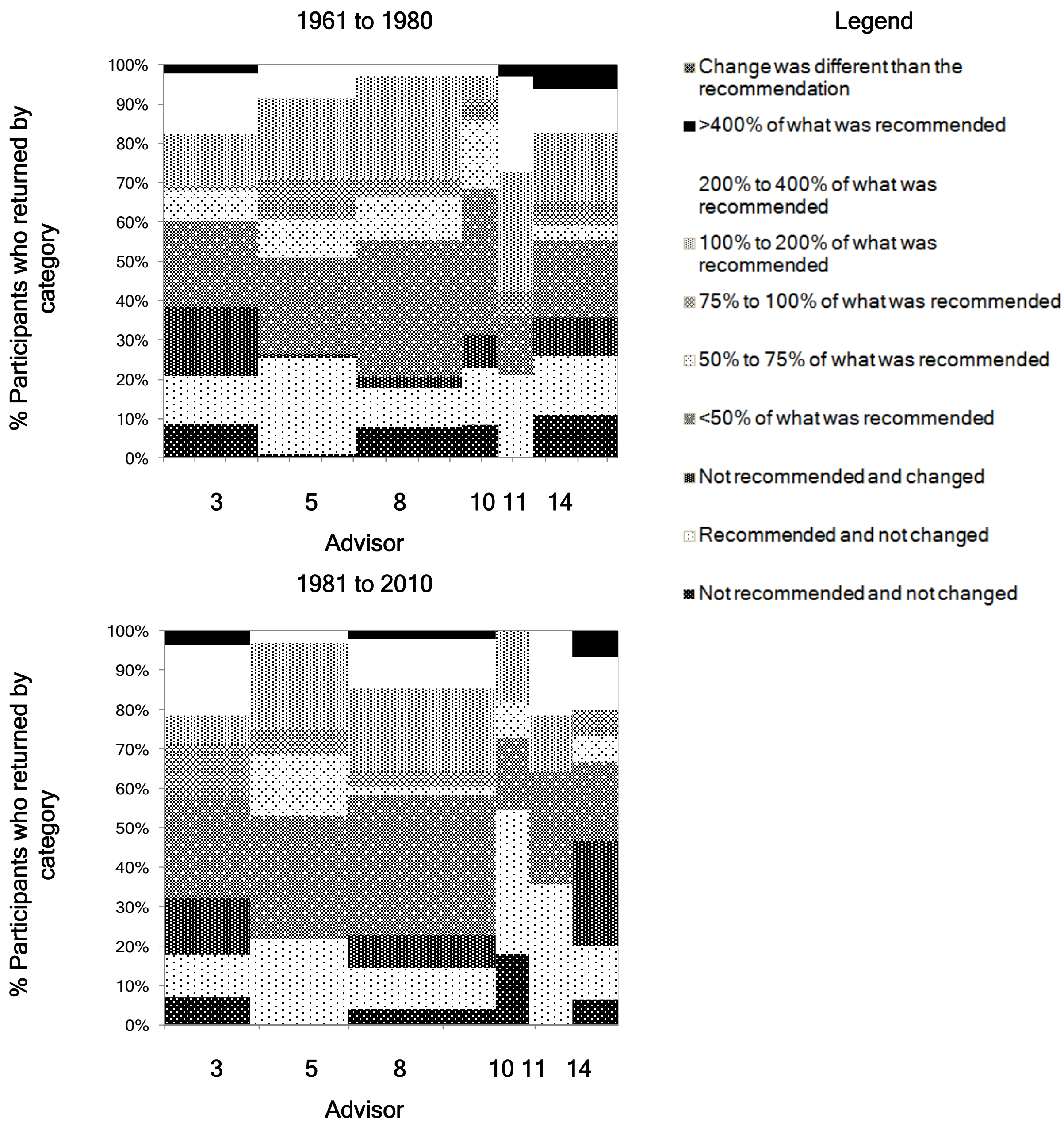


Figure 5.29 Duo: Advice-following to Reduce Air Leaks in Period 2 (continued)

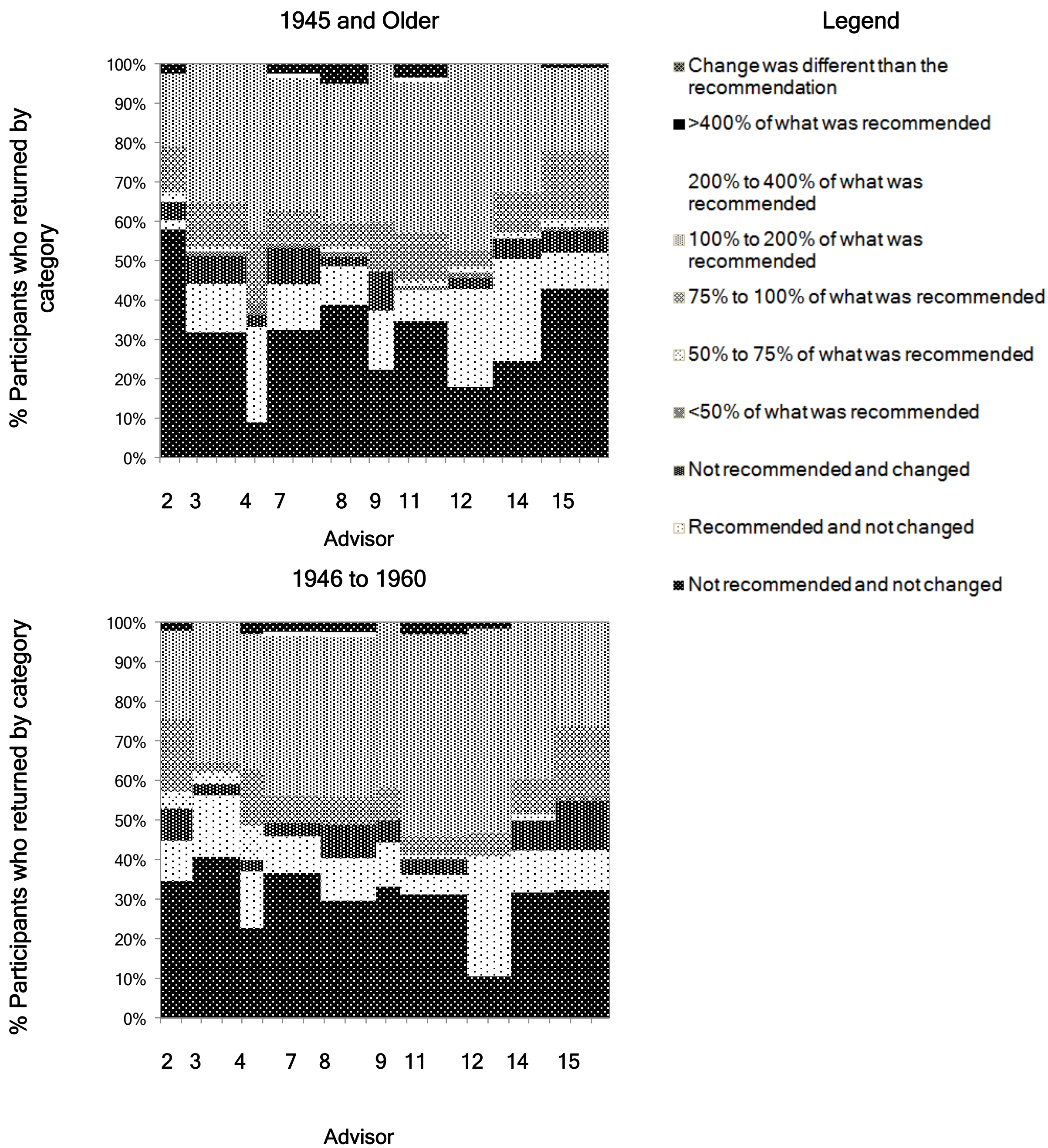


Figure 5.30 Driver: Advice-following to Replace Heating Systems in Period 4

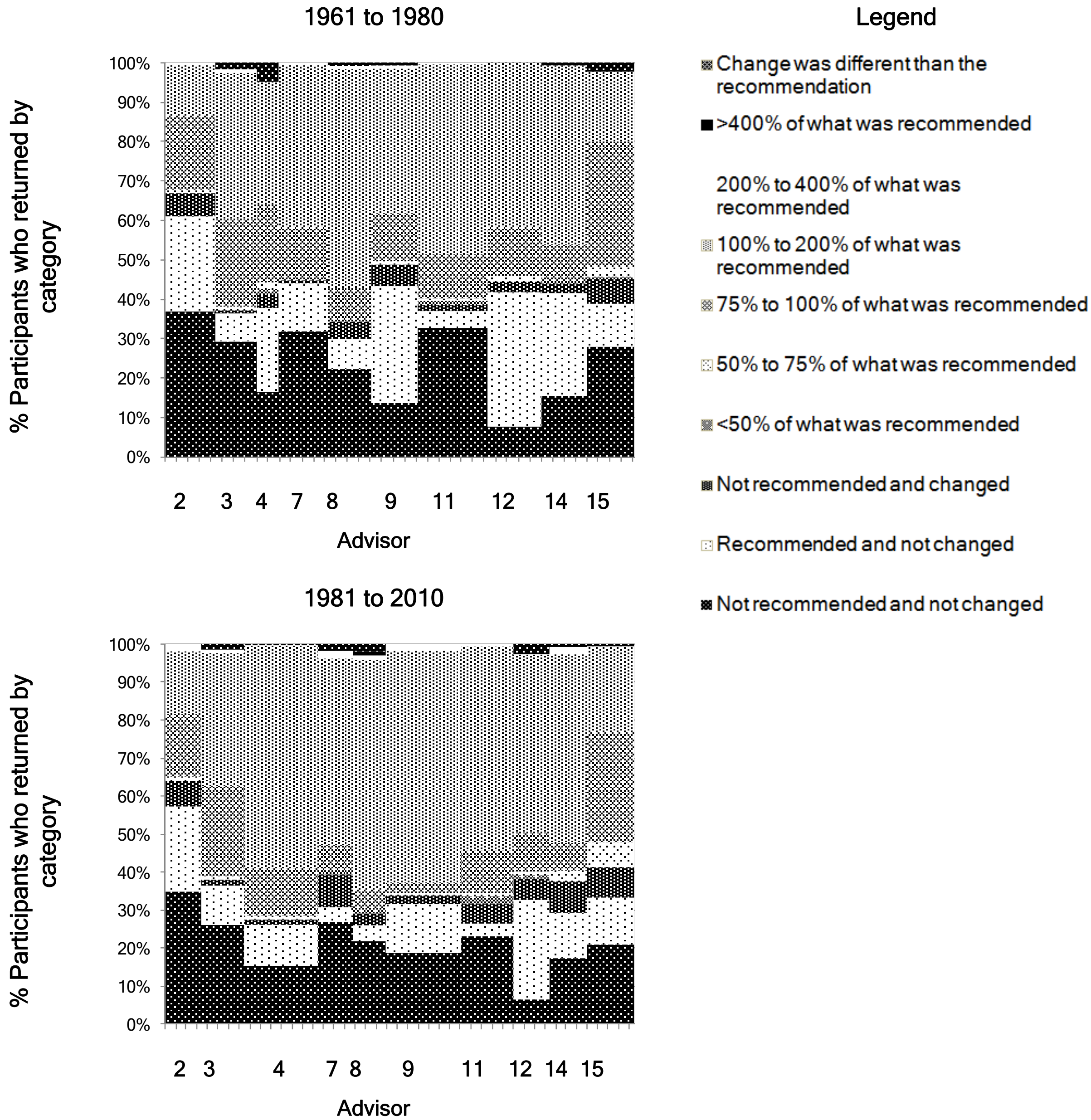


Figure 5.30 Driver: Advice-following to Replace Heating Systems in Period 4 (continued)

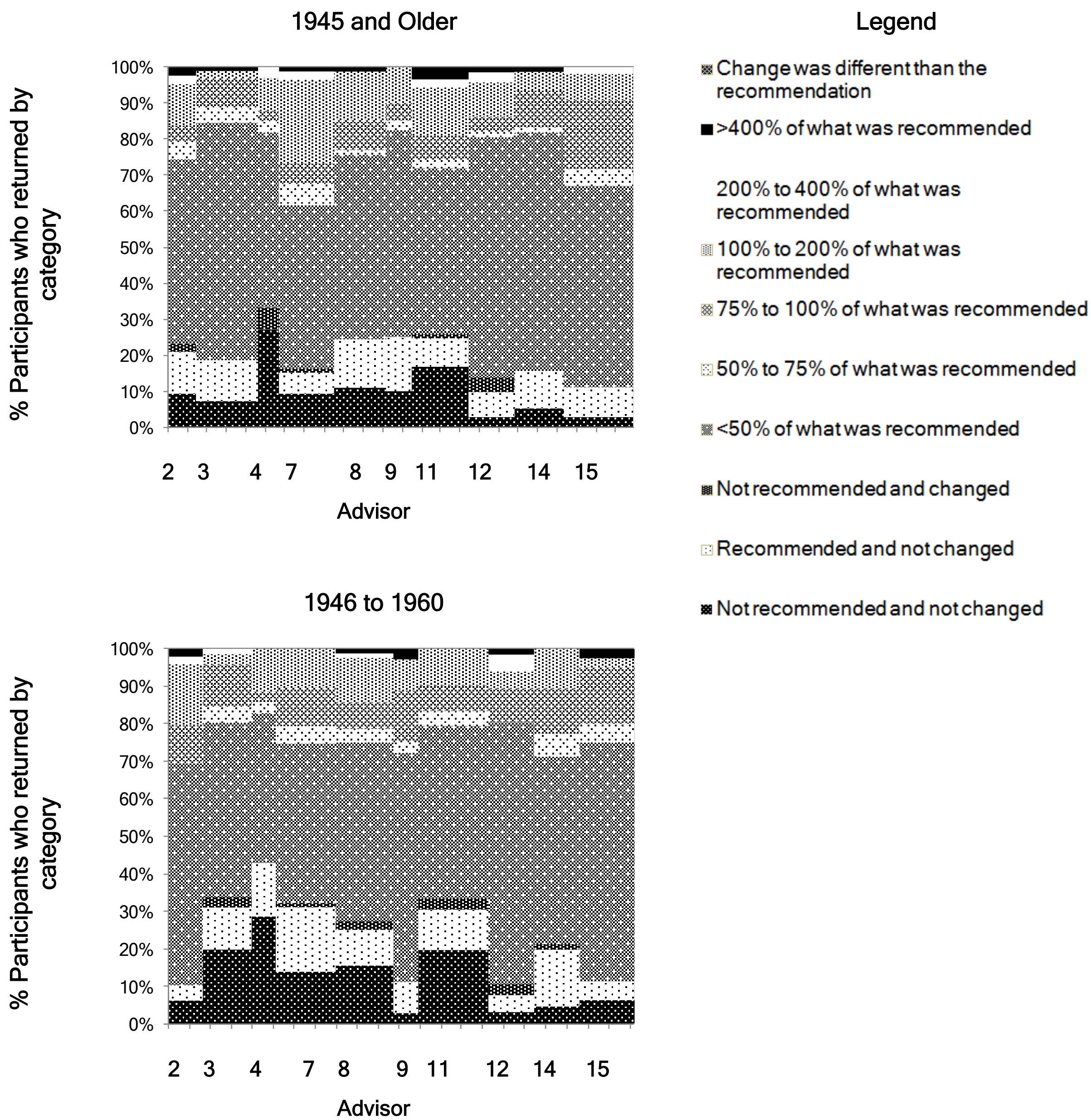


Figure 5.31 Determined: Advice-following to Insulate Basement in Period 4

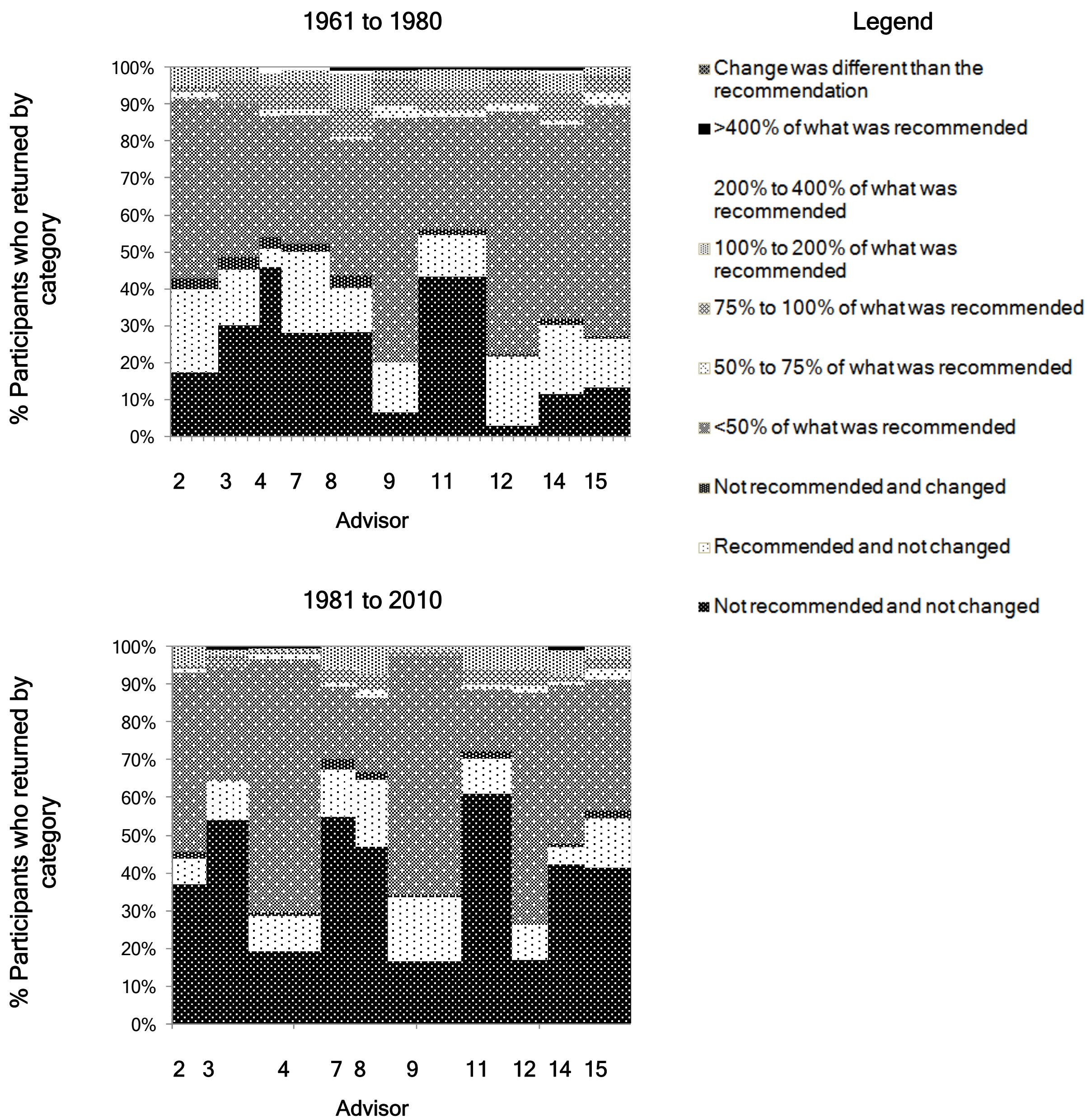


Figure 5.31 Determined: Advice-following to Insulate Basement in Period 4 (continued)

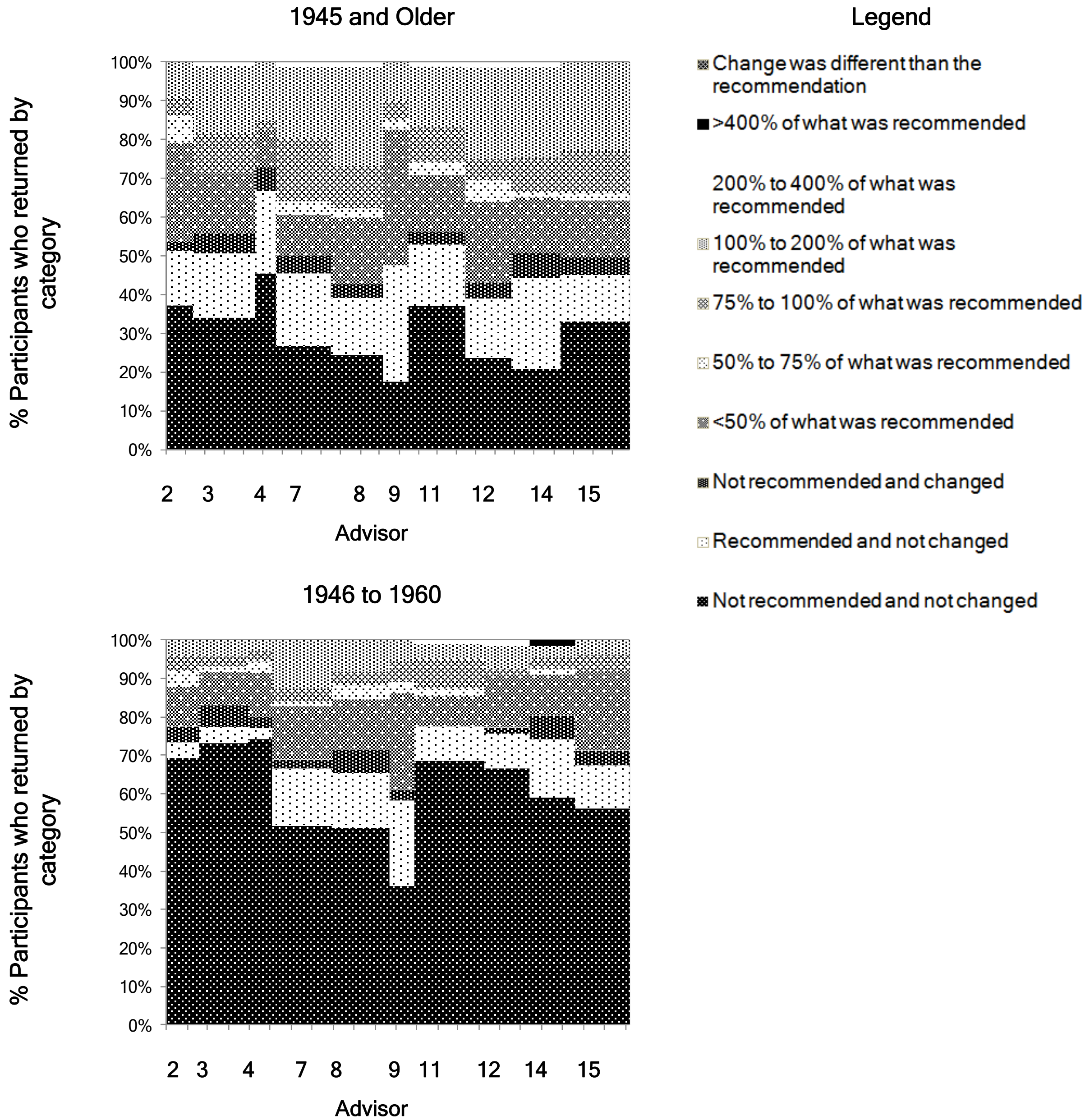


Figure 5.32 Discouraged: Advice-following to Insulate Walls in Period 4

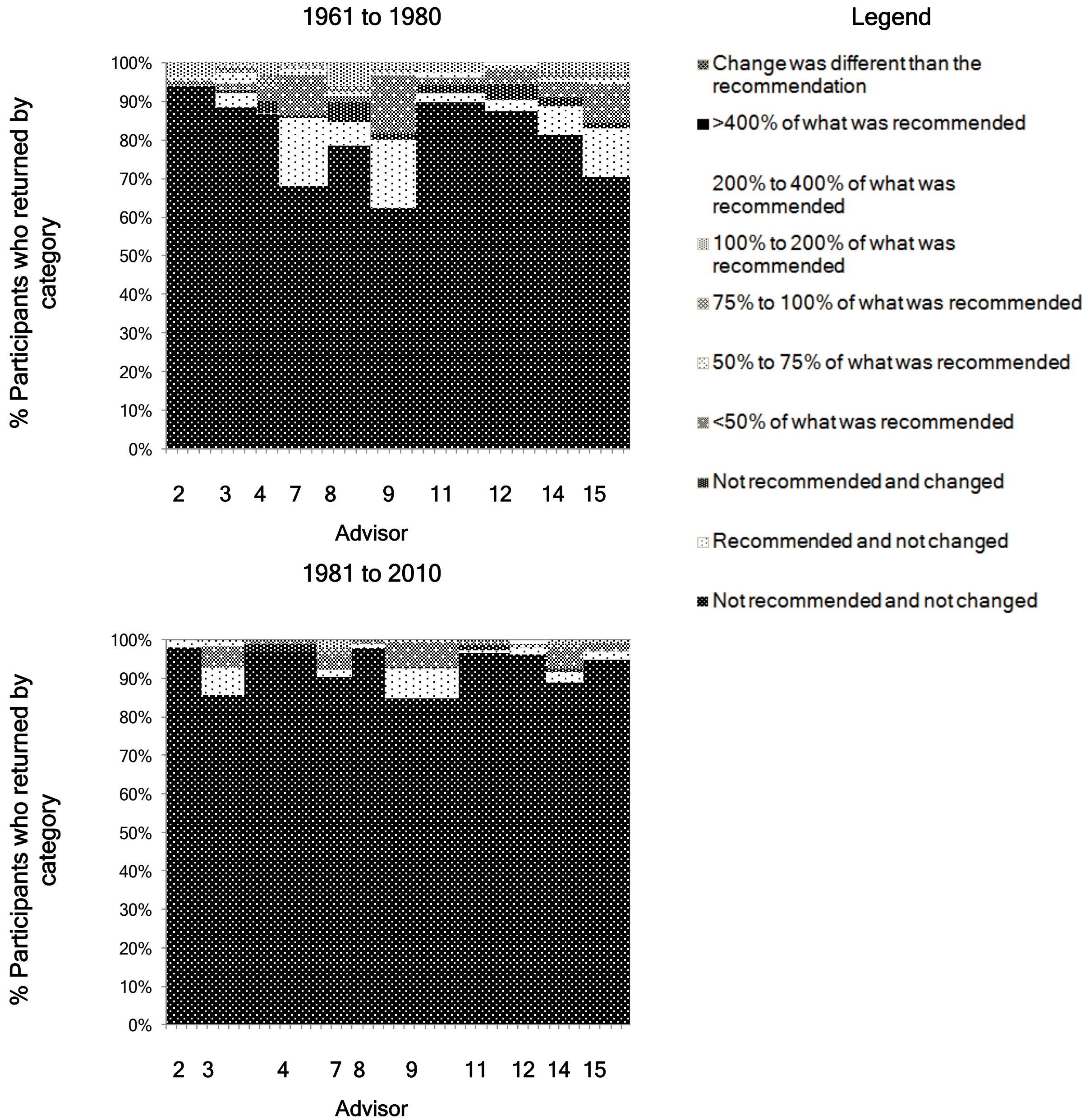


Figure 5.32 Discouraged: Advice-following to Insulate Walls in Period 4 (continued)

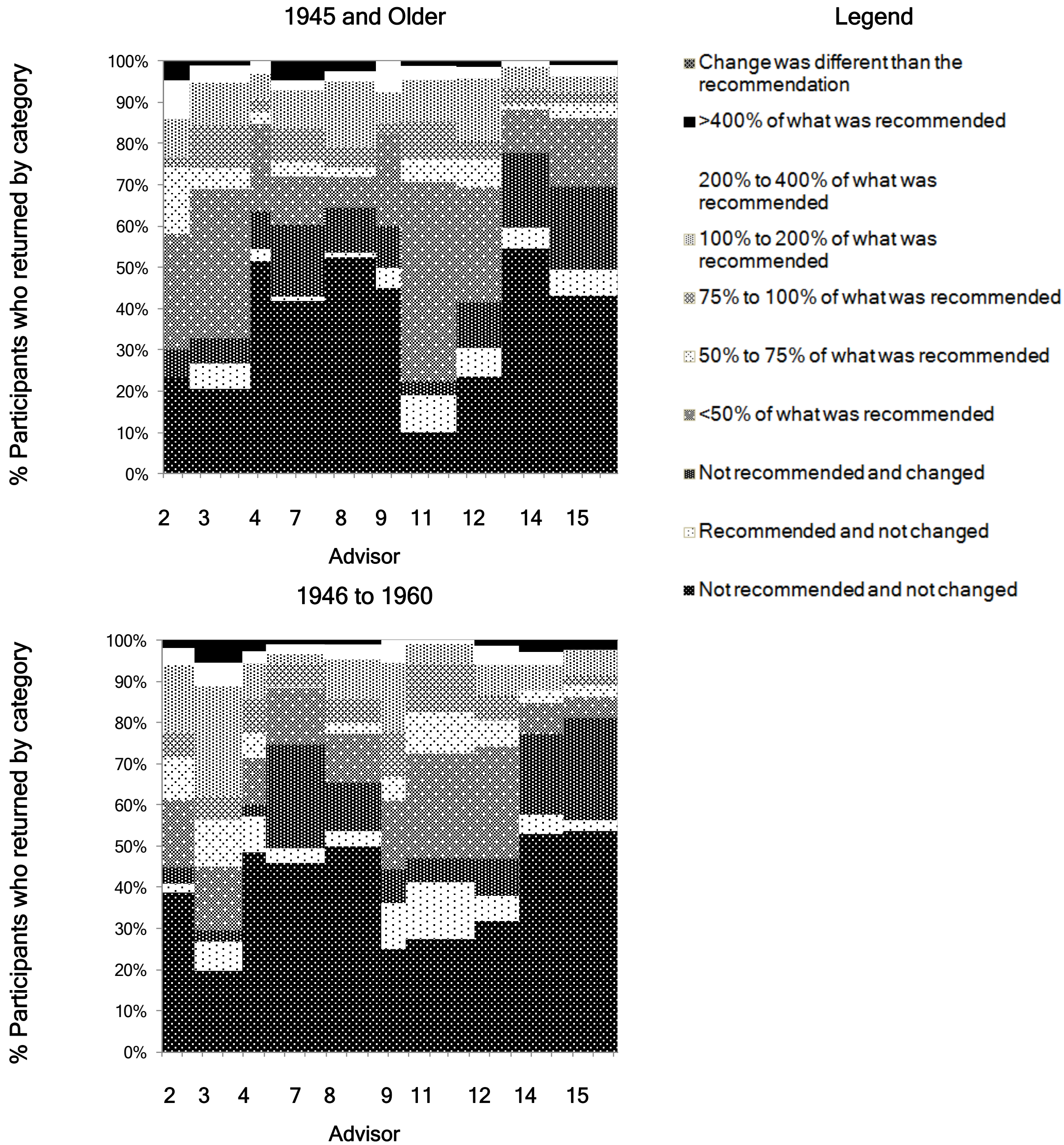


Figure 5.33 Distraction: Advice-following to Replace Windows and Doors in Period 4

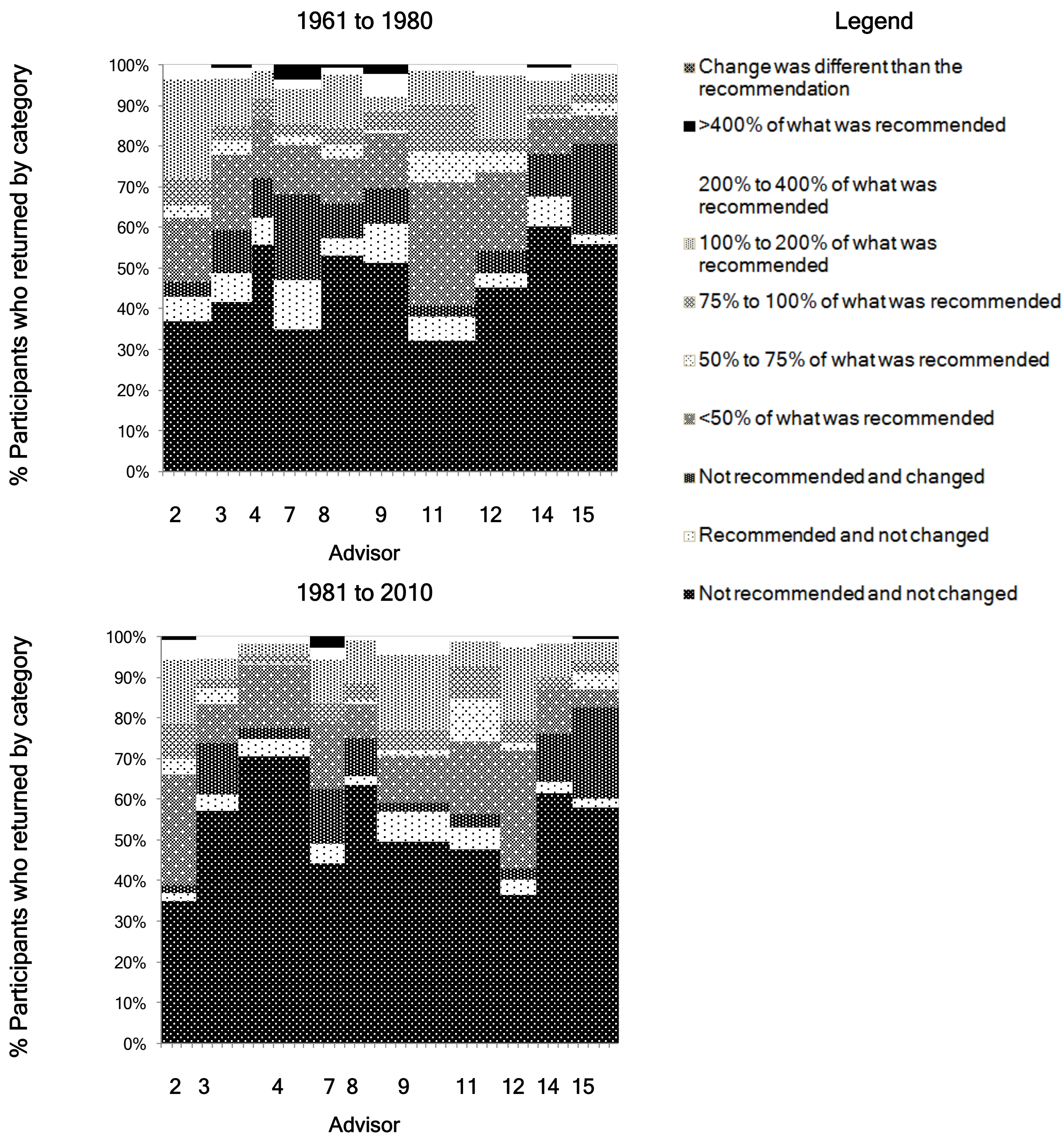


Figure 5.33 Distraction: Advice-following to Replace Windows and Doors in Period 4 (continued)

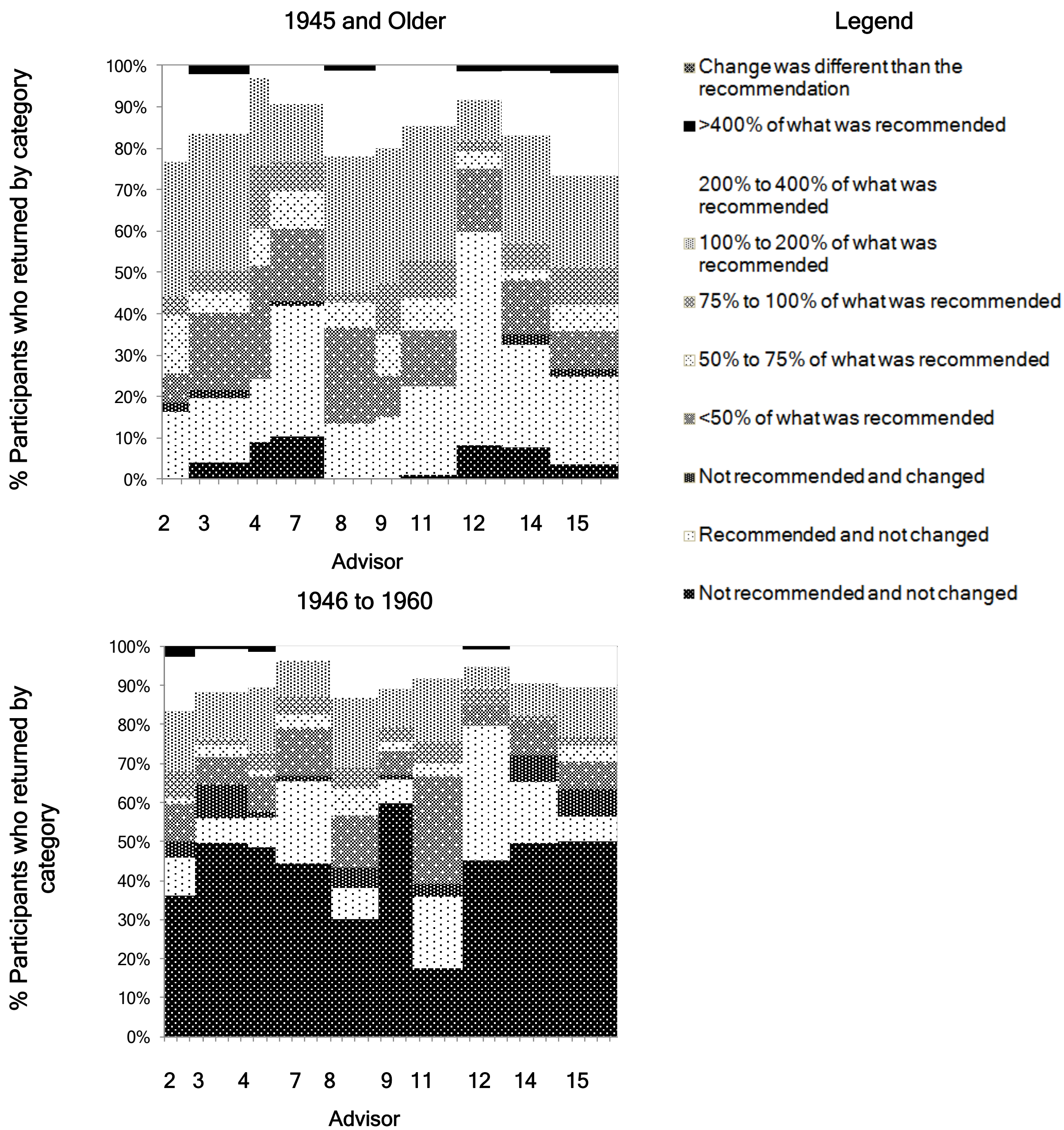


Figure 5.34 Duo: Advice-following to Reduce Air Leaks in Period 4

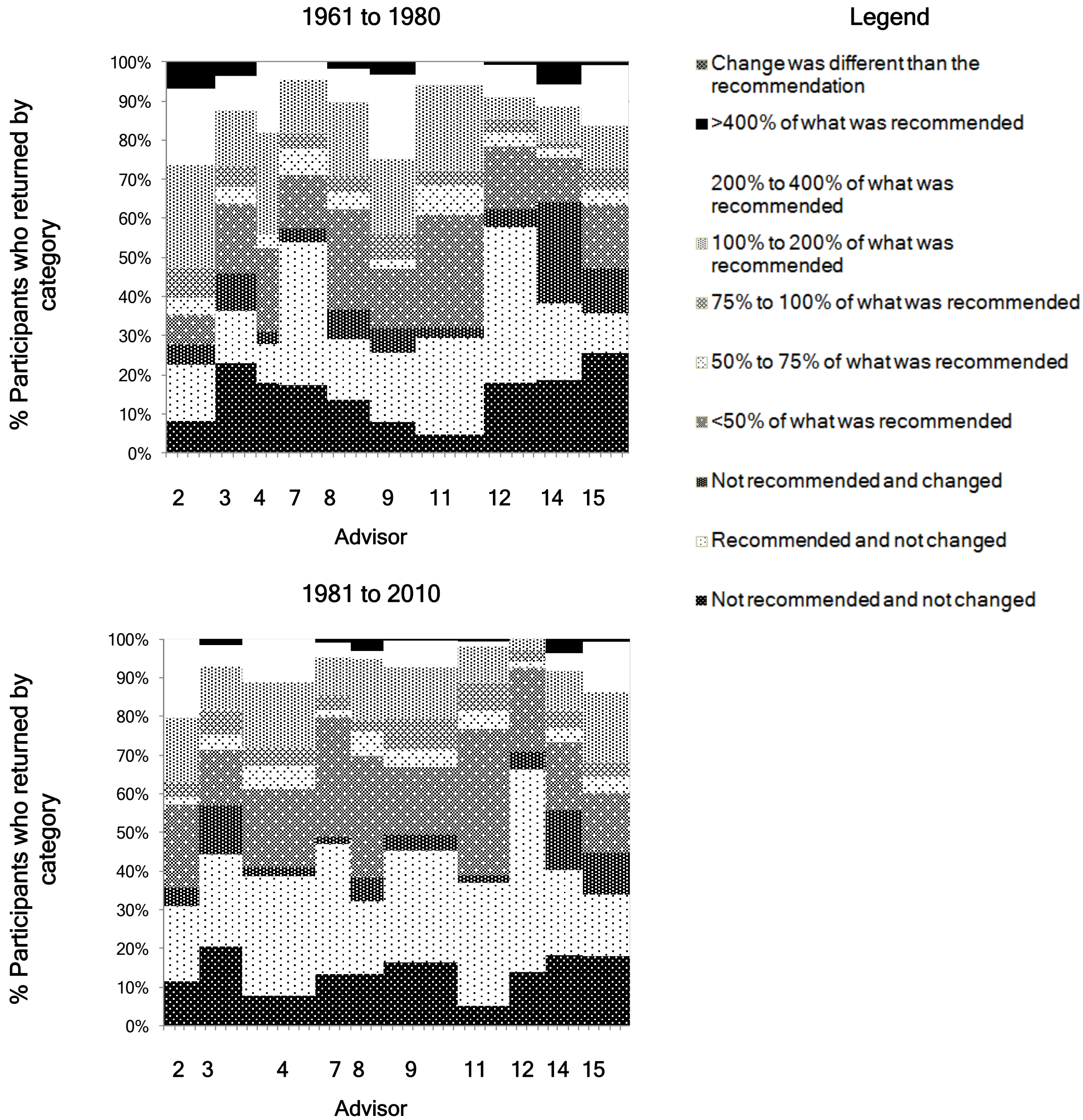


Figure 5.34 Duo: Advice-following to Reduce Air Leaks in Period 4 (continued)

Chapter 6
Discussion

This dissertation analysed the process of participation in a home energy evaluation program as it was delivered by REEP over a 12-year period. This chapter presents a discussion of the results. The study consisted of a quantitative analysis of advice-giving and advice-following of 13,429 initial and 6,123 follow-up evaluations delivered between 1999 and 2011. During that timeframe, four program structures occurred. The qualitative data were collected by interviewing eight advisors who delivered more than half of the initial and follow-up evaluations for REEP. These interviews were supplemented by interviews with four advisors from the Elora Center for Environmental Excellence. Chapter 4 presents a quantitative analysis of the impacts of program structure on participation in a home energy evaluation program and advice-following. Chapter 5 presents the results of a qualitative analysis of the process of advice-giving and compares this to a quantitative analysis of advice-giving and advice-following by advisor under the four program structures. Chapter 3 describes how the results for both chapters were interpreted in the discussion and triangulated with previous findings from the national level studies of the EnerGuide for Houses programs and previous analyses of REEP's delivery of the EnerGuide for Houses and ecoEnergy programs.

This chapter presents an interpretation of the findings in five parts. The first section discusses findings about heterogeneity in response to four program structures. The second section discusses evidence of relationships between the variables under investigation, in that the program structure appears to have affected advice-giving. The third part focuses on advice strategies. The fourth section discusses the overall findings with respect to specific decisions. The fifth section presents a triangulation of the findings of this dissertation with other studies. These findings are followed by suggestions for future research.

6.1 Heterogeneity

The literature review in Chapter 2 presents a discussion of the need for studies that reveal heterogeneity in preferences and clarify the context of decisions. The review of studies by Wilson and Dowlatabadi (2007) sheds light on this gap in knowledge. The energy cultures framework of Stephenson et al. (2010) is formed around the call for understanding heterogeneity and context. In a variation on these perspectives, the multilevel transitions perspective describes niche experimentation as necessary to create innovations that might “break through” to broader usage or application. The program that was analysed in this study offered advice to homeowners on eight retrofit decisions; however, over four program periods, the initial price of the evaluation, the amount and the structure of the financial reward varied, as did the level of formal government support. A natural quasi-experimental design was applied to examine whether the different program structures appealed to the general population or if they appealed to subsets of the population with particular characteristics. The natural quasi-experimental design was also applied to assess within the program periods for subsets of the initial group that returned for a follow-up evaluation, which may explain why some households returned and some did not.

The findings from this research project indicate that there were differences in response to each program structure. This implies that the structure of the program did have an impact on advice-following. There were several results associated with this conclusion. As homeowners self-selected into the program in response to program structure, the vintage and location of the samples were not representative of housing stock in the Region of Waterloo and therefore were not considered a random sample. This finding is in agreement with Maruejols and Ryan’s (2009) examination of the national uptake of the EnerGuide for Houses program.

Another response to the variation in program structure was a variation in rates of participation. The rate of participation in an initial evaluation did not vary between Periods 1 and 2. However, the rate of participation in a follow-up evaluation was higher during Period 2, when a performance-based reward was offered, than during Period 1. The removal of federal government support as well as the financial reward resulted in lower participation rates in both initial and follow-up evaluations as the mean weekly participation in Period 3 was lower than Period 1. There are a few plausible explanations for this. One is that the highly visible federal cancellation of the program limited public awareness about the local continuation of the program. Alternatively, participants may have been influenced by the perceived credibility provided by a partnership between national and local levels. A third explanation is that Period 3 occurred after a highly visible and abrupt program cancellation. Potential participants may have framed the lack of financial reward as a loss of the available financial rewards in Period 2, rather than a gain from not having a program at all, as was faced by many other communities.

The addition of a larger list-based financial reward offered during Period 4 was associated with a higher rate of participation in an initial evaluation than Periods 1 and 2, and a higher rate of participation in a follow-up evaluation than Period 2. The percentage of participants who had an initial evaluation during Period 2 and returned for a follow-up was 36%, and for Period 4, nearly double, at 77%. It appears that homeowners were motivated by rewards to participate in a follow-up evaluation, and a higher reward was associated with a higher rate of participation in both the initial and follow-up evaluation.

Heterogeneity in the distribution of material characteristics was found between the participating groups of each program structure, and within the participating groups of each program structure. Different program structures attracted groups of houses for which the means of some material characteristics, such as energy rating or energy consumption, were different. Differences of means were found within periods (between initial only and follow-up) for various material characteristics. These findings indicate that different subsets of the population of housing stock in the Region of Waterloo were attracted to each program structure. Within each period, it was subsets with different types of material characteristics than the initial-only group that returned for a follow-up evaluation. These are indications of different types of perceived problems that responded to the different program structures.

The performance-based reward that was offered during Period 2 attracted the participation in the initial evaluation of the high priority cohort of lower performing and older houses than the groups of houses that participated in other periods. The information and list-based financial reward structures, Periods 1 and 4, attracted houses with higher energy performance characteristics to the initial evaluation, although the causes for this may be different for each period: it could have been due to the low price in Period 1, and the high financial rewards offered during Period 4. The periods that offered information only or a performance-based financial reward, Periods 1 and 2, attracted houses with even lower energy performance characteristics to the follow-up than those of the initial-only group. Period 4 attracted more houses to return for a follow-up evaluation, and also attracted a large share of houses with better energy performance than the houses that only had an initial evaluation.

These differences in the material characteristics of those who self selected into the program affected the advice given. This is because the frequencies of the various recommendations and of the depth of recommended change were found to be different across periods, likely in response to the variations of material characteristics of participating houses. One recommendation was given more often during the periods that were associated with a financial reward and less so with information only: heating systems. A change to the heating system was recommended to a greater share during Periods 2 and 4 than during Periods 1 and 3. For all periods, the mean recommended change to natural gas furnace efficiency was higher for each follow-up group when compared to its corresponding initial only group. The recommendation to reduce heat losses only appeared to affect the decision to return during Periods 1 and 1.1. The recommendation to reduce heat losses did not appear to affect the decision to return for a follow-up for Periods 2 or 4.

In Period 2, as the number of recommendations increased, the share of houses that returned also increased. That is, more recommendations were associated with a larger percentage of the follow-up evaluations. However, the number of recommendations given to houses that participated during in Period 4 appears to have had little effect on the decision to return for a follow-up evaluation: as the number of recommendations increased, the share of houses that returned for a follow-up evaluation varied little. This could be due to a stronger association between the number of recommendations and the opportunity to make a deeper improvement to the energy performance of the house during Period 2. It may also have been that homeowners responded differently to the number of recommendations during these program periods.

The findings also showed that the variation of price of an initial evaluation within a program period did not seem to affect the types of houses that participated. Indeed, the mean price paid was different for each program period, but the rate of participation in an initial evaluation was higher in a higher cost, higher financial reward program than in other periods with a lower initial price. It appears that combinations of factors beyond price within program structure (such as financial rewards) affected participation rates.

The literature review presents that Stern et al. (1986) and Stern (1999) report conflicting findings about whether the size of the financial reward affects the rate of participation in a program. De Young (1993) says it is unclear if the reward size affects decisions. Furthermore, Stern et al. (1986) and Stern (1999) discussed the differences between types of rewards, such as loans or grants, but not the structure of the rewards, such as performance or list-based. Stern (1999) has also suggested research into segmentation by preferences for finance structure. The findings from this research contribute to answering these questions. In the context of this research, the reward size and structure did impact the level of participation, particularly for a follow-up evaluation, and it also affected decisions.

The effects of the program structures on recommendations and advice-following are discussed in more detail in the sections that discuss advice strategies and specific decisions.

6.2 Relationship between Program Structure and Advice-giving

Section 6.1 describes that the different program structures attracted subsets of the population of the Region of Waterloo for an initial evaluation, and subsets of the population of the initial evaluation for a follow-up evaluation as determined by differences in material characteristics. To some extent, this affected the recommendations given. Findings from the interviews with advisors showed that different advice was given to the different groups of homeowners not only due to differences in material characteristics, but also due to their perceptions of differences in homeowners' receptiveness towards certain types of information and recommendations. The general perception amongst advisors was that during Period 1, homeowners were typically intent-oriented. During this period, homeowners were interested in learning about their house and about how to reduce their environmental impact. In Period 2, there were mixed judgments over whether homeowners were intent or impact-oriented. In Period 4, while some advisors discussed a few intent-oriented homeowners, the general perception was that they were impact-oriented, and focused on the financial rewards. That is, according to the advisors, the program structure appears to have affected the motivations of the homeowners who self-selected into the program. Advisors described that during the periods in which financial rewards were offered, homeowners generally had preconceived ideas of retrofits in mind. The two most commonly discussed decisions that were mentioned as preconceived were replacements of windows and changes to heating systems. One of the findings of this study is that heating systems were recommended more often during the periods that offered financial rewards than during the periods that did not.

The results of Chapter 5 describe how advisors tailored their messages, the process of the evaluation and sometimes their recommendations by their perceptions of homeowners. This is shown in Figure 6.1. For example, during Periods 2 and 4, the lack of trust sometimes enhanced homeowner involvement, either because the advisor or the homeowner insisted on the homeowner physically following the advisor throughout the evaluation process. Perceptions of liability and trust altered the message framing that advisors used. For example, some advisors avoided making guarantees related to comparative and vivid statements about other homeowners, or guarantees of savings associated with gain framed messages. Lack of trust may have been why many avoided using loss framed messages. All of these demonstrate the impact that differences in the receptiveness of homeowners had on advice-giving. The program structure affected advice-giving, since it impacted advisors' perceptions of homeowners' openness to considering decisions which were not preconceived. Some advisors added homeowners' preconceived ideas of retrofits to the list of recommendations, or did not recommend important retrofits due to lack of receptiveness on the part of the homeowner.

While many advisors discussed some tension-filled experiences from engaging with different types of homeowners who participated in the program during Period 4, it can be pointed out that while these homeowners were not necessarily intent-oriented, the evaluation was an opportunity to educate and convince a broader audience of homeowners skeptical of the benefits of multiple home energy retrofits. As described by Advisors 2, 3 and 15, there was the possibility of turning around a tension-filled process such that homeowners did learn and participate in the program.

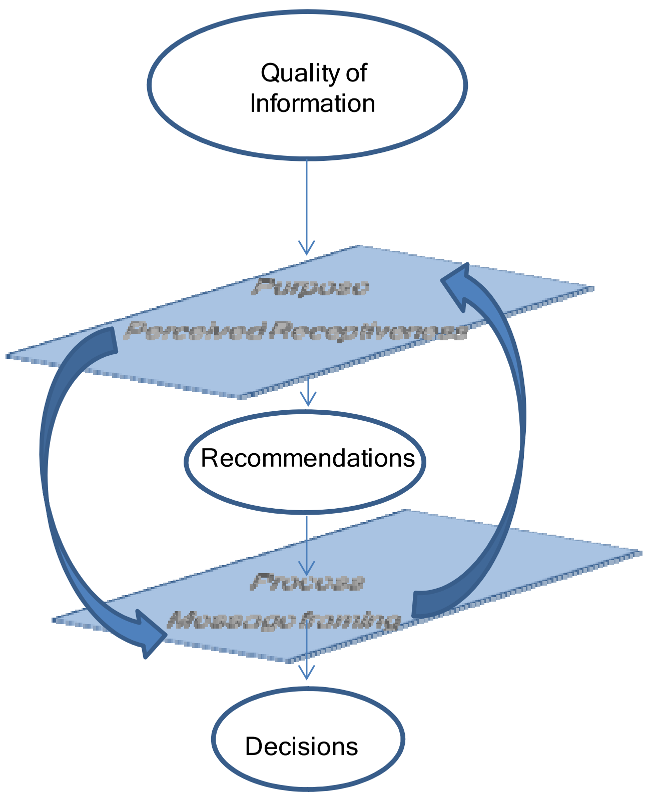


Figure 6.1 Elements that Affect Advice-Giving Strategies

The findings are therefore that the program structure affected the process as it affected the perceived receptiveness of homeowners; that, in turn, affected the advice-giving process and the outcome in terms of the selection of recommendations and how information was framed and communicated to the homeowner. This is shown in Figure 6.1. Figure 6.2 shows an updated conceptual framework which clarifies how the program structure affected the process of participation in a home energy evaluation, and this clarifies how the program structure impacted advice-giving. Figure 6.2 illustrates that preconceived ideas and interests were formed prior to signing up for an evaluation, and that perceived receptiveness of homeowners and perceived purpose of the evaluation by the advisor mediated the recommendations, and that the process of the evaluation and message framing appears to have affected the decisions made by homeowners.

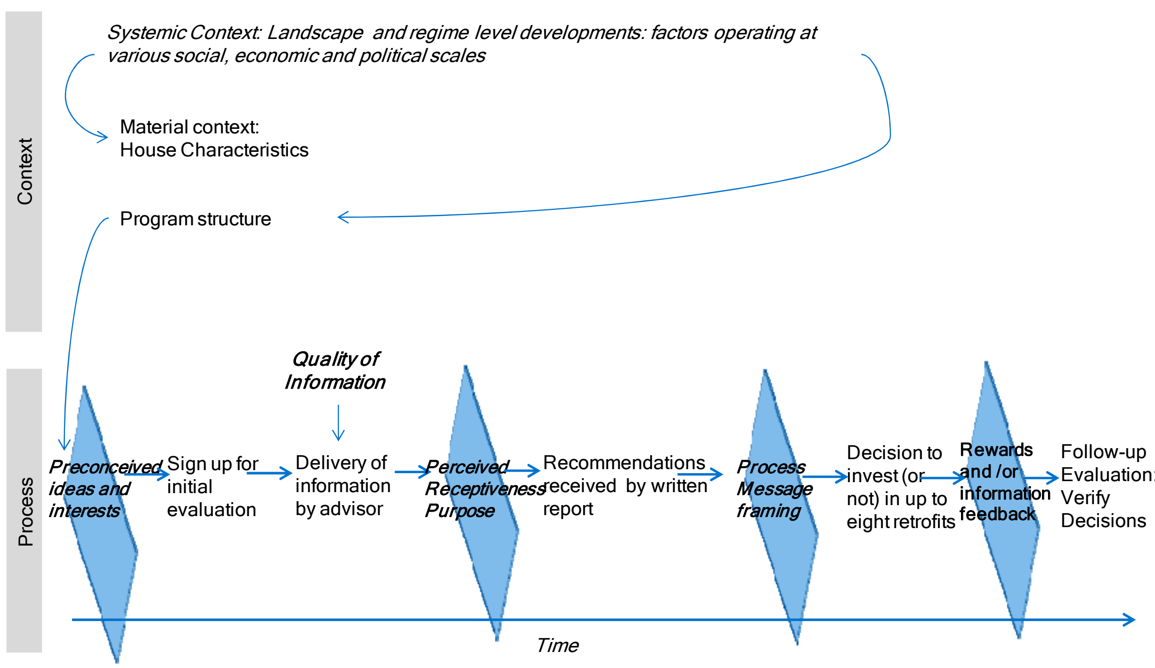


Figure 6.2 The Relationship between Program Structure and Advice-Giving

6.3 Advice-giving Strategies

As described in Section 5.2.2, the advice-giving strategy was guided by the importance of quality of information. The advice-giving strategy varied by advisor, and was affected by the relationship between the perceived receptiveness of homeowners, the purpose of the evaluation, the framing of the messages, and the process of the evaluation.

The programs were designed to focus on the science of "the house as a system" (Office of Energy Efficiency 2007). This could be what unified advisors' views on the importance of recommendations; advisors in fact had diverging backgrounds, diverging environmental norms, and diverging views on messaging, but for the most part, similar views on the relative importance of each decision in terms of the energy performance of each house.

In terms of message framing, overall, all advisors described a preference for using scientific or economic statements. Many advisors expressed a preference for scientific statements over loss or gain framed statements. Advisors generally expressed a preference for scientific or economic statements over comparative or environmental statements. This finding is in agreement with Nolan et al. (2011) who found that advisors preferred financial over normative messages, even after being exposed to information that describes the effectiveness of normative messages. Of loss-framed and gain-framed statements, advisors generally described a preference for gain-framed, and seemed evenly split over whether to advise energy savings, savings on energy bills, or both. Few advisors discussed using vivid messages; however, advisors tended to employ techniques that were vivid during the evaluation process or during a leak hunt that occurred during the blower door test. The use of messages that incorporated stories about themselves or other homeowners seemed to have been more common if an advisor reported that they usually conducted both the initial and follow-up evaluations for each house.

In Chapter 4 it was shown that as the number of recommendations increased, so did the mean and median number of changes made, although the rate of increase was faster for Period 2 than for Period 4. However, Chapter 5 showed that this does not necessarily hold amongst advisors.

Further, advisors who generally gave more recommendations did not necessarily make deeper recommendations to improve the energy performance of the house. While more recommendations were associated with more changes, it is interesting to note that the advisors who gave more recommendations were not necessarily associated with homeowners making more improvements. This shows that the number of recommendations is an important influence, but it does not appear to be sufficient to achieve more changes and deeper improvement to the energy performance of the house. The other factor of importance is how the information was delivered; hence, the advice-giving process is also an important factor in influencing pro-environmental decisions. Again, this shows that both the style of advice-giving and the program structure affected advice-following. However, it is unclear if there is a relationship between the two variables on the outcome of the number of changes made.

Table 6.1 summarizes some of the contrasts in advice-giving among six advisors: Advisors 3, 8, 9, 12, 14, and 15. These advisors either gave or achieved the deepest and/or the highest number of recommendations or achievements, and therefore should be examined more carefully. The largest contrast was that Advisor 15 was associated with deep changes to energy performance and more changes achieved than other advisors across vintage groups in Period 4. Meanwhile, Advisor 12, who was not interviewed, was associated with the most recommendations in Period 4, but not the most changes or the deepest improvements to energy performance. The other advisors varied in terms of depth of recommendations and depth of improvements. Of the advisors interviewed, in Period 4, Advisors 9 and 15 appear to have advised houses that achieved the deepest improvements and Advisor 15 with houses which made more changes.

The approach that Advisor 15 described can be related to a social learning model: he generally invited homeowners to come along, and when they focused on certain decisions which might not improve energy performance as much, he described explaining differences between alternative decisions and discussing the pros and cons of each specific decision. Advisor 15 described using gain framed messages as “all part of the conversation”, he did not use loss framed messages, as he said they were aggressive. He also affirmed that he would discuss other houses and homeowners with homeowners. Advisor 15 also described the report as a blueprint for changes to be made in the future. However, it should be noted that Advisor 15 was also a solar advisor. Studies have examined for differences between solar adopters, potential solar adopters, and non-adopters (e.g., Labay and Kinnear 1981; Keirstead 2007) and found difference, hence, a subset of the homeowners advised by Advisor 15 might also have had a different disposition and material characteristics of their houses.

Advisor 9 described using a combination of loss- and gain-framed messages, depending on the situation. He described discussing other homeowners and houses to homeowners, and using vivid messages to communicate, incorporated following and troubleshooting energy problems into the evaluation. His described strategy was to give information on what was important. Advisor 9 considered the report as a long term blueprint for homeowners to follow over time.

Advisor 3 recommended deeper changes to energy performance during Period 1.1, and the houses that returned achieved deeper changes. Advisor 3 was also associated with deep, but not the deepest, recommendations or most recommendations in Period 4. Advisor 3 also described viewing the report as an important tool for homeowners. However, Advisor 3 did not necessarily involve homeowners in the process of the evaluation and used the report to outline prioritization or trade-offs between decisions.

Comparing these three advisors, one notable difference is whether the pros and cons of decisions with less or no priority were discussed in person or in the report. This could be a topic of future research. It can be noted that the advisors who recommended many changes (e.g., Advisor 12) or larger depth (e.g., Advisor 14) were not necessarily associated with better outcomes; it appears that depth and number of recommendations may not be sufficient to achieve deeper improvements. The social learning model employed by Advisor 15 warrants further implementation and testing.

	Advisor 15	Advisor 9	Advisor 3	Advisor 12	Advisor 14	Advisor 8
Type of Message	Gain framed messages Comparative messages No loss framed messages No vividness messages of objects	Loss framed messages Gain framed messages Comparative messages Vivid statements	Scientific messages Gain framed messages (save money) Measurements, not vivid statements			
Engageme nt	Engagement of homeowners throughout Discusses pros and cons of any decision	Engagement of the homeowner Troubleshooting	Focus on measurement, sometimes more engagement with homeowners			
Recommendations and Report	Keeps the report to what is important Solar evaluator Not associated with most recommendations or deepest recommended reductions	Keeps the report to what is important Not associated with most recommendations or deepest recommended reductions	Pros and cons contained in the report with recommendations Bring houses to a modern level of energy performance (minimum 75 energy rating) Deepest recommended improvements and most recommendations in Period 1	Most recommend-dations in Period 4	Deepest recommended change to energy performance in Period 2	Least recommend-dations in Period 2 Some of the deepest recommendatio ns in Period 4
Homeowner Achievement	Deepest improvements to energy performance More changes achieved than other advisors across vintage groups in Period 4	Deepest improvements to energy performance	Deep, but not deepest improvements to energy performance in Period 4 Deeper improvements to energy performance in Period 1.1, and more changes for some vintage groups Deeper changes in Period 2	Neither the most nor the least number of changes, nor the deepest changes in Period 4	Most changes Period 2 1961 to 1980	Deeper changes in Period 2 and in Period 4 Most changes overall in Period 2

Table 6.1 Summary of Advice-giving Strategies and Results

6.4 Specific Decisions

In the literature review, it was described that Bird (2006) has argued that each retrofit poses its own sets of barriers; hence, retrofit decisions merit separate examination as different decisions rather than as one decision or part of a whole. Bird (2006) found that barriers to furnace and basement retrofits were markedly different. Darby (2006) argues that procedural knowledge and know-how are a necessary component in increasing home energy retrofits. Darby's model describes how the tacit knowledge required to carry out renovations increases in time and is related to the ability to learn unaided combined with information feedback and action. Furthermore, Peattie (2010) described that consumption should be understood as a process with several stages of decisions or behaviours to be studied. This research contributes to expanding the process-based perspective as it examined the timeframe of the number and type of decisions taken. A summary of findings about the five key decisions is shown in Table 6.2, and presents them in terms of participation in the programs, and how they were treated during the process of advice-giving and advice-following. These five decisions are heating systems as "drivers", basement insulation as "determined", wall insulation as "discouraged", window replacement as "distraction" and reduction of air leakage as "duo"[36].

6.4.1 Homeowner Decisions and the Process-Based View

Focusing on the decisions in Table 6.2, some of the differences can be discussed in more detail. For example, heating systems and air sealing were measured as changed in nearly any timeframe, whereas, the majority of decisions to improve insulation to basements and walls, and to replace windows, were associated with longer timeframes. Many of the households that completed these changes returned to the program in the timeframe of 15 months or longer.

Homeowners exhibited preferences for the five decisions in different combinations: heating systems were the most common single change. Air sealing and heating systems were changed more often than other changes when houses had two changes. Air sealing, heating systems, and changes to windows and doors was the most common combination when three changes were made. Advisors described heating systems as a typical driver of homeowners into the programs, and windows as a typical distraction. These observations were somewhat confirmed by the order of preference that was revealed by comparing the decisions made to the number of changes made.

[36] Recommendations to change hot water heater and heat recovery ventilators did not seem to be a motivator and very few changes were made, so these were not included in the analysis.

Windows and heating systems were preferred action items by homeowners and were commonly changed by homeowners. This finding is in agreement with Gamtessa and Ryan's (2007) analysis of national level data from the EnerGuide for Houses from 1998 to 2006. Among the eight decisions that could be made, their analysis chart shows that windows/doors and heating systems were changed with the highest frequencies.

The decisions to add insulation to walls and basement were made less frequently, were more commonly done in combination with other changes, and were associated with longer timeframes between evaluations. Many advisors pointed out that homeowners lacked procedural knowledge to make these changes, and that homeowners were aware of their own lack of knowledge; a typical question from homeowners was about how to make these changes. As Advisor 9 noted, homeowners wanted someone else to take responsibility for the renovation. These findings back up Darby's (2006) view that procedural knowledge and know-how are a necessary component in increasing home energy retrofits. This finding contributes to a process-based view of a home energy retrofit. These findings also may confirm the prospect theory view on trade-offs. According to prospect theory, when an internal standard exists, a decision is easier to make, but otherwise the decision is avoided. In this case, the lack of procedural knowledge appears to increase uncertainty, and homeowners therefore avoid the decision.

Adding to the process-based view is the finding that the number of changes made were positively associated with increase in timeframe, even if the number increased more slowly under the list-based financial reward program structure of Period 4, than the performance-based reward structure of Period 2. Hence, different than prospect theory, the recommendation of more changes was not a deterrent to homeowners, and in Period 2, was a motivator.

Another finding that contributes to the social learning perspective was that the small group of homeowners who were measured to engage in decision patterns that were incongruent with recommendations took more time and made more changes. This pattern of decision making could be argued to represent differences of opinion with the advisor. This pattern of decision making could also represent an information search pattern that represents the ability to learn unaided and the accumulation of information. It appears as though this group did take time to engage and make changes as a process, and this group appears to have engaged in an effective strategy of decision making to achieve more retrofit changes. Thirty-one homeowners were verified as belonging to this group, however, other homeowners may also have engaged in more active decision making patterns although it was not verified in the data.

Overall, it is seen that longer timeframes were associated with more incongruent patterns of decision making, with more changes made, and with more effective and economic changes (i.e., insulation to walls and basements). The findings appear to support Darby's (2006) and Bird's (2006) views that it is more appropriate to view home energy retrofits as a process associated with learning from advice, experience and may support the importance of information searches.

6.4.2 Advice-giving Strategies and Decisions

The described prioritization of decisions by homeowners did not match the prioritization that advisors gave to the eight decisions. Advisors typically described homeowners' interest in windows as a distraction. According to advisors, homeowners were focused on changing their windows, and did so even when advised not to. Most advisors would prefer to see homeowners upgrade the building envelope prior to changing windows or the heating system. However, many advisors saw the value in changing a heating system, particularly when there was risk of imminent failure, or when there was potential to gain a significant improvement in efficiency, but advisors for the most part agreed that windows are expensive and do not present a sufficient improvement in energy performance to justify the investment.

It is interesting that advisors held this perception and knowledge of homeowners, but also described a marked preference for economic statements. Some advisors discussed a preference to give homeowners the information, and discuss pros and cons, but in their view, ultimately it was the homeowner's choice. None of the advisors discussed that if a homeowner did invest in windows, that this would be a diversion of funds and time away from improvements which have a greater effect on energy performance. If windows are as expensive as the estimates given ($10,000 to $20,000), and associated financial rewards as low as estimated by the home energy advisors[37]), homeowners diverted significant funds towards windows, a choice that would not be considered as rational with respect to energy savings from an economic viewpoint. Advisor 11's perceptions were in greatest contrast with homeowner actions: he recommended windows if they were a preconceived focus of the homeowner because he expressed the belief that at the expense that windows presented, chances of

[37] Some advisors reported approximately $50 as a financial reward for windows during Period 2, while approximately $80 was offered per Energy Star window installed in Period 4.

the windows being changed were slim to none. This again highlights and agrees with findings outlined by Nolan et al. (2011) that even though financial statements are found to be less effective, experts prefer to use them with homeowners.

The finding of lack of economic rationality is in agreement with findings of Aydinalp et al.(2001) and Fung et al. (2007) that homeowners did not make the most economically efficient decisions and rarely achieved the recommended energy savings.

Advisor EEE3 sums up well the negotiation between advisors and homeowners over windows and how it can be hard to alter decisions:

> Sometimes you've got to be a little bit persuasive in making your recommendations for improvements because sometimes their vision for what they want to do may be a little bit skewed. As an example, windows. I mean, I get solicitations, I don't know about you, but I get solicitations every second or third day, you know, "we're in the area. We're looking to upgrade windows to houses, would you like to upgrade your windows?" Well, I don't need to upgrade my windows but a lot of homeowners they call us and say "well I want to change the windows to my house". But windows are a very small impact from the whole energy impact but they're very frankly expensive, and so sometimes I'm going to suggest you might be better to put your money to other areas other than windows or if you're going to change your windows, work on a five year plan, and change the ones that can have the greatest impact as far as that's concerned, basements, second floors, that sort of thing, along the way. But sometimes they'll say "Oh, all I want to do is change my windows." (Advisor EEE3)

Within this negotiation of where homeowners should focus their attention, some advisors described hesitation to recommend wall insulation, as they believe that it is too disruptive a retrofit, and that homeowners would not make this change. Some advisors described that they might not recommend insulation to the basement if it was finished, even if insulation would greatly improve the energy performance of the house. However, for both wall and basement insulation, the findings are that the more often it was recommended, the more often it was done, even if the frequency of changes made was generally low. In general, the analysis shows that it is better to recommend wall and basement insulation in the report if it makes an important contribution to improving energy performance of the house. Even when advisors highly recommended the prioritization of the building envelope, these decisions tended to be a lower priority for homeowners and associated with more time. Wall and basement insulation were also the changes that were made the most poorly (as a percent of the recommended change), and this is could be related to the observation of advisors that homeowners lacked the procedural knowledge to accomplish these. This could also be because homeowners decided to take action only on a small portion of the area, for example, they only insulated on wall, or one room, or the basement header, and this possibility implies a lack of time to complete more insulation retrofits.

The knowledge that a house functions as a system, where one change can affect the balance within the house, appears to have been one of the biggest barriers to homeowners in gaining procedural knowledge. The heat recovery ventilator (HRV) is the improvement which mediates this balance in the house, impacting health and comfort. However, a lack of understanding on the part of homeowners was shown as the least implemented decision and advisors generally agreed on a perception that homeowners were resistant to the suggestion of implementing an HRV.

In terms of advice-giving, the results seem clear that if an advisor believes that windows will not provide sufficient energy savings and might distract homeowners from more effective retrofits, it is better to keep windows off the list in the report and to discuss other options as well as the pros and cons of windows in person. This may not change all homeowners' minds, but it appears to be the most effective means to reduce the frequency of this action.

Decision	D	Timeframe	Description
Heating system	Driver	Changed nearly equally across timeframes; can be changed within nearly any time frame.	• Advisors agreed the heating system has a great impact on improving a house's energy performance. • Some advisors prioritized it after the building envelope (decisions 1 to 5) • Advisors perceived the heating system as a driver for homeowners to participate in the program when there were rewards, sometimes due to recommendations by furnace installers. • Appears to have been a motivating factor to return. The mean recommended change to natural gas furnace efficiency was higher for all follow-up groups than initial only groups. Larger share of homeowners changed than other decisions and to a higher degree in periods with financial rewards. • The most frequent change if one thing is changed but also changed in combination with other changes.
Basement insulation	Determined	Longer timeframes Period 2: 54% achieved in 15+ months Period 4: 44% achieved in 15+ months	• Advisors agreed that insulation to basements was a large opportunity to impact a house's energy performance, but they generally agreed that this is usually a more achievable opportunity. • Basement insulation was often advised. • Rates of recommendations were highest for the oldest vintage groups. Recommended 35 to 90% of the time across periods. • Next to air sealing, insulation to basements had the least variation in frequency recommended by advisor. • Some advisors avoided recommending to finished basements. • Did not appear to affect the decision to return for a follow-up evaluation (no differences found in depth of recommended change between initial only and follow-up). • Was not done unless advised, and those achieved reached a low proportion of what was advised. • Rarely changed alone, typically changed in combination with other decisions.
Wall insulation	Discouraged	Longer timeframes Period 2: 59% achieved in 15+ months Period 4: 42% achieved in 15+ months	• Advisors generally agreed that for older houses, the building envelope, including wall insulation, was an important measure to improve energy performance of the house. • Overall, across periods, walls were the decision recommended the least often. • Frequency of recommendations of wall insulation by advisor had the highest variation of all recommendations. • Some advisors recommended frequently to older vintages because it is important, others did not recommend because it is disruptive, or as a strategy to choice edit and focus homeowners' attention on basements. • A large percentage of decisions were "recommended not changed". • Higher percentage of wall recommendations was associated with a higher percentage of changes made. • Changes were typically at a poor level of achievement (majority changed were <50% of what was recommended).

Table 6.2 Summary of Findings on Five Key Decisions

Decision	D	Time Frame	Description
Window replacement	Distraction	Longer timeframes Period 2: 56% achieved in 15+ months Period 4: 41% achieved in 15+ months	• Strong agreement amongst advisors that windows are costly retrofits and do not generate enough energy savings to justify the cost in energy terms. Costs cited at $10,000 to $20,000 by various advisors. • General perception that homeowners were interested in changing windows, some for convenience, some for normative reasons, and sometimes there is the belief that homeowners justified the cost as an energy benefit. • Recommended more often in Period 2 and Period 3. • Wide variation amongst advisors in the percentage of houses to which windows and doors were recommended. Some advisors recommended fairly evenly across vintage groups. • Most advisors preferred that homeowners invest in insulation in the basement rather than windows. • Some advisors added windows to the report if it was a preconceived idea of the homeowner. Some described the differences in savings between windows and basements in the report. Some discussed the differences, but do not put windows in the report. • When windows were less often recommended, they were less often changed overall, but a higher percentage of decisions were "changed not recommended". Overall, the largest percentage amongst decisions of "not recommended and changed" (5 to 10% across periods, less than 5% to 30% across advisors) • When windows were more often recommended, they were more often changed, with a high percentage of decisions of "recommended and not changed", i.e., homeowners who changed their minds. • Typically were changed in combination, and commonly done if three or more changes were made.
Air leakage	Duo	Changed nearly equally across timeframes; can be changed within nearly any time frame.	• Air tightness due to air sealing should be balanced with improved ventilation with a heat recovery ventilator. • Advisors agreed that proper air sealing can lead to large improvements in energy performance. However, there was some agreement over the difficulty in achieving an effective level of air sealing. • Co-benefits with insulation–insulation can reduce air leakage, and air sealing can improve insulation. • The most vividly recommended, either with blower door test, feeling drafts with hands, and searching for cobwebs. • Across periods, 55% to 85% changed, and approximately 30% changed to the level recommended. • Typically done in combination, and commonly done if two or more changes were made.

Table 6.2 Summary of Findings on Five Key Decisions (continued)

6.5 Triangulation with Other Studies

This dissertation examined the actions taken by homeowners in a home energy evaluation program in response to different program structures and different styles of advice-giving. Chapter 2 summarized several studies that examined REEP's delivery of the EnerGuide for Houses and ecoEnergy programs between 1998 and 2010. In this interpretation stage, the results of this study were compared to those of other studies using triangulation. The results provided another perspective about homeowners' self-perceptions of what information is important to them. In particular, the results of this research call into question either the perceptions or representativeness of the samples in the studies done by Gilby (2010) and Scott et al. (2001).

In 2000, Scott et al. (2001) delivered a survey to REEP participants to gain an understanding of their motivations and actions. In 2010, Gilby (2010) delivered a similar survey to a subset of REEP participants, and additionally, compared results to those from 2000. Both surveys were delivered to participants at the stage of the initial evaluation, and Gilby's (2010) received 71 responses which were compared to 198 responses received by Scott et al. (2001) in 2000. A summary of the relevant survey findings from Gilby (2010) and Scott (2001 as they appear in Gilby 2010), are shown in Figure 6.3, Figure 6.5, Figure 6.4 and Figure 6.6. It should be noted that responses of "very important" and "important" were combined for a clearer differentiation between "not important" and "important". Gilby (2010) found that attitudes and behaviours remained similar in participation groups separated by 10 years.

On average, the participants in the 2010 study had been living in their house for close to 10 years and expected to live there for roughly another 32 years (Gilby 2010). In 2000, an increased resale value of the home was not commonly selected as an important motivation to improve the house's energy efficiency (Scott et al. 2001 as they appear in Gilby 2010).

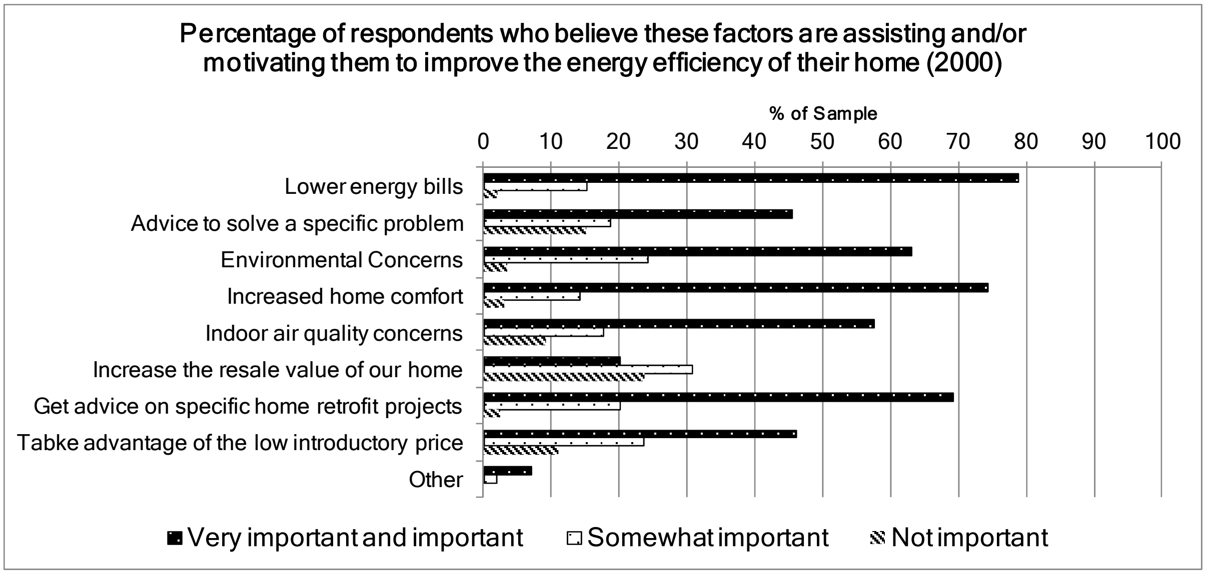


Figure 6.3 Motivations to Improve Energy Efficiency (Scott 2001 as reported in Gilby 2010)

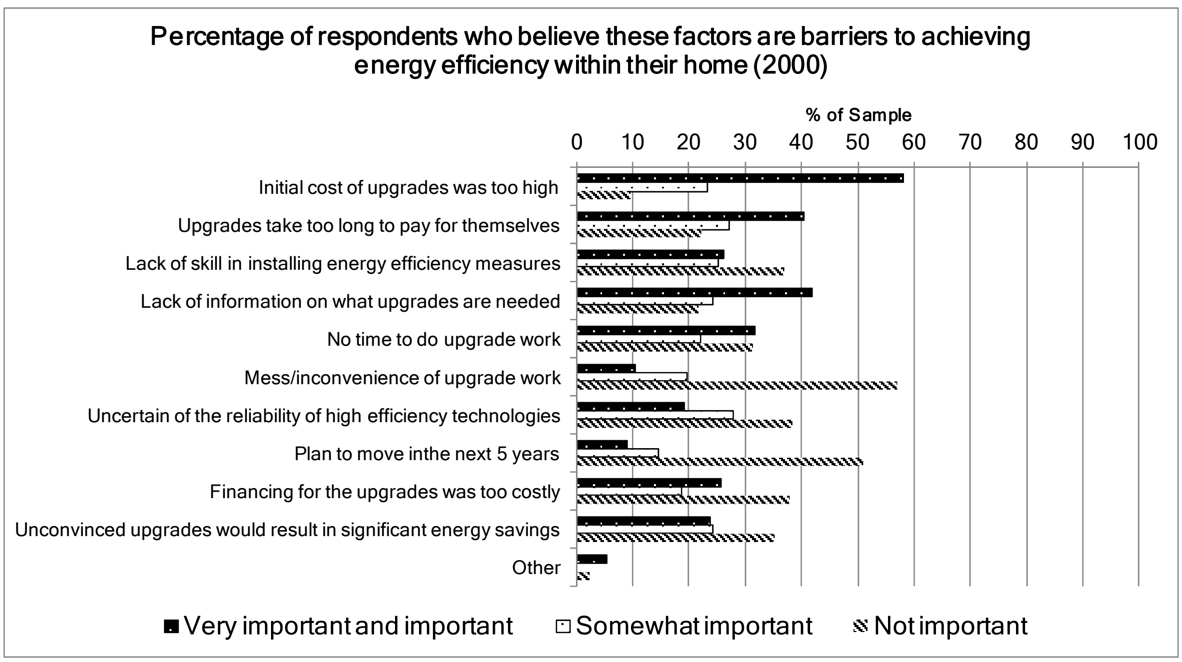


Figure 6.4 Barriers to Achieving Energy Efficiency (Scott 2001 as reported in Gilby 2010)

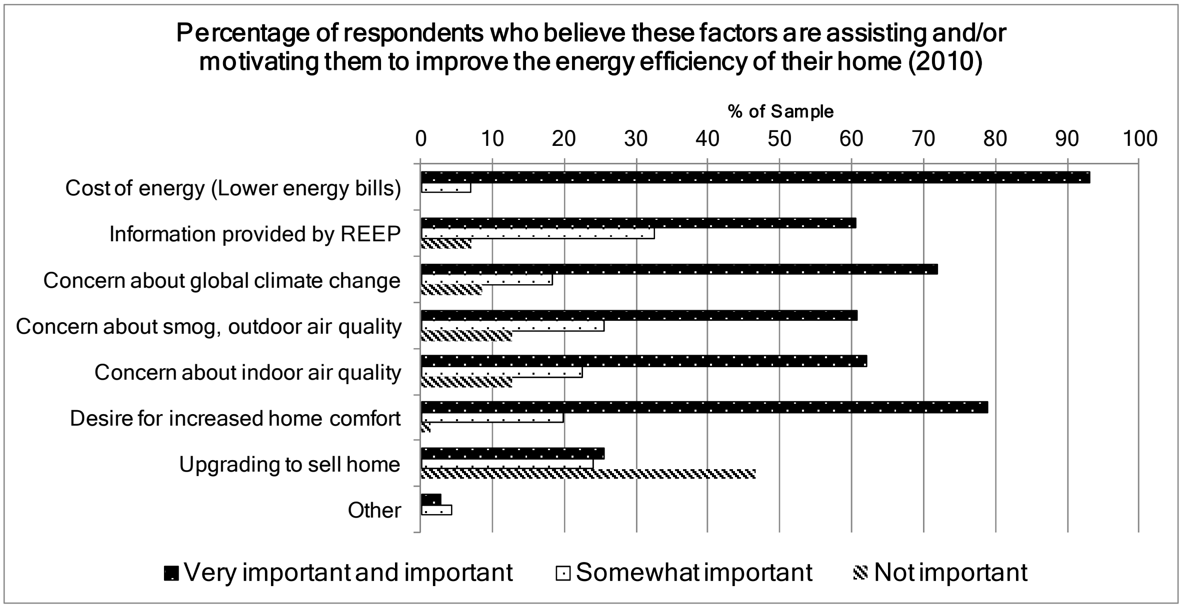


Figure 6.5 Motivations to Improve Energy Efficiency (Gilby 2010)

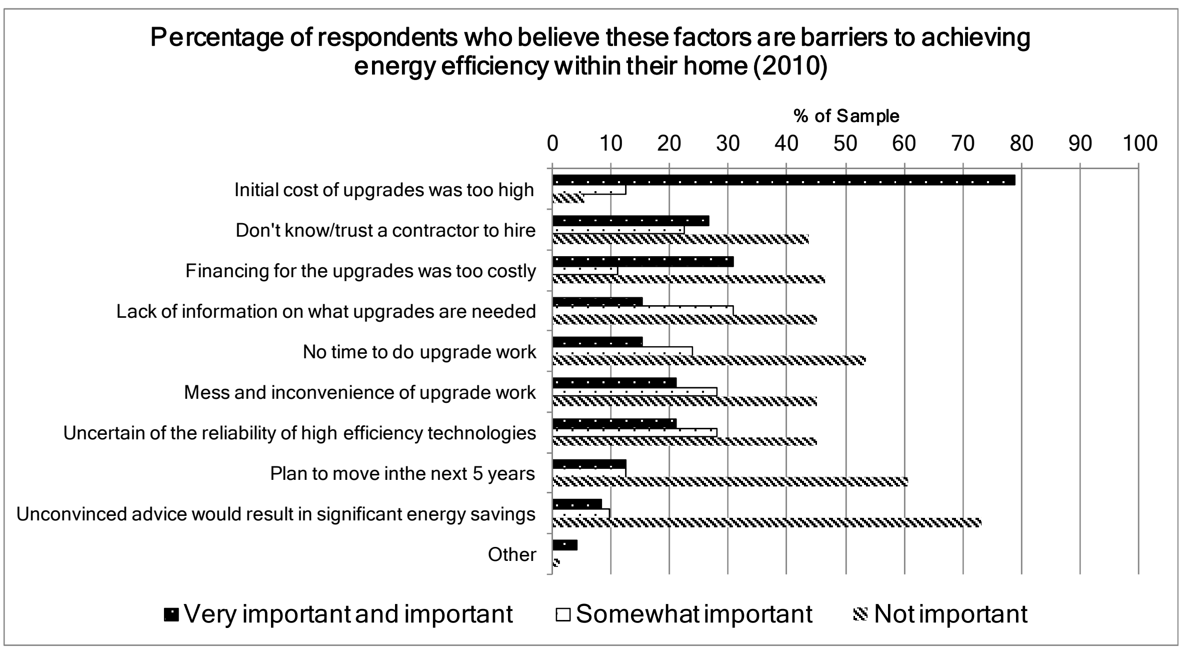


Figure 6.6 Barriers to Achieving Energy Efficiency (Gilby 2010)

Many of the results presented in Gilby's (2010) study are in contradiction with the findings of this study. According to advisors, improvement to the building envelope (all decisions except windows) and managing the ventilation were the decisions most often associated with comfort. In this dissertation, most advisors reported discussing decisions that are related to comfort with homeowners (e.g., insulation, HRV). In Gilby's (2010) study, homeowners claimed to be motivated by comfort. Meanwhile, the findings from Chapter 4 and 5 demonstrate that homeowners did not predominantly make decisions that the advisors related to a significant improvement in comfort in any period (at least associated with energy efficiency). It could be that homeowners interpreted comfort in a variety of ways: not just personal comfort in the home related to temperature, but also as comfort in reducing the amount of effort they exerted. It could also be that homeowners interpreted comfort as feeling drafts by the windows. However, the home energy advisors who encountered this said they often tested the windows for air leakage, and found none. One advisor mentioned that drafts around windows had to do with the installation of the window, not the window itself (Advisor EEE1).

In the studies by Gilby (2010) and by Scott et al. (2001), homeowners also expressed concern for indoor air quality. However, advisors reported a low level of interest by homeowners in learning about the house as a system and in installing a heat recovery ventilator. Several advisors described that they explained to homeowners the health benefits of installing a heat recovery ventilator. The quantitative analysis confirmed the advisors' perceptions by showing that homeowners rarely invested in heat recovery ventilators.

As reported in Figure 6.3 and Figure 6.5, concern for the environment was listed as "important and very important" by the majority of participants in the studies by Gilby (2010) and Scott et al. (2001). Meanwhile, in this study, advisors reported that they rarely, if ever, discussed environmental concern with homeowners in Period 4, as it did not seem to gain traction in the discussion. Homeowners also less often implemented the decisions that advisors understood as more environmentally sustainable.

The contradictions that are presented here call into question some of the homeowners' perceptions of their own motivations, or the advisors' perceptions of homeowners' motivations, their ability to improve comfort, or their learning capacity understood as their capacity to process information. Another possibility is that it reinforces the observation by Bird (2006) that that each retrofit poses its own sets of barriers; hence, retrofit decisions merit separate examination as different decisions. It could also be that there was self-selection within the subsets of surveys returned: perhaps those with more environmental and economic motivation returned the surveys.

The findings in the studies by Gilby (2010) and Scott et al. (2001) about barriers to improvements are in agreement with the results presented in this dissertation. This study found that time was an important factor in implementing several decisions, which is in agreement with Gilby's (2010) findings that time is a barrier. The homeowners surveyed in the studies by Gilby (2010) and Scott et al. (2001) reported that the disruptiveness of some retrofits is a barrier, and the advisors who were interviewed in this study agreed with this. One of the findings from Bird's (2006) study was that "Focus group participants expressed the relative ease involved with arranging a furnace installation. As one noted, 'You just call one day and the next, they're there.'" (42). These findings may in part explain why a change to the heating system was the most typical single decision made, and made within nearly any timeframe. An interesting finding from Gilby's (2010) study to also consider was that homeowners did not consider "no time to do upgrade work" to be an important challenge. The findings on the insulation show that there was not enough time; these responses may have been related to the preconceived ideas of heating systems and windows.

Another contradiction found between the studies was that the surveys found that homeowners perceived the lack of financing as a barrier. A finding of this research was that windows were a favoured retrofit and that they represent a high upfront investment coupled with a small financial reward. REEP does have more detailed data for Period 4 and further research could examine the specificity of window decisions and determine the extent of the changes of windows, for example, exactly how many were changed and the type installed. This might clarify the extent of the investment in windows. However, the two results appear to contradict each other.

Another contradiction, or omission, found between the studies is that advisors perceived homeowners to have little knowledge of how to perform retrofits and how their house works, whereas, this did not emerge as a major concern on the part of homeowners in the surveys. A key gap between homeowner and advisor motivations is that gaining knowledge was not the highest priority as motivator for homeowners, whereas, teaching was a common motivation amongst advisors. Not knowing or trusting a contractor was not top of mind as concerns for homeowners, but these were concerns strongly expressed by the advisors. Furthermore, in the case of advisors who considered that the improvement of wall insulation would cause mess and inconvenience, mess and inconvenience was listed more frequently as “unimportant” than “important and very important” by homeowners in both studies. Advisors might alter their perception about whether this is a barrier.

Bird’s (2006) findings from focus groups were that homeowner perspectives supported the provision of economic information support decision making (e.g., payback, etc.). This presents a potential self-contradiction of homeowners’ self-perceptions of what their information needs are. In this study, advisors reported that they gave this information to homeowners informally, but homeowner decisions demonstrated that they did not necessarily apply this information to decision making.

These findings point to some form of incongruence between perceptions and reality. This incongruence may be a difference in homeowners’ perceptions of their own needs or desires and the needs and desires that they act on. This incongruence may be between advisors’ perceptions of homeowners’ motivations and the actual motivations of homeowners. The incongruence between what advisors reported to have told homeowners and homeowners actions and stated motivations may be due to a lack of ability by homeowners to process the information given to them during the evaluation. As reported in the literature review, many studies and policies favour a rational choice model and economic theories of behaviour. The advisors and homeowners both perceived that homeowners required economic information to better inform decisions. However, this analysis demonstrates that homeowners did not necessarily make decisions that maximized energy savings per cost, and this implies that other forms of rationality may have affected their decisions. For example, these other forms of rationality could involve goals besides saving energy, such as improving the appearance or performance of windows, regardless of the opportunity for better energy or investment returns on other potential upgrades.

Attitude, behavior and context theory states that context plays a large role in tipping the balance towards whether a decision is acted upon. That is, the decisions that are valued are influenced by forms of rationality which are influenced by knowledge or heuristics of decision making formed in different contexts. Hastie (2001) describes that there is no overarching theory of decision making. Rather, context can affect decisions in a variety of ways. Shrader-Frechette (1990; 1991) argues that scientific knowledge cannot be considered neutral and unbiased, and therefore cannot be relied upon to make the best decisions for society. Which decisions are deemed better or worse is different dependent upon the type of rationality employed to evaluate the decision. Indeed, Morgan et al.

(2004) confirm that the mental models upon which experts form opinions and decisions are different than those of non-experts. The mental models approach is important to explore and understand the factors that influence decisions and how to better communicate to influence those decisions. Therefore, this research confirms that there are different barriers associated with each decision, but further research should examine more carefully the context of these decisions.

Overall, contradictions between the findings of this study and those of studies that surveyed participants of REEP's programs call into question the method of self-reporting. The contradictions also call into question the self-perceptions of homeowners of what motivated them in various decisions. Other methods of eliciting this information may be more useful.

6.6 Summary

In summary, different retrofit decisions were associated with different processes of decision making and affected by different barriers to action. The study shows that program structure and advice-giving were both important factors that influenced participation in a home energy evaluation program. Further, program structure influenced advice-giving as different types of homeowners with different types of houses responded to each program structure, and this affected the advice-giving process. The advice-giving process is an important factor in influencing pro-environmental decisions, and a social learning model of advice-giving, qualified by discussion of pros and cons, involvement, and trouble shooting, is associated with deeper and more changes made by homeowners. An increase in the specificity of decisions and material context greatly enhanced the quality of analyses and findings. Finally, the comparison of verified decisions and homeowner survey responses raises contradictions between homeowners and advisors' perceptions of homeowners' motivations, or points to homeowners' difficulty in processing information. The broader implications of these findings are discussed in the conclusion in Chapter 7.

Chapter 7
Conclusion

The objective of this dissertation was to assess the importance and effects of two factors on pro-environmental behaviour. The conceptual framework presented in Chapter 2 included the factors and literatures that are most relevant to understanding how an advice program influences residential energy efficiency retrofit decisions. This research makes contributions in several key areas. The first is that it gives a better understanding to the path dependency of energy consumption behaviour. The second is that it shows the importance of both behavioural and social learning approaches to addressing pro-environmental behaviour. The third is that this dissertation contributes an example of the application of an integrated approach to evaluate the importance of various influences on pro-environmental behaviour, which is achieved by combining a cross-disciplinary research approach with a mixed methods research design. While the findings of this dissertation explain the relative importance of the program structure and advice-giving as they affect advice-following, the findings reveal many new areas for future research and useful application in practice. This chapter describes the usefulness of these findings and the conceptual framework to researchers who investigate a wide range of topics related to consumption and pro-environmental behaviour. The suggested further areas of research are focused towards further clarifying the importance of factors as they influence pro-environmental behaviour or affect the context presented in the conceptual framework, or towards further clarifying Peattie's (2010) six-stage process of consumption.

7.1 Better Understanding Path Dependency of Behaviour

In Chapter 1, a critical question that researchers of climate change mitigation grapple with is presented as: *What factors can lead to a relatively rapid systemic change and deep reductions in energy consumption?* This research contributed to answering this question by developing a conceptual framework that makes the critical link between behaviour and time and frames the behaviour within a broader context. This was achieved by incorporating an impact-oriented definition of pro-environmental behaviour as a process made up of multiple stages. At each stage, the decision can be influenced and affect the outcome. The consideration of depth of reductions in this critical question was addressed in interviews with the home energy advisors. One of the findings of this research was that insulation to walls and basements were considered by the advisors to be some of the most effective retrofits to address the energy efficiency gap and improve the energy performance of the house. That is, an efficient building envelope is a critical step to reduce fuel used for heating and cooling. When the decisions of homeowners were assessed, insulation to basements and walls were not found to be the highest priority amongst the set of eight decisions. Furthermore, the majority of households that made these changes returned after at least 15 months, and they usually insulated their walls and basements to a poor degree compared to what was recommended. Hence, a critical finding of this study was that these programs were not sufficient to alter the path dependence of energy consumption or of energy systems as the program participants usually did not implement the most effective retrofits, and if they did, the retrofits did not achieve adequate depth of reductions to energy consumption in a timely manner.

This path dependency of behaviour might be linked to the theory of planned behaviour that was presented in the literature review. According to the theory of planned behaviour, once an intention is formed, it is a strong predictor of behaviour (Armitage and Conner 2001). According to the home energy advisors, many homeowners had pre-conceived ideas upon entering the program of replacing their heating systems and windows. The interpretation of the qualitative and quantitative data showed that these intentions were often not altered, particularly in the case of windows, the decision that advisors believed to be the least effective of energy decisions. This study appears to confirm the relevance of intentions when analysing energy efficiency retrofit decisions, although these intentions may not relate to pro-environmental norms.

The studies by Scott et al. (2001) and Gilby (2010), and many other studies described in Chapter 2, sought to understand pro-environmental behaviour as motivated by environmental norms. Gilby (2010) used the theory of planned behaviour as a framework of analysis. In contrast, in this study, the home energy advisors perceived that most homeowners were not motivated by environmental concern. The analysis of the quantitative data showed that homeowners did not make decisions that were consistent with the intent to reduce environmental impact in the most efficient manner. In a meta-analytic review of studies, Armitage and Conner (2001) report that subjective norms are the weakest predictor in the theory of planned behaviour.

A critical finding then is that when researchers of pro-environmental behaviour employ the theory of planned behaviour as a framework of analysis, they should not narrow their analysis to pro-environmental intentions; rather, they should acknowledge and describe all intentions associated with these decisions. These findings imply that decisions are formed in different contexts; that is, homeowners may consider and prioritize the information and decisions surrounding a home energy retrofit program for purposes other than energy savings. Therefore, researchers should seek to understand and influence these intentions prior to and during the evaluation, and this will involve consideration of a broader context for each decision.

In seeking to understand how to influence the decisions that the advisors desired to be prioritized by homeowners, researchers might focus on perceived behavioural control. Perceived behavioural control affects both intention formation and behaviour in the theory of planned behaviour, and it is increased by salient beliefs about adequate resources and opportunities and fewer anticipated impediments or barriers (Armitage and Conner, 2001). Armitage and Conner (2001) identify that perceived behavioural control has been measured as: "self-efficacy … defined as 'confidence in one's own ability to carry out a particular behaviour'; perceived control over behaviour … defined as 'perceived controllability of behaviour'; and [perceived behavioural control] … defined as the perceived ease or difficulty of performing behaviour (Ajzen, 1991)" (:479). According to Ajzen (1991), "perceived behavioral control can often be used as a substitute for a measure of actual control" (184). In the case of home energy efficiency retrofits, actual control may be related to the knowledge and ability to carry out renovations or find a contractor, both sets of knowledge and ability that Darby (2006) relates to social learning.

Two intentions that homeowners had formed prior to having a home energy evaluation and that generally did not alter were to improve their heating system and replace windows. In relation to this, it is interesting to note that Bird (2006) described that homeowners reported that they could call the furnace installer who could arrive as early as the next day. Similarly, Advisor EEE3 discussed aggressive window sales representatives who would phone to promote sales. The installation of a furnace or windows were often selected before the initial evaluation, and the homeowner continued along that path even if a more cost effective means of saving energy was identified to them. An important finding of this research is that in order to adequately alter path dependency of energy consumption, researchers should address a broader set of intentions, particularly the intentions that are formed prior to entering the program. Furthermore, researchers should address these intentions at every stage of the process through careful attention to perceived behavioural control.

7.2 Behaviourist and Social Learning Approaches

The central question of this thesis was: how can we better understand how to influence pro-environmental behaviour so that we can develop better policies and programs that effectively reduce environmental impact? One of the major theoretical debates in this area of research is whether behaviourist or social learning approaches are more appropriate and effective in influencing pro-environmental behaviour. The behaviourist perspective, often employed by marketers, is to employ rewards and penalties to affect pro-environmental behaviour, that is, it seeks to create conditions for behaviour change through incentives and disincentives (Takahashi 2009). Meanwhile, advocates of social learning theory argue that people learn from the trial and error of life (Darby 2006), whether learning by counter-example or through the imitation of attractive or influential models (Jackson 2005). The findings of this research contribute to this critical debate, and demonstrate that both approaches are effective in influencing or explaining pro-environmental behaviour; however, it depends on the stage of the process. For example, the behaviourist approach of offering financial rewards was very effective in encouraging homeowners to return for a follow-up evaluation. Furthermore, the availability heuristic is associated with an individual's ability to more easily retrieve information that is presented vividly and more clearly than other types of information that might be considered more objective (e.g., statistics). During the home energy evaluation, most advisors described inviting homeowners to follow them during the blower door test to feel for air leaks and learn more about sealing them. Even though home energy advisors tended to agree that air sealing is difficult to do well, this decision was associated with a high number of improvements that were implemented at a high level of achievement compared to the recommendation. On the other hand, prospect theory, which predicts that more choices would result in fewer decisions, was not held up as an appropriate explanation in the case of the eight competing options; under the performance based financial reward structure, as the number of recommendations increased, so did the proportion of homeowners who returned for a follow-up evaluation; and the more recommendations that homeowners received, the more recommendations they followed.

Information, as delivered by the report, can be considered as providing visibility within the information deficit model to raise awareness. However, information presented in the report was not sufficient for action to occur; it was found that social learning approaches used during the evaluation, based on the strategies employed by the different advisors, appear to be more promising as a way to encourage homeowners to focus on more effective improvements. The social learning model is also somewhat supported in that advisors claimed that homeowners required knowledge to carry out renovations to improve insulation; these types of renovations were typically associated with a follow-up evaluation that took place after longer time periods. This may have been associated with a higher level of difficulty to gain procedural knowledge and take action. The method of delivering the blower door test and asking homeowners to search and feel for air leaks may also have been a component of social learning, as most advisors described the problem and the solution in detail at its location to homeowners, and this could be why homeowners prioritized air sealing as the second most common decision, and tended to implement it to a high level of achievement compared to what was recommended. Advisors described the lack of understanding by homeowners of how a house operates as a system as a barrier to decisions such as the installation of a heat recovery ventilator. If this lack of knowledge is a barrier to action, then social learning approaches provide the most promise as an intervention to diminish it.

7.3 Contributions to Methodology in Analysing Pro-Environmental Behaviour

The final major contribution made by this dissertation is to the challenge of employing an integrated approach that contributes to better understanding the relative importance of influencers of pro-environmental behaviour when it is understood as a process. This study confirmed the value of taking a cross- or interdisciplinary perspective when employing an integrated approach as a framework of analysis. These contributions to methodological approaches were made in two ways: with the development of a conceptual framework and with the use of a convergent mixed methods research design. The importance of these contributions should not be limited to analyses of energy consumption; indeed, the framework of consumption as process was adapted from Peattie's (2010) approach that addressed all forms of consumption. Furthermore, this thesis demonstrates an appropriate form of integration and a model of analysis of a convergent mixed methods research design that can be employed to analyse all types of consumption within contexts where several strands of data are available. As a result, this thesis demonstrates how researchers can move beyond a reductionist tradition of research that attempts to isolate and identify cause-and-effect relationships and improves the ability to explain how to influence more environmentally sustainable outcomes.

The conceptual framework presented in this dissertation was informed by findings from research from multiple disciplines and from interdisciplinary research projects. With pro-environmental behaviour understood as a process, it was easy to recognise that the decision pathway can be influenced at each stage. The delineation of multiple stages in the decision making process enhanced the quality of analyses and findings and provided a framework to organize the various disciplinary and interdisciplinary knowledge that were employed in the dissertation. This approach enhanced our understanding of the research problem and highlighted the linkages between a variety of explanatory and contextual factors in the analysis of energy decisions. This enabled critical insights to be gained into how the two factors of program structure and advice-giving affected advice-following. This research approach also revealed that one of the factors in the study influenced the other factor, as the program structure affected the receptiveness of homeowners as perceived by advisors, which affected advice-giving. This confirms that an integrated approach to examining pro-environmental decisions and energy decisions is supported as a useful framework for analysis, and should be considered in research into other types of consumption. Furthermore, this supports the research tradition of geographers, who use integrated approaches to address a variety of human-environment problems, and typically incorporate findings from various research traditions (e.g., Parker et al. 2003; Mitchell 2008; Parker and Gliedt 2012).

The use of a convergent mixed methods research design and the conceptual framework allowed for the use of quantitative and qualitative data to explain the importance of the various influences. Peattie (2010) encourages an integrated approach that relies on modeling to distinguish the importance of the various influences. This research demonstrates that a mixed methods research design can produce detailed and rich results. By focusing on the case of one particular program that is acknowledged to be a best practice of delivery (Parker et al. 2003; Berry 2010) that had previously been studied from many different perspectives (Kennedy et al. 2001; Parker et al. 2001; Scott et al. 2001; Parker et al. 2003; Parker et al. 2005; Bird 2006; Parker and Rowlands 2007; Song 2008; Gilby 2010), this study increased the available findings for triangulation and elaboration. This approach of combining qualitative and quantitative strands with many previous studies of the same context allowed this study to make an in-depth examination of one context of pro-environmental behaviour.

7.4 Contributions to Broader Frameworks

The literature review in Chapter 2 describes several areas of research that address pro-environmental behaviour. The findings of this study can enhance analysis and our understanding of pro-environmental behaviour as it is addressed in several different areas of research. The literature review identified five critical areas of research that are important to understanding consumption and pro-environmental behaviour, but that were not addressed to a significant degree in the conceptual framework of this research. The first is the debate over whether price is an important influence of consumption. The second is whether psychographics are more predictive of behaviour change than demographics. The third is the fundamental importance of habits and routines on the outcome of behaviour and decision making. The fourth is the importance of social networks in influencing decisions, whether through the social interactions described by diffusion of innovation theory, normative messages, comparative information feedback, or publicly stated goals. The fifth is information feedback, particularly high frequency or real-time energy information feedback, such as systems that relate to the deployment of smart grids. As the process presented in the conceptual framework of this study was drawn from an impact-oriented conceptualization of consumption that framed it as a six-stage process (Peattie 2010), these discussions will consider the conceptual framework presented in this study, as well as the final two stages of this six-stage process, "Use" and "Post-use":

(1) Recognition of a want or a need → (2) Information search → (3) Evaluation of alternatives → (4) Purchase → (5) Use → (6) Post-use (Peattie 2010).

7.4.1 Price and Demand

Economists argue that price is a fundamentally important stimulus that affects demand and consumption. While many findings show that consumers do not necessarily make decisions that are economically rational with respect to energy consumption, many economists argue that this is because the price is not high enough; Jaccard (2005) estimates that energy prices need to rise by 25 to 50% over the long run in order to achieve sustainable levels of energy consumption; the IPCC has estimated that a price of 20 to 100 USD per tonne CO_2equivalent would be required to reduce the use of carbon based fuels to appropriately mitigate climate change (Barker et al. 2007).

This study can be related to the influence of price in other important ways. In the conceptual framework of this research, the price of energy was considered within the context, but was not considered explicitly in the study. As a decentralized mechanism, price would affect the context of consumption in a far-reaching manner. For example, it would affect supply factors and demand and decisions of other consumers.

On the other hand, depending on the format of energy billing, energy prices should be most visible at the stage of "use", the fifth stage of the six-stage process that is described by Peattie (2010). To incorporate an understanding of the effects of energy prices, the conceptual framework of this study would be understood within the broader context of Peattie's (2010) six-stage process. This study is relevant to the discipline of economics as the influence of price on consumption could be examined within the process of pro-environmental behaviour. In light of the findings that homeowners often invested in decisions that were less energy efficient, the relationship between energy price and preferences for specific decisions could be considered in more detail. Another potential relationship that can be considered is that the use stage, which would be influenced by price, may influence the first stage of signing up for a home energy evaluation. Many studies find that energy efficiency improvements can lead to a rebound effect; that is, an increase in energy consumption at the stage of use compared to using the level of energy service use prior to the change (Sorrell et al. 2009). To counter the rebound effect, price should be considered as an important influence at the stage of use. This would build on studies such as that by Parker et al. (2005), which analysed household natural gas usage before and after a home energy evaluation by REEP.

7.4.2 Habits and Routines

It was described in the literature review that habits of activity or of how information is processed in making a decision are strong influencers of behaviour. Habits are affected by context, and can run counter to behavioural intentions. It was described that when pro-environmental behaviour is understood as a process, the decision pathway can be influenced at each stage. The delineation of multiple stages in the decision making process allows us to highlight links between a variety of explanatory and contextual factors. Researchers who attempt to understand and influence habits of consumption behaviour can make use of this process based approach to organize their consideration of habits and contextual forces at each stage of the decision. For example, while prospect theory might not be a useful predictor of the effects of the number of retrofit decisions that are recommended on the outcome of the follow-up evaluation, prospect theory could prove to be useful to understand the outcome of each decision considered within this process: it could be that homeowners who consider insulation face too many options to make a decision. Habits and heuristics of decision making could be considered with respect to the report, an important document delivered to homeowners after the evaluation that they can refer to throughout the process. Most importantly, habits of action and decision making can be investigated to assess at what point in the process habits run counter to intentions to reinforce challenges that significantly diminish the effectiveness of the outcome. Moreover, the decision making heuristics of satisficing, recognition, elimination and availability could be investigated for their employment, usefulness or inhibiting effect in affecting the outcome at various stages of the process.

7.4.3 Psychographic and Marketing Approaches

Psychographic approaches are increasingly used by marketers and behaviour researchers. The benefits of the psychographics approach is that it is considered to offer a more temporally stable approach to predicting behaviour than demographic approaches (Oliver et al. 2011). Psychographics are the measure of people's values, attitudes, interests, opinions, personality, and trends (Weinstein 1986), or offer a way in which companies can make connections between a particular product and an individuals' personal ambitions (Cheon et al. 2007; Vyncke, 2002 cited in Swim et al. 2009). Psychographic segmentation is also used to segment audiences for climate change messages (Maibach et al. 2009). Understanding pro-environmental behaviour as process could therefore be useful to market segmentation researchers to refine how they target behaviour change in populations. For example, psychographics researchers and practitioners might be interested to learn whether the differentiation of market segments can predict the variation in the process of pro-environmental behaviour. They might also attempt to predict at which stage of the process a specific type of intervention is critical to the outcome, depending on the market segment. They also might assess at what point in the process the different market segments encounter challenges that significantly diminish the effectiveness of the outcome, or how to influence the different segments at the various stages of the process.

7.4.4 Social Networks and Influence

There are many studies that demonstrate the effectiveness of social influence as an important influence of pro-environmental behaviour (e.g., Siero et al. 1996; Goldstein et al. 2008 cited in Peattie 2010; Nolan et al. 2011; Axsen and Kurani 2012). Axsen and Kurani (2012) argue that the mechanisms of social influence on consumer behaviour are not well defined. However, social influence may be exerted through social networks in a variety of ways. For example, diffusion of innovation is a well recognized theory that offers one explanation for the ways that social networks influence technology adoption. Social influence may also be exerted with the use of comparative information feedback (Siero et al. 1996) or publicly stated goals (Pallak and Cummings 1976 as cited in Abrahamse et al. 2005), which are each found to be highly effective in influencing pro-environmental behaviour. Normative messages that tell the consumer that other people are engaging in a certain behaviour are also found to be effective in influencing pro-environmental behaviour (Goldstein et al. 2008 cited in Peattie 2010; Nolan et al. 2011). Researchers of social influence might therefore consider the incorporation of the conceptual framework presented in this study, as well as the concept of pro-environmental behaviour as process into their thinking. They could consider at what stages the various forms of social influence can affect pro-environmental behaviour, and which of these forms of social influence are most effective in altering the outcome. For example, in cases like home energy renovations where long stretches of time are associated with the process of multiple or different types of renovations, social influence approaches could be highly useful to learn from peers and shorten these lengths of time, or provide a form of encouragement to continue the process. While diffusion of innovation theory describes technology adoption in social networks, it could be considered in the context of models of renovation: homeowners may observe the work of various contractors and the associated process of renovation through their social networks. This could also be applied to other behaviours, such as the process of purchasing and using a vehicle.

On the other hand, as described in the introduction of this research, consumption behaviour is path dependent in part due to lifestyles and social influence. In the case of energy, it has proven difficult to alter consumption towards a low-carbon pathway. One of the broader discussions about consumption in wealthier countries addresses the issue of “conspicuous consumption” which is related to lifestyles of high levels of resource consumption (Carolan 2005). Conspicuous consumption can also be understood within the definition of “positional goods”, which economists call goods that are purchased for the purpose of increasing or confirming one’s social status (Heath and Potter 2006; Victor 2008). Examples of positional goods are a more expensive or exotic car, or a larger house. These have important implications on resource consumption: Harris et al. (2007) describe the impacts on energy services due to the trend of growing size of houses as the rate of occupancy diminishes in the United States. It is therefore widely recognized that social influence works against pro-environmental behaviour. Researchers of social influence who examine how social influence plays a role in increasing or maintaining levels of consumption may also consider using the conceptual framework presented in this study, and the definition of consumption as process. Researchers could consider at what stages social influence inhibits outcomes of pro-environmental behaviour.

7.4.5 Information Feedback and Smart Grid Deployment

The literature review discussed the concept of information feedback, a consequence-based strategy that is employed to raise awareness of consumers about their energy consumption. Increased frequency of information feedback at the "use" stage of the process is considered to be more effective in raising awareness by Darby (2000). Continuous, or real-time information, is currently being widely deployed through smart or advanced metering for the deployment of smart grids. Information feedback is shown to maintain effects while the consequences are in place but the effects cease with the removal of the consequence (Dwyer et al. 1993). Many visions of the smart grid promote optimistic perspectives with respect to consumer engagement and involvement with the energy system through information feedback and automation (e.g., Yeager 2004; Webb 2008). However, there are consistent findings in studies that organizations and households misuse and disuse energy information and management systems, and this would diminish the effectiveness of information feedback on behaviour change. For example, Hopper et al. (2006) found no meaningful relationship between ownership of enabling technologies and price response, and 70% of the businesses in their study did not review hourly prices posted daily. Goldman et al. (2002) found that 60% of businesses in their study did not check their real-time information more than once a week. Schembri (2008) found that consumers using a home energy management system that offered information feedback and automation self-assessed with strong technology skills, yet, many reduced their frequency of use over time and reported numerous examples of misuse and disuse of the system. An IBM study found that consumers described a preference for a refrigerator magnet that contained information of time of use periods instead of internet communication (IBM et al. 2007). Hargreaves et al. (2010) described that homeowners who were considered early adopters of home energy monitors expressed dissatisfaction with these monitors in many ways. For one, some homeowners reported that the information given in the monitors was not sufficient or adaptable to their interests. Further, if the monitor was not aesthetically pleasing, it was not situated in a visible area of the house.

One aspect that was not discussed in any of the aforementioned studies was whether homeowners were taught how to use these devices. An analogy to this study is that home energy advisors described spending the most time with homeowners during the blower door test showing them the leaks and how to find and fix them. Even though advisors agreed that air sealing is difficult to do, homeowners did tend to address this retrofit often and to a high degree of achievement compared to what was advised to them. The findings from this study of the importance of social learning approaches should be carefully considered in the deployment of energy information and management systems under smart grid deployment; consumers might use these systems more effectively with personalized demonstrations by energy advisors. For instance, in the same way that energy advisors had a “leak hunt” with the family that encouraged the homeowners to explore and feel for air leaks, real-time information feedback could be used to encourage exploration of cause-and-effect relationships by homeowners through real-time experiments that involve turning equipment on and off to learn about the energy impacts of various devices and appliances alone or in combination.

Additionally, when energy information is received through real-time feedback, it may influence learning or habits of decision making at other stages of the process. For example, Houde et al. (2011) conducted a field experiment that found that 9% of the homeowners who were exposed to real-time electricity information feedback sought a home energy evaluation, while only 1% of the homeowners who had not been exposed to the information sought an evaluation during the same timeframe. Hence, the “use” stage affected the stage of “Recognition of a want or a need”, which in this study, was the decision to sign up for a home energy evaluation.

7.5 Recommended Future Research and Application

By providing insight into the importance of factors that influence participation in the delivery of home energy efficiency advice programs many new research questions are revealed. The recommended future areas of research and application are in three main areas. The first area is to incorporate the process-based view of the conceptual framework into how programs are designed and delivered. The second area is to increase our understanding of the context presented in the conceptual framework as it affects decisions. For example, activities occurring in the community that alter the housing stock, or activities occurring on the supply-side of home energy efficiency, or that influence homeowner intentions prior to their participation in the program.

7.5.1 Further Explaining Process in the Conceptual Framework

The conceptual framework delineated five stages associated with participation in a home energy evaluation program; however, this research did not explain the influencers at all stages. Many findings of this dissertation confirm the usefulness of the process-based view of pro-environmental behaviour that is presented in the conceptual framework. A first step in extending the study is to contribute to research that further explains the influencers at each stage.

7.5.1.1 Assess the Effects of Report Format

The third stage presented in the conceptual framework of the process of participation in a home energy evaluation was to receive a report with recommendations. This study did incorporate findings from interviews with advisors that focused on the strategies they used in selecting the recommendations that could go into the report, but the study did not take into account the format of the report itself. It is unclear how the presentation of information in the report affects homeowners' decisions. Winnett and Kagel (1984) and Magat et al. (1986) all point out that similar information presented differently can produce different decisions. In the experiment by Magat et al. (1986), changes in presentation of the same information led to stated preferences that varied in economic efficiency.

Since the report is the information that homeowners have in their possession permanently, it is an important document to analyse. It could be that homeowners require more information presented in a more effective format in order to persuade them to pursue most effective with respect to improvement of energy performance of decisions. Previous research related to REEP has touched on this: Bird (2006) suggests providing homeowners with information that describes the estimated return on investments and the step-by-step processes of renovations. Advisors EEE2, 9 and 11 all discussed problems with the presentation of information in the report. Advisor 11 pointed out that the information in the report was poorly formatted, including graphs split over two pages. Advisor 9 pointed out that because the report was "hard-wired" by the government, it limited options to present prioritization of recommendations. Advisor EEE2 said that the reports were not personalized enough for the homeowner's situation. Advisor 3 mentioned including a discussion of pros and cons of the various decisions in the report.

Experiments within the delivery of the program could trial differently formatted reports to otherwise similar populations. Focus groups with homeowners and advisors would lead to options to improve the report's format, and these considerations would be taken into account in the experimental design. Experiments could be done on the effects of tailoring information on learning and decision prioritization, for example, by tailoring reports by vintage (as advisors agreed that knowing the vintage is a general starting point to prioritize recommendations), or by experimenting with market segmentation (e.g., Egmond et al. 2006a; Egmond et al. 2006b; Egmond et al. 2006c) or by psychographics (e.g., Anable 2005).This would lead to a better understanding of the effects of the report's design in terms of the best way to present recommendations and information.

7.5.1.2 Incorporating the Process-Based View into Research and Programs

Another pragmatic outcome of these findings would be to support further research and experimentation about how to best give advice in a process-based manner. The findings of this dissertation suggest that more attention should be paid to social learning of the homeowners and of the home energy advisors throughout the implementation of these programs. How social learning can be tested and incorporated into future research and application is discussed throughout the rest of this section.

Firstly, the social learning model used by Advisor 15 warrants further implementation; Advisor 15 did not necessarily give the deepest or the most recommendations, but was associated with the deepest and higher number of changes made. Further, some advisors discussed the pros and cons of a decision in person and others wrote it into the report; it could be useful to clarify in which context it is better to discuss the pros and cons of a decision not important to energy performance.

Social learning for home energy advisors should also be considered. One justification that the advisors of REEP gave for not using vivid and comparative messages was that they had not necessarily seen the results in the follow-up evaluation due to scheduling procedures. A recommendation of this research is to experiment with scheduling to maximize the matching of houses and advisors from the initial evaluation so that the advisors can experience the before and after of their advice. This could lead to a more complete understanding on the part of home energy advisors of the extent to which they were able to persuade homeowners, to see what homeowners implemented, and how technically effective the implemented decisions were. This could lead to more experimentation and use of vivid comparative statements about results that other homeowners achieved or other improvements from this program delivery change. Additionally, many advisors who worked during Periods 2 and 4 discussed tensions with less receptive homeowners. In this way, they may also see whether, despite the initial tension, homeowners did learn and take their advice.

It is important to heed the opinions of the advisors who viewed the report as a road map or blue print for the future. The findings suggest that important measures should all be included in the report rather than excluding important measures which are viewed as disruptive or expensive. All important decisions should be viewed as part of a larger plan rather than as time-limited options which force trade-offs. Many advisors did report providing specific information on specific decisions to homeowners.

Another area that warrants more investigation is about whether the decisions that are not considered important to saving energy should be kept off the report. This could serve several functions. For example, it could serve to clarify the incongruence between homeowners' perceptions of their own motivations and knowledge and actions. To clarify, Advisor 2 said that while there are better options for saving energy than replacing windows, there are reasons to replace windows. The analysis shows that many homeowners replaced windows whether windows were recommended or not. Not including windows in the report and advising against them for energy reasons would offer an opportunity to counter the belief that advisors perceived that homeowners had that replacing windows saves energy. Supporting the social learning perspective, homeowners may learn to rationalize their decision to replace windows for other reasons.

In keeping with the recommendation to view the report within the process of home energy retrofits over time, researchers and practitioners should examine more carefully whether the time limit of 18 months for a follow-up evaluation is the most effective timeframe. Bird (2006) suggested that the program should allow for longer than 18 months to return for a follow-up evaluation, which may result in greater impact in terms of improvement of a house's energy performance. This analysis found that many of the retrofits associated with the building envelope were done in combination with other retrofits and over longer timeframes. This finding implies that there could be substantial benefits to encouraging homeowners to make decisions over a longer timeframe. This could be assessed by conducting further analyses of the required time to complete building envelope retrofits to a high degree of achievement and in combination with other retrofits. Focus groups and interviews with experts and homeowners could provide information about appropriate timeframes to consider.

Given the success of financial rewards in influencing participation, analysis could also focus on experimentation with different processes and timeframes of awarding financial rewards with the purpose of influencing homeowners to continue to participate in the program over a longer timeframe and potentially increase the number of retrofits that they consider and implement. There are two major design possibilities to grant financial rewards to homeowners in light of the process of home energy retrofits. One is to experiment with giving financial rewards in portions, as decisions are made successively over time. Another is to experiment with using minimum, rather than maximum, timeframes to receive full financial rewards, with the potential to offer partial rewards as each retrofit action is taken.

Researchers should also prioritize an examination of the linkages between longer timeframes, information search patterns, the number of changes made, and the type of changes made. An important, but weak finding of this study that contributes to the social learning perspective is that the majority of the homeowners who were measured to engage in decisions that were incongruent with advice given to them took more time between evaluations and made more changes. This may have been due to wider information search patterns, but this is currently unclear. A priority research project should survey previous REEP participants in order to match questionnaires to the evaluation files, in order to assess for any information search patterns that helped homeowners gain procedural knowledge to carry out renovations. Prospective experiments could also be conducted through REEPs delivery of subsequent programs. These different search patterns could be compared to the number of changes made and the timeframe between evaluations. This would serve to clarify the role that broader engagement with information serves in this type of program. Further to this, experimentation in program design could be done to address the finding of this research that certain decisions are associated with longer timeframes and the learning of procedural knowledge. For example, this study found that basement insulation was often recommended, but not often done, or done effectively, and this decision usually associated with a longer timeframe. Through focus group interviews, Bird (2006) found that "It was felt that having more detailed, step-by-step instructions on how to complete the retrofits would assist those undertaking the retrofits themselves." (41)

While still employing a conceptual framework of participation as process, experiments in program design should examine the effects of social learning and publicly stated goals on increasing the number and depth of improvements. This suggestion is based on the findings of this study, and also from several findings from the literature review. Pallak and Cummings (1976 cited in Abrahamse et al. 2005) found that a group that gave a public commitment showed a lower rate of increase in energy use than a group that gave a private commitment. Behaviour changes are further strengthened when combined with rewards (Dwyer et al. 1993; Abrahamse et al. 2005). Normative messages also appear to have stronger influence than financial messages (Peattie 2010; Nolan et al. 2011). Scott et al. (2001) found that social networks were associated with technology investment and energy management behaviours. Darby (2006) found "Respondents who saw themselves as 'strongly energy conscious' were far more likely than others to ... discuss energy use at home" (2936). These experiments on the effects of social learning and publicly stated goals on the depth and number of improvements could be done by inviting homeowners to join peer learning groups, possibly defined by similar house vintages, locations, and combinations of recommendations. This would provide the opportunity for homeowners to combine the benefits of publicly stated goals with a group of peers in an environment that promotes social learning. Furthermore, in keeping with the process-based view, the program could experiment with incorporating expert check-ins and phone calls into program delivery to further answer questions and explain the report, remind homeowners of goals, and to help plan retrofit decisions.

7.5.2 Further Understanding the Context of Home Energy Evaluation Programs

The second broad area of analysis that should be pursued by researchers and practitioners is to increase our understanding of the context presented in the conceptual framework as it affects decisions. This would include the effects of context on how intentions are formed prior to entering the program and activities that are occurring on the supply-side of home energy efficiency.

Future research should produce a comparative analysis of marketing, services, and guarantees for the eight decisions to describe the supply-side options homeowners chose from. This would improve our understanding of how the supply side addressed or reinforced the particular barriers associated with each decision type within the constraints of the program design. An example was previously given of Window Wise, a program that, for a small fee, offered a guarantee of correct installation through certified window installers and random inspections of window installation. It could be that the guarantee increased trust by homeowners in the quality of the installation of windows.

It appears that to counter the path dependency of behaviour, the intentions that homeowners form prior to participating in the program are critical to understand. A key area of recommended future research is to map out homeowners' understandings of the eight decisions of the program. Mapping out homeowners' perceptions of windows would be done to gain better knowledge on why they are distracted by this retrofit, and divert investments away from other retrofits towards windows. This could be done using the mental models approach, developed for the purpose of understanding risk perception in science communication (e.g., Werner and Scholz 2002; Morgan et al. 2004; Lowe and Lorenzoni 2007; Sterman and Sweeney 2007). The mental models approach can be used to uncover and unpack homeowners' perceptions of any of the retrofit decisions to provide a better description of the context in which the decision was formed, and the form of rationality that drives the decision.

Experimentation should also be done in the broader community to find out the impact of differently structured financial rewards. One of the findings of this research was that while the higher list-based financial reward offered in Period 4 attracted a higher level of participation in both the initial and the follow-up evaluation, the mean energy performance of the houses that it attracted was higher, and the mean energy consumption lower than what was attracted by the performance-based financial reward used in Period 2. Further, the houses that were attracted to a follow-up evaluation in Period 4 had higher mean energy performance than the houses that only had an initial evaluation, whereas, the lower performing houses were attracted to a follow-up evaluation in Period 2. In order to differentiate between the effects of the amount offered by the reward and the structure of the reward, a performance-based financial reward that offers a higher dollar value per improvement in energy rating could be implemented. Future studies could demonstrate if this type of reward would attract more of the lower performing houses to both the initial and follow-up evaluations. The greatest verified reductions of energy can be made by attracting the lowest performing houses. Economists might argue that it is better to target the higher performing groups, as the payback associated with their improvements extends over a longer period of time. However, as summarized in Chapter 2, the literature and previous research on decisions in the EnerGuide for Houses program, as well as this research, show that homeowners do not necessarily make energy decisions based strictly on payback and discount rates-other factors affect decision making.

7.6 Summary

As discussed in the introduction, timing is of critical importance to alter energy consumption patterns in order to mitigate climate change and reduce the financial impacts associated with climate change or of fuel scarcity. A critical finding of this dissertation is that home energy evaluation programs, as they were delivered by an organization recognized for best practices, are not sufficient to alter path dependence of energy consumption of homeowners. Overall, this dissertation found that the two main factors of program structure and advice-giving affected advice-following. One factor influenced the other, as the program structure affected the receptiveness of homeowners as perceived by advisors, which affected advice-giving. This study confirms that an integrated approach to examining pro-environmental decisions and energy decisions is supported as a useful framework for analysis. These findings also support a process-based definition of pro-environmental behaviour as a useful model and form of integration that should be considered by researchers who focus on topics related to consumption. Further, a convergent mixed methods research design is supported as a useful and rigourous approach to examining the impact of various factors simultaneously. This methodological approach maximizes specificity, corroboration, triangulation, and elaboration of results leading to a depth of understanding that is valuable. This methodological approach should also be considered by researchers who focus on topics related to consumption. Another critical finding was that both behaviourist and social learning approaches are important influencers of pro-environmental behaviour. Social learning and process-based models of pro-environmental behaviour should be applied to research and practice related to advice-giving and pro-environmental behaviour.

Appendix A

Period 2 Financial Reward Structure

Pre-rating/Post-rating	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
20 or less	1,760	1,816	1,873	1,931	1,989	2,048	2,107	2,167	2,227	2,288	2,350	2,412	2,475	2,539	2,603	2,668	2,733	2,799	2,865	2,932	3,000	3,068	3,137	3,207	3,277	3,348
21	1,724	1,780	1,837	1,894	1,952	2,011	2,070	2,130	2,190	2,251	2,313	2,375	2,438	2,501	2,565	2,630	2,695	2,761	2,827	2,894	2,962	3,030	3,099	3,168	3,238	3,309
22	1,687	1,743	1,800	1,857	1,915	1,974	2,033	2,093	2,153	2,214	2,275	2,337	2,400	2,463	2,527	2,592	2,657	2,723	2,789	2,856	2,923	2,991	3,060	3,129	3,199	3,270
23	1,650	1,706	1,763	1,820	1,878	1,936	1,995	2,055	2,115	2,176	2,237	2,299	2,362	2,425	2,489	2,553	2,618	2,684	2,750	2,817	2,884	2,952	3,021	3,090	3,160	3,230
24	1,613	1,669	1,725	1,782	1,840	1,898	1,957	2,017	2,077	2,138	2,199	2,261	2,323	2,386	2,450	2,514	2,579	2,645	2,711	2,778	2,845	2,913	2,981	3,050	3,120	3,190
25	1,575	1,631	1,687	1,744	1,802	1,860	1,919	1,978	2,038	2,099	2,160	2,222	2,284	2,347	2,411	2,475	2,540	2,605	2,671	2,738	2,805	2,873	2,941	3,010	3,080	3,150
26	1,537	1,593	1,649	1,706	1,763	1,821	1,880	1,939	1,999	2,060	2,121	2,183	2,245	2,308	2,371	2,435	2,500	2,565	2,631	2,698	2,765	2,833	2,901	2,970	3,039	3,109
27	1,498	1,554	1,610	1,667	1,724	1,782	1,841	1,900	1,960	2,020	2,081	2,143	2,205	2,268	2,331	2,395	2,460	2,525	2,591	2,657	2,724	2,792	2,860	2,929	2,998	3,068
28	1,459	1,515	1,571	1,628	1,685	1,743	1,801	1,860	1,920	1,980	2,041	2,103	2,165	2,228	2,291	2,355	2,419	2,484	2,550	2,616	2,683	2,751	2,819	2,888	2,957	3,027
29	1,420	1,475	1,531	1,588	1,645	1,703	1,761	1,820	1,880	1,940	2,001	2,062	2,124	2,187	2,250	2,314	2,378	2,443	2,509	2,575	2,642	2,709	2,777	2,846	2,915	2,985
30	1,380	1,435	1,491	1,548	1,605	1,663	1,721	1,780	1,839	1,899	1,960	2,021	2,083	2,146	2,209	2,273	2,337	2,402	2,467	2,533	2,600	2,667	2,735	2,804	2,873	2,943
31	1,340	1,395	1,451	1,507	1,564	1,622	1,680	1,739	1,798	1,858	1,919	1,980	2,042	2,104	2,167	2,231	2,295	2,360	2,425	2,491	2,558	2,625	2,693	2,761	2,830	2,900
32	1,299	1,354	1,410	1,466	1,523	1,581	1,639	1,698	1,757	1,817	1,877	1,938	2,000	2,062	2,125	2,189	2,253	2,318	2,383	2,449	2,515	2,582	2,650	2,718	2,787	2,857
33	1,258	1,313	1,369	1,425	1,482	1,539	1,597	1,656	1,715	1,775	1,835	1,896	1,958	2,020	2,083	2,146	2,210	2,275	2,340	2,406	2,472	2,539	2,607	2,675	2,744	2,813
34	1,217	1,272	1,327	1,383	1,440	1,497	1,555	1,614	1,673	1,733	1,793	1,854	1,915	1,977	2,040	2,103	2,167	2,232	2,297	2,363	2,429	2,496	2,563	2,631	2,700	2,769
35	1,175	1,230	1,285	1,341	1,398	1,455	1,513	1,571	1,630	1,690	1,750	1,811	1,872	1,934	1,997	2,060	2,124	2,188	2,253	2,319	2,385	2,452	2,519	2,587	2,656	2,725
36	1,133	1,188	1,243	1,299	1,355	1,412	1,470	1,528	1,587	1,647	1,707	1,768	1,829	1,891	1,953	2,016	2,080	2,144	2,209	2,275	2,341	2,408	2,475	2,543	2,611	2,680
37	1,090	1,145	1,200	1,256	1,312	1,369	1,427	1,485	1,544	1,603	1,663	1,724	1,785	1,847	1,909	1,972	2,036	2,100	2,165	2,230	2,296	2,363	2,430	2,498	2,566	2,635
38	1,047	1,102	1,157	1,213	1,269	1,326	1,383	1,441	1,500	1,559	1,619	1,680	1,741	1,803	1,865	1,928	1,991	2,055	2,120	2,185	2,251	2,318	2,385	2,453	2,521	2,590
39	1,004	1,058	1,113	1,169	1,225	1,282	1,339	1,397	1,456	1,515	1,575	1,635	1,696	1,758	1,820	1,883	1,946	2,010	2,075	2,140	2,206	2,272	2,339	2,407	2,475	2,544
40	960	1,014	1,069	1,125	1,181	1,238	1,295	1,353	1,411	1,470	1,530	1,590	1,651	1,713	1,775	1,838	1,901	1,965	2,029	2,094	2,160	2,226	2,293	2,361	2,429	2,498
41	916	970	1,025	1,080	1,136	1,193	1,250	1,308	1,366	1,425	1,485	1,545	1,606	1,667	1,729	1,792	1,855	1,919	1,983	2,048	2,114	2,180	2,247	2,314	2,382	2,451
42	871	925	980	1,035	1,091	1,148	1,205	1,263	1,321	1,380	1,439	1,499	1,560	1,621	1,683	1,746	1,809	1,873	1,937	2,002	2,067	2,133	2,200	2,267	2,335	2,404
43	826	880	935	990	1,046	1,102	1,159	1,217	1,275	1,334	1,393	1,453	1,514	1,575	1,637	1,699	1,762	1,826	1,890	1,955	2,020	2,086	2,153	2,220	2,288	2,356
44	781	835	889	944	1,000	1,056	1,113	1,171	1,229	1,288	1,347	1,407	1,467	1,528	1,590	1,652	1,715	1,779	1,843	1,908	1,973	2,039	2,105	2,172	2,240	2,308
45	735	789	843	898	954	1,010	1,067	1,124	1,182	1,241	1,300	1,360	1,420	1,481	1,543	1,605	1,668	1,731	1,795	1,860	1,925	1,991	2,057	2,124	2,192	2,260
46	689	743	797	852	907	963	1,020	1,077	1,135	1,194	1,253	1,313	1,373	1,434	1,495	1,557	1,620	1,683	1,747	1,812	1,877	1,943	2,009	2,076	2,143	2,211
47	642	696	750	805	860	916	973	1,030	1,088	1,146	1,205	1,265	1,325	1,386	1,447	1,509	1,572	1,635	1,699	1,763	1,828	1,894	1,960	2,027	2,094	2,162
48	595	649	703	758	813	869	925	982	1,040	1,098	1,157	1,217	1,277	1,338	1,399	1,461	1,523	1,586	1,650	1,714	1,779	1,845	1,911	1,978	2,045	2,113
49	548	601	655	710	765	821	877	934	992	1,050	1,109	1,168	1,228	1,289	1,350	1,412	1,474	1,537	1,601	1,665	1,730	1,795	1,861	1,928	1,995	2,063
50	500	553	607	662	717	773	829	886	943	1,001	1,060	1,119	1,179	1,240	1,301	1,363	1,425	1,488	1,551	1,615	1,680	1,745	1,811	1,878	1,945	2,013
51	452	505	559	613	668	724	780	837	894	952	1,011	1,070	1,130	1,190	1,251	1,313	1,375	1,438	1,501	1,565	1,630	1,695	1,761	1,827	1,894	1,962
52	403	456	510	564	619	675	731	788	845	903	961	1,020	1,080	1,140	1,201	1,263	1,325	1,388	1,451	1,515	1,579	1,644	1,710	1,776	1,843	1,911
53	354	407	461	515	570	625	681	738	795	853	911	970	1,030	1,090	1,151	1,212	1,274	1,337	1,400	1,464	1,528	1,593	1,659	1,725	1,792	1,859
54	305	358	411	465	520	575	631	688	745	803	861	920	979	1,039	1,100	1,161	1,223	1,286	1,349	1,413	1,477	1,542	1,607	1,673	1,740	1,807
55	255	308	361	415	470	525	581	637	694	752	810	869	928	988	1,049	1,110	1,172	1,234	1,297	1,361	1,425	1,490	1,555	1,621	1,688	1,755
56	205	258	311	365	419	474	530	586	643	701	759	818	877	937	997	1,058	1,120	1,182	1,245	1,309	1,373	1,438	1,503	1,569	1,635	1,702
57		207	260	314	368	423	479	535	592	649	707	766	825	885	945	1,006	1,068	1,130	1,193	1,256	1,320	1,385	1,450	1,516	1,582	1,649
58			209	263	317	372	427	483	540	597	655	714	773	833	893	954	1,015	1,077	1,140	1,203	1,267	1,332	1,397	1,463	1,529	1,596
59			157	211	265	320	375	431	488	545	603	661	720	780	840	901	962	1,024	1,087	1,150	1,214	1,278	1,343	1,409	1,475	1,542
60				159	213	268	323	379	435	492	550	608	667	727	787	848	909	971	1,033	1,096	1,160	1,224	1,289	1,355	1,421	1,488
61					160	215	270	326	382	439	497	555	614	673	733	794	855	917	979	1,042	1,106	1,170	1,235	1,300	1,366	1,433
62						162	217	273	329	386	443	501	560	619	679	740	801	863	925	988	1,051	1,115	1,180	1,245	1,311	1,378
63							163	219	275	332	389	447	506	565	625	685	746	808	870	933	996	1,060	1,125	1,190	1,256	1,322
64								165	221	278	335	393	451	510	570	630	691	753	815	878	941	1,005	1,069	1,134	1,200	1,266
65									166	223	280	338	396	455	515	575	636	697	759	822	885	949	1,013	1,078	1,144	1,210
66										168	225	283	341	400	459	519	580	641	703	766	829	893	957	1,022	1,087	1,153
67											169	227	285	344	403	463	524	585	647	709	772	836	900	965	1,030	1,096
68												171	229	288	347	407	467	528	590	652	715	779	843	908	973	1,039
69													172	231	290	350	410	471	533	595	658	721	785	850	915	981
70														174	233	293	353	414	475	537	600	663	727	792	857	923
71														116	175	235	295	356	417	479	542	605	669	733	798	864
72															117	177	237	298	359	421	483	546	610	674	739	805
73																118	178	239	300	362	424	487	551	615	680	745
74																	119	180	241	303	365	428	491	555	620	685
75																		120	181	243	305	368	431	495	560	625
76																			121	183	245	308	371	435	499	564
77																				122	184	247	310	374	438	503
78																					123	186	249	313	377	442
79																						124	187	251	315	380

Appendix B
Description of File Errors

Grants: Many of the EnerGuide for Houses files did not contain the recommended grant amount, the grant amount paid to the homeowner, or the cost of the initial or follow-up evaluations. REEP provided the incentive chart for the EnerGuide for Houses Program, and the values were estimated and input into the dataset. REEP also provided an official pricing schedule for evaluations which was used to estimate the price paid, and the price values were also estimated an input into the dataset.

Hot water efficiency: In the EnerGuide for Houses dataset some recommended hot water efficiencies had been rounded to 1 from a decimal representing percentage. The ecoEnergy files were scanned for hot water heater type and fuel, and the corresponding percentage was used for the missing EnerGuide for Houses data.

Heat Recovery Ventilator: Many recommended HRV values were missing in all files. Technical staff from REEP and the Elora Center for Environmental Excellence were consulted and they clarified that HRV recommended when "A crit nat ACH" or "U crit nat ACH" (or "B crit nat ACH") were 0.22 or less. An assumption was made that the presence of HRV in the B files was correct in confirming if an HRV was installed. This is based on the rationale that it is likely that either the computer program or a data quality analyst fixed the files before submission. Other forms of ventilation were missing from many files.

Initially, the dataset consisted of two datasets, which were either pre or post 2007, with an overall count of 13,545 initial evaluation files, and 6,695 follow-up evaluation files. However, these sets contained duplicate files and problematic files. The files were sorted and time stamped and problem files were discarded from the database, which left 13,429 initial files and 6,123 follow-up files remained. REEP also maintained a contact database, which kept track of the date for each evaluation done, and in some cases, the date when the evaluation was scheduled and this was used to timestamp the data. In the case of the post-2007 files (ecoEnergy program), this contact database is automatically linked to the database which contains the technical measurements (technical database). In the case of all evaluations prior to 2007, the contact database was linked to the technical database through the use of iterative matching queries in Microsoft Office Access. Any data which could not be time-stamped was discarded. Following this, the initial and follow-up evaluation files were then matched to each other using an NRCan identification number for the file. A duplicates query was run to remove duplicates, and further data checking techniques were used to find mismatched and incomplete files.

Appendix C

Letter of Recruitment of Organization and Permission Form

September 26, 2011

Dear Ms. Mary Jane Patterson,

This letter is a request for Residential Energy Efficiency Project (REEP)'s assistance with a project I am conducting as part of my doctoral degree requirements in the Department of Geography and Environmental Management at the University of Waterloo, Ontario, under the supervision of Dr. Paul Parker. The title of my research project is "Understanding the impact of evaluators and advice strategies on greenhouse gas reductions and the selection of energy efficiency improvements in the Residential Energy Efficiency Project (REEP)". I would like to provide you with more information about this project that explores the impact of customized information on homeowner's energy retrofit decisions.

The purpose of this study is to learn about the different types of "advice strategies" employed by various home energy evaluators, and the effectiveness of these strategies in convincing home owners to undertake home energy improvements. Knowledge and information generated from this study may help other researchers who study issues related to energy behaviour and climate change, the designers of programs to reduce residential greenhouse gas emissions, and trainers of home energy evaluators.

It is my hope to connect with key past and present REEP evaluators, as well as past and current evaluation schedulers, to invite them to participate in this research project. I believe that home energy evaluators at REEP may have unique ways of deciding on home energy advice and communicating this advice to homeowners. During the course of this study, I would like to interview some past and present evaluators in order to gain an understanding of the variety of strategies they employ in deciding and communicating advice to homeowners. To understand patterns of advice-giving, the research will also examine patterns of recommended and implemented home energy efficiency improvements in REEPs database. I expect the interview will involve approximately one hour of the evaluators time. I would like to interview schedulers to confirm for any differences in how assignments were made. I expect the interview will involve approximately 20 minutes of the schedulers time. At the end of this study the publication of this thesis will share the knowledge from this study with other researchers of energy behaviour and climate change, the designers of programs to reduce residential greenhouse gas emissions, and trainers of home energy evaluators.

To respect the privacy and rights of the Residential Energy Efficiency Project and its evaluators, I will not be contacting the evaluators directly. What I intend to do, is provide the Residential Energy Efficiency Project with the Natural Resources Canada (NRCan) identification numbers of the evaluators I wish to interview, and a letter inviting each evaluator to participate in this study at their discretion. I hope that the Residential Energy Efficiency Project can distribute these letters to the selected past and present home energy evaluators. Contact information for me and my advisor will be contained in the letters. If a home energy evaluator is interested in participating they will be invited to contact me, Christina Hoicka, to discuss participation in this study in further detail. I ask that if any evaluators who have not responded within one week, the Residential Energy Efficiency Project may re-contact them by telephone (if available) or, again by email (if telephone is unavailable), inviting them again to participate in the study.

To respect the privacy and rights of the Residential Energy Efficiency Project and its past and present schedulers, I will not be contacting the schedulers directly. What I intend to do is provide the Residential Energy Efficiency Project with a letter inviting schedulers to participate in this study at their discretion. I hope that the Residential Energy Efficiency Project can distribute these letters to the selected past and present schedulers. Contact information for me and my advisor will be contained on the letters. If a scheduler is interested in participating they will be invited to contact me, Christina Hoicka, to discuss participation in this study in further detail.

Participation of any home energy evaluator or schedulers is completely voluntary. Each home energy evaluator or scheduler will make their own independent decision as to whether or not they would like to be involved. All participants will be informed and reminded of their rights to participate or withdraw before any interview, or at any time in the study. Home energy evaluators and schedulers will receive an information letter including detailed information about this study, as well as informed consent forms.

To support the findings of this study, quotations and excerpts from the stories will be used labelled with pseudonyms to protect the identity of the participants. Names of participants will not appear in the thesis or reports resulting from this study. Participants will not be identifiable, and only described as a home energy evaluator, and by characteristics of their style of advice selection and delivery.

Further, if the Residential Energy Efficiency Project wishes the identity of the organization to remain confidential, a pseudonym will be given to the organization. All paper field notes collected will be retained locked in my office and in a secure cabinet in the Department of Geography and Environmental Management at the University of Waterloo. All paper notes will be confidentially destroyed after three years. Further, all electronic data will be encrypted and stored indefinitely on an external hard drive with no personal identifiers. Finally, only myself and my advisor, Paul Parker in the Department of Geography and Environmental Management at the University of Waterloo will have access to these materials. There are no known or anticipated risks to participants in this study.

I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics, University of Waterloo. However, the final decision about participation belongs to the Residential Energy Efficiency Project, and the evaluators. If you have any comments or concerns with this study, please feel free to contact Dr. Susan Sykes, Director, Office of Research Ethics at (519)888-4567 ext. 36005 or by email ssykes@uwaterloo.ca

If you have any questions regarding this study or would like additional information to assist you in reaching a decision about participation, please contact me at 519-xxx-xxxx or by email choicka@uwaterloo.ca. You may also contact my supervisor, Paul Parker at (519) 888-4567 ext. 32791 or by email pparker@uwaterloo.ca.

I hope that the results of my study will be beneficial to the Residential Energy Efficiency Project, to the home energy evaluators and their trainers, as well as the broader research community. I very much look forward to speaking with you and thank you in advance for your assistance with this project.

Yours sincerely,

Christina Hoicka
Doctoral Candidate

Department of Geography and Environmental Management
University of Waterloo

Paul Parker
Associate Dean, Graduate Studies
Professor, Geography and Environmental Management
and School of Environment, Enterprise and Development
Faculty of Environment
University of Waterloo

Organization Permission Form

We have read the information presented in the information letter about a study being conducted by Christina Hoicka of the Department of Geography and Environmental Management at the University of Waterloo, Ontario, under the supervision of Paul Parker at the University of Waterloo. We have had the opportunity to ask any questions related to this study, to receive satisfactory answers to our questions, and any additional details we wanted.

We are aware that the name of our organization will only be used in the thesis or any publications that comes from the research with our permission.

We were informed that this organization may withdraw from assistance with the project at any time. We were informed that study participants may withdraw from participation at any time without penalty by advising the researcher.

We have been informed this project has been reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo and that questions we have about the study may be directed to Christina Hoicka at 519-xxx-xxxx or by email choicka@uwaterloo.ca and Paul Parker at 519-888-4567 ext. 32791 or email pparker@uwaterloo.ca.

We were informed that if we have any comments or concerns with in this study, we may also contact Dr. Susan Sykes, Director, Office of Research Ethics at (519) 888-4567 ext. 36005 or ssykes@uwaterloo.ca.

Christina Hoicka

Doctoral Candidate
Department of Geography and Environmental Management
University of Waterloo

Paul Parker
Associate Dean, Graduate Studies
Professor, Geography and Environmental Management
and School of Environment, Enterprise and Development
Faculty of Environment
University of Waterloo

We agree to help the researchers recruit participants for this study from among the staff or former staff of the Residential Energy Efficiency Project.

□ YES □ NO

We agree to the use of the name of the Residential Energy Efficiency Project in any thesis or publication that comes of this research.
□ YES □ NO
If NO, a pseudonym will be used to protect the identity of the organization.

Director Name: ___________________________________ (Please print)
Director Signature: ________________________________
Board of Directors Representative Name: ___________________________________ (Please print)
Board of Directors Representative Signature: _______________________________
Witness Name: _____________________________________ (Please print)
Witness Signature: _________________________________
Date: ___________________________________

Appendix D
Letter of Recruitment to Advisors of REEP and Consent Form

September 26, 2011

Dear evaluator,

This letter is sent to you by the Residential Energy Efficiency Project on behalf of the researcher. You are invited to participate in a study I am conducting as part of my doctoral degree in the Department of Geography and Environmental Management at the University of Waterloo under the supervision of Professor Paul Parker. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

Information, including tailored advice, is understood as a key factor in influencing greener consumption decisions. In the case of home energy consumption, providing households with information about energy-saving options is typically viewed as a solution to overcome barriers to investments in energy efficiency. That is, the provision of information may result in increased household energy savings. Further, there is wide agreement that the persuasiveness of information in influencing behaviour change is determined by a variety of factors. These include factors which shape the structure and delivery of the information, combined with how the receiver receives the information. The Residential Energy Efficiency Project has been successful in delivering home energy efficiency programs since 1999. The purpose of this study, therefore, is to understand success factors in communicating advice to homeowners in influencing the decision to make energy efficiency improvements.

The Residential Energy Efficiency Project has delivered a very successful home energy efficiency program. This study will focus on how advice was selected and delivered by home energy evaluators within the Residential Energy Efficiency Project. In particular, I believe that home energy evaluators at the Residential Energy Efficiency Project may have unique ways of deciding on home energy advice and communicating this advice to homeowners. Since you have delivered a significant number of home energy evaluations as an evaluator for the Residential Energy Efficiency Project in Waterloo Region, I would like to include you as one of several home energy evaluators to be involved in my study. Given your extensive experience in delivering these evaluations, I would like to learn about what you enjoy about giving home energy evaluations, how you conducted these evaluations, how you selected advice to give to homeowners, how you explained this advice to homeowners, and your perceptions on the factors which are important in a successful home energy evaluation. To understand patterns of advice-giving, the research will also examine patterns of recommended and implemented home energy efficiency improvements in REEPs database.

Participation in this study is voluntary. It will involve an interview of approximately one hour in length to take place in a mutually agreed upon location. If you are outside of Waterloo Region, I suggest we conduct the interview via skype or telephone. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. With your permission, the interview will be audio recorded to facilitate collection of information, and later transcribed for analysis. Shortly after the interview has been completed, I will send you a summary of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish.

I would like to assure you that no one at REEP will know who participated in this study or not (unless you choose to participate and provide this information to REEP). A decision to participate or not will have no impact on your job at REEP or relation with REEP. All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used. Data collected during this study will be retained for three years in a locked filing cabinet in the researchers or supervisors locked office. Electronic data will be encrypted and stored indefinitely on an external hard drive with no personal identifiers. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study.

If you would like to participate in this study, please contact me directly at **519-xxx-xxxx** or by email at **choicka@uwaterloo.ca**, so that we may arrange an interview. You can also contact my supervisor, **Professor Paul Parker** at **519-888-4567** ext. **32791** or email **pparker@uwaterloo.ca**. If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me.

I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes of this office at 519-888-4567 Ext. 36005 or ssykes@uwaterloo.ca.

I believe that this will be one of the first studies from the perspective of the evaluator, and will highlight the importance of the evaluator in the process of home energy evaluations. I hope that the results of my study will be of benefit to the Residential Energy Efficiency Project, other researchers of energy behaviour and climate change, the designers of programs to reduce residential greenhouse gas emissions, and trainers of home energy evaluators.

I very much look forward to speaking with you and thank you in advance for your assistance in this project.

Yours Sincerely,

Christina Hoicka

choicka@uwaterloo.ca

CONSENT FORM

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study being conducted by Christina Hoicka and Paul Parker of the Department of Geography and Environmental Management at the University of Waterloo. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in the thesis and/or publications to come from this research, with the understanding that the quotations will be anonymous.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher.

This project has been reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo. I was informed that if I have any comments or concerns resulting from my participation in this study, I may contact the Director, Office of Research Ethics at 519-888-4567 ext. 36005 or by email at ssykes@uwaterloo.ca.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

☐YES ☐NO

I agree to have my interview audio recorded.

☐YES ☐NO

I agree to the use of anonymous quotations in any thesis or publication that comes of this research.

☐YES ☐NO

Participant Name: ____________________________ (Please print)

Participant Signature: ____________________________

Witness Name: ________________________________ (Please print)

Witness Signature: ______________________________

Date: ____________________________

Appendix E

Advisor Interview Questions

BREAKING THE ICE/INTEREST LEVELS

This section is meant a) as an easy opener to the interview b) to gain a sense of skills as they might affect credibility and trustworthiness (from the perspective of the homeowner) c) to gauge their personal motivations and level of enthusiasm.

1	How long have you been a home energy evaluator?
Prompt	Can you tell me the month and year you started?
2.	What motivated you to become a home energy evaluator?
2.1	What prepared you for this role?
Prompt	Like life experience?
Prompt	Have you had training? What kind?
Prompt	Do you have certification?
Prompt	Did any formal training prepare you?
3	How do you keep up to date on knowledge about building improvements?
4	What do you enjoy about being a home energy evaluator?

PROCESS

The purpose of this section is to learn about how they conduct an evaluation and to gauge the level of commitment encouraged by them of homeowners, to gauge their perception of homeowners (and hence, how they might select and sell advice).

5	Can you briefly describe the process of a typical home energy evaluation for me?
Prompt	Approximately how long does the home energy evaluation take?
6	How involved in the evaluation process do homeowners become?

Prompt/ sub-question	o Is it typical for a homeowner to follow you or aid you in the course of a home evaluation?
	o [Question] Are you generally comfortable with this or do you find it gets in your way?
	OR
	o [Prompt] I want to gauge your comfort level with this:
	    ▪ On a scale of 1 to 10, if 1 was lowest level of comfort, and 10 was highest level of comfort, how would you rate your comfort level with this?
	o What proportion of homeowners stay with you throughout the evaluation?
	o Are there any particular parts/points/sections/steps in the home energy evaluation when homeowners are most interested?
	o Are there any particular parts/points/sections/steps in the home energy evaluation when you insist that homeowners accompany you?
	o (Maybe) Are there ever evaluations where homeowners do not accompany you at all?
	    ▪ [If yes] About what proportion is this?
	o Is this because someone else attends the evaluation instead?
	    o Who?
	    o Does that change whether you ask them to follow you or not at ____ point in the evaluation?

6.1	In your experience, what type of information are homeowners looking for?
Prompt	[If long enough] Has this changed between EnerGuide for Houses and ecoEnergy?
Visual	Present home energy evaluator with Question Card 1
6.2	How important are the following to homeowners to achieve from having a home energy evaluation performed? That is, based on your observations, rate the importance of the following from the homeowners' perspective. (1= Lowest level of importance, 10= Highest level of importance) ❑ Increase personal comfort ❑ Gain knowledge about how their home works in relation to energy usage ❑ Save money on energy bills ❑ Environmental—reducing greenhouse gas emissions ❑ Maximize grants received ❑ Improve occupant health by improving conditions of the home
Sub-question	Can you tell me why you rated them this way?
Prompt	I noticed that you have rated X, Y, Z all the same. Are there any that you think are more, or less, important to the homeowner, or do you think that they are equally important? Can you tell me why you think this?
6.3	Considering home energy evaluation, are there any more steps involved between knocking on the door, and the homeowner receiving their recommendations package that we have not covered?

ADVICE SELECTION AND COMMUNICATION

The purpose of this section is to understand the thought process they go through in selecting their advice, and to understand how they determine what makes it onto the homeowner's list.

7	How do you determine which improvements to recommend to a homeowner?
Prompt	Besides ________(factor just mentioned), which other factors do you take into consideration? Or Which factors do you take into consideration? • Which factors are most important? • Which are least important?
7.1	Do you usually recommend savings in your report which you don't think are important, or only for information?
Visual	Present home energy evaluator with Question Card 2
7.2	Select the statement that you agree with most: Statement 1: I want to make sure that homeowners know all of the possible improvements they can make, even if they won't make them all. Statement 2: I want to recommend only the most effective improvements the homeowners can make to keep them focused on an achievable list.
Sub-question	Has your approach changed over time?
7.3	What is the single most important improvement a homeowner typically can make to improve the home's energy performance?
8	How do you communicate your recommendations to homeowners?
Prompts	Do you sit down with them at the table? Can you give me an example? Can you give another? Besides _____ (information discussed) is there any other information you typically show them? Do you display the ecoEnergy [EnerGuide] pamphlet which contains the list of grants? Do you usually display the ecoEnergy program or EnerGuide program list to the homeowner as you give advice? Do you show information describing the technologies? (i.e., Keeping in the Heat) Do you bring out the list of certified contractors? In what order do you communicate your recommendations? Do you discuss them in order of importance or in the order given in the pamphlet? Do you encourage them to contact you with questions after the report arrives?
8.1	In your experience, is there information or advice which is typically more difficult for homeowners to understand? How have you gotten around this communication barrier?
Visual	Present home energy evaluator with Question Card 5
8.2	What are important opportunities that homeowners can gain from a home energy evaluation? That is, from your own perspective, please rate the importance of what you think homeowners can achieve from a home energy evaluation. (1= Lowest level of importance, 10= Highest level of importance) ❑ Increase personal comfort ❑ Gain knowledge about how their home works in relation to energy usage ❑ Save money on energy bills ❑ Environmental—reducing greenhouse gas emissions ❑ Maximize grants received ❑ Improve occupant health by improving conditions of the home

Sub-question	Can you tell me why you rated them this way?
Prompt	I noticed that you have rated X, Y, Z all the same. Are there any that you think are more, or less, important for the homeowner to gain during the evaluation, or do you think that they are equally important? Can you tell me why you think this?
Visual	Present home energy evaluator with Question Card 6
8.3	Have you ever said anything like: [This is a loss framed statement] "If you don't seal your fireplace, you're throwing money up the chimney as wasted heat!"?
Sub-question	[if yes] In what proportion of home energy evaluations do you estimate that you have said something like this?
If confusion Visual	resent home energy evaluator with Question Card 7
	"If you don't fix this problem, you're wasting energy, it's like throwing money out the window!"
	[if yes] In what proportion of home energy evaluations do you estimate that you have said something like this?
Visual	Present home energy evaluator with Question Card 8
8.4	Have you ever said anything like: [This is a gain framed statement] "If you were to improve [x problem], you'll increase your energy savings and save money on your energy bill" ?
Sub-question	[if yes] In what proportion of home energy evaluations do you estimate that you have said something like this?
If confusion visual	Present home energy evaluator with Question Card 9
	"If you were to make X improvement, you'll save energy"
Sub-question	[if yes] In what proportion of home energy evaluations do you estimate that you have said something like this?
Visual	Present home energy evaluator with Question Card 10
8.5	Have you ever said anything similar to: [This is a statement about other "super conservers"]"I just finished the second evaluation on a home similar to yours. They originally had the same problems with drafts in their house, and they took the same action I'm recommending to you, insulating their walls and basement, and now they have managed to save X% off their energy bill, and they reduced their greenhouse gas emissions by one tonne per year." ?
Sub-question	[if yes] In what proportion of home energy evaluations do you estimate that you have said something like this?
If confusion visual	Present home energy evaluator with Question Card 11
	I have evaluated dozens of homes like yours. I tell you, I've seen some homeowners of these types of houses put a lot of effort into [x measures] and when they did that, they really reduced their energy bills and saved a lot of greenhouse gases. They accomplished this on homes just like yours!

Sub-question	[if yes] In what percent of home energy evaluations do you estimate that you have said this?
Visual	Present home energy evaluator with Question Card 12
8.6	Have you ever said anything like: [This is a vivid statement] "When you add up the effect of all of the leaks in your walls, you would have a hole the size of a window in the middle of your dining room."?
Sub-question	[if yes] In what percent of home energy evaluations do you estimate that you have said this?
Visual	Present home energy evaluator with Question Card 13
	"To improve the air tightness of your home, imagine you're trying to waterproof a boat."
Sub-question	[if yes] In what percent of home energy evaluations do you estimate that you have said this?
Sub-question	Among the four types of sentences (two of each) above, can you give an indication of how often you use each? For instance, you can order them from most used, to least or never used?
8.8	Besides the report, what else is important information to communicate to homeowners in a home energy evaluation?
Prompt	How do you communicate this information? Can you give me an example?

ELEMENTS OF SUCCESS

9	What do you consider to be a successful initial home energy evaluation?
9.1	What do you consider to be a successful follow-up home energy evaluation?
9.2	What do you consider to be an unsuccessful initial home energy evaluation?
9.3	What do you consider to be an unsuccessful follow-up home energy evaluation?
9.4	Do you have any suggestions on what could be done to improve the success of home energy evaluations?

WRAP UP

10	I have one final short question: can you tell me, how did you decide on the number of occupants in the building to put into the HOT2000 energy model?
11	Is there anything else you would like to tell me, or clarify?
12	Do you have any questions for me?
13	Please, may I contact you again if any other questions come up?

Appendix F
Appreciation Letter

Dear (***Name***);

I am writing to thank you for a stimulating interview last week. I appreciated gaining your perspective about providing home energy evaluations. It was indeed a pleasure meeting you.

My project, *Understanding the impact of evaluators and advice strategies on greenhouse gas reductions and the selection of energy efficiency improvements in the Residential Energy Efficiency Project (REEP)*, is proceeding according to design, and in particular my research for the chapter on the impacts of advice strategies is nearing completion.

I hope you will get in touch with me if further thoughts occur to you about the subject of our conversation, particularly if you decide in retrospect that you would like to designate some of it for non-attribution. Should you have any comments or concerns you could also contact Dr. Susan Sykes of our Office of Research Ethics at 519-888-4567 Ext. 36005 or ssykes@uwaterloo.ca. This project was reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo.

I shall as promised, be sending you a typescript copy of the chapter, for your criticism and comments. I expect it to be ready for your review by January or February, 2012.

Sincerely,

Christina Hoicka

Appendix G

Letter of Recruitment to REEP Schedulers

September 26, 2011

Dear scheduler,

This letter is sent to you by the Residential Energy Efficiency Project on behalf of the researcher. You are invited to participate in a study I am conducting as part of my doctoral degree in the Department of Geography and Environmental Management at the University of Waterloo under the supervision of Professor Paul Parker. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

Information, including tailored advice, is understood as a key factor in influencing greener consumption decisions. In the case of home energy consumption, providing households with information about energy-saving options is typically viewed as a solution to overcome barriers to investments in energy efficiency. That is, the provision of information may result in increased household energy savings. Further, there is wide agreement that the persuasiveness of information in influencing behaviour change is determined by a variety of factors. These include factors which shape the structure and delivery of the information, combined with how the receiver receives the information. The Residential Energy Efficiency Project has been successful in delivering home energy efficiency programs since 1999. The purpose of this study, therefore, is to understand success factors in communicating advice to homeowners in influencing the decision to make energy efficiency improvements.

The Residential Energy Efficiency Project has delivered a very successful home energy efficiency program. This study will focus on how advice was selected and delivered by home energy evaluators within the Residential Energy Efficiency Project. In particular, I believe that home energy evaluators at the Residential Energy Efficiency Project may have unique ways of deciding on home energy advice and communicating this advice to homeowners. Since you have worked as a scheduler for the Residential Energy Efficiency Project in Waterloo Region, I would like to include you to be involved in my study. Given your experience in scheduling the evaluators, I would like to learn about any factors which affected your decision to place an evaluator with any particular type of home. To understand patterns of advice giving, the research will also examine patterns of recommended and implemented home energy efficiency improvements in REEPs database.

Participation in this study is voluntary. It will involve an interview of approximately 20 minutes in length to take place in a mutually agreed upon location. If you are outside of Waterloo Region, I suggest we conduct the interview via skype or telephone. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. With your permission, the interview will be audio recorded to facilitate collection of information, and later transcribed for analysis. Shortly after the interview has been completed, I will send you a summary of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish.

I would like to assure you that no one at REEP will know who participated in this study or not (unless you choose to participate and provide this information to REEP). A decision to participate or not will have no impact on your job at REEP or relation with REEP. All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used. Data collected during this study will be retained for three years in a locked filing cabinet in the researcher's or supervisor's locked office. Electronic data will be encrypted and stored indefinitely on an external hard drive with no personal identifiers. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study.

If you would like to participate in this study, please contact me directly at **519-xxx-xxxx** or by email at **choicka@uwaterloo.ca**, so that we may arrange an interview. You can also contact my supervisor, **Professor Paul Parker** at **519-888-4567 ext. 32791** or email **pparker@uwaterloo.ca**. If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me.

I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes of this office at 519-888-4567 Ext. 36005 or ssykes@uwaterloo.ca.

I believe that this will be one of the first studies from the perspective of the evaluator, and will highlight the importance of the evaluator in the process of home energy evaluations. I hope that the results of my study will be of benefit to the Residential Energy Efficiency Project, other researchers of energy behaviour and climate change, the designers of programs to reduce residential greenhouse gas emissions, and trainers of home energy evaluators.

I very much look forward to speaking with you and thank you in advance for your assistance in this project.

Yours Sincerely,

Christina Hoicka

choicka@uwaterloo.ca

519-xxx-xxxx

Appendix H
Interview With Schedulers

Breaking the ice

When have you worked with the Residential Energy Efficiency Project as a scheduler?

Main questions

(Show a list of advisors of interest)

From this list of advisors, can you tell me which advisors you have scheduled?

(Referring to short list of advisors) Can you tell me, were there any specific circumstances for which you scheduled any of these advisors?

(prompts)

For example, were any advisors generally scheduled for homes which were:

Significantly larger

Older or newer

With specific heating or cooling systems?

In certain neighbourhoods/regions?

Can you explain your rationale for these types of scheduling decisions?

Wrap up

Is there anything else you would like to tell me, or clarify?

Do you have any questions for me?

Please, may I contact you again if any other questions come up?

Appendix I

Grouping Energy Characteristics of Houses by Vintage

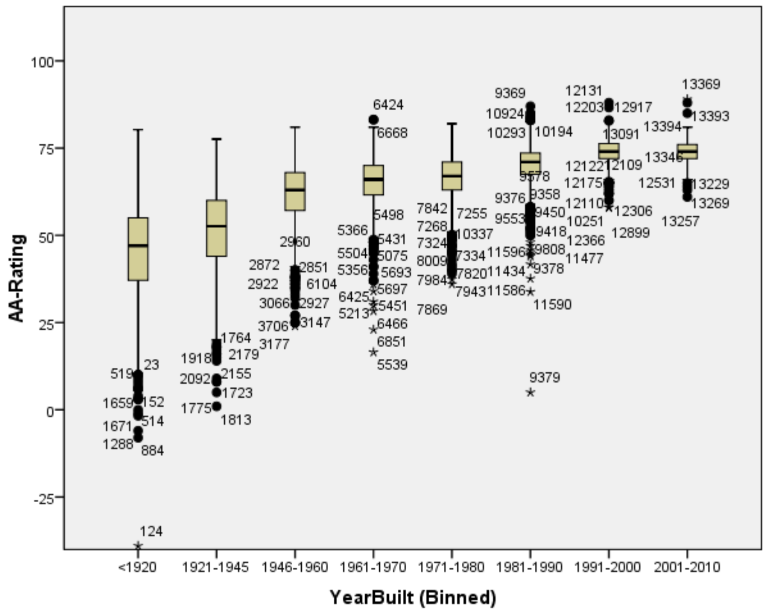


Figure 7.1 Box Plot of Energy Rating by Census of Canada Vintage Group

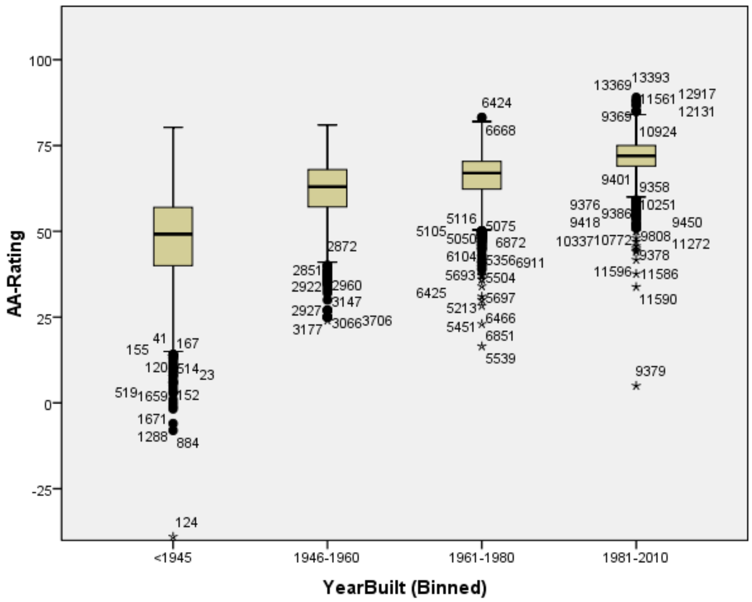


Figure 7.2 Box Plot of Energy Rating by Grouped Vintage

Appendix J
Effects of Price Paid

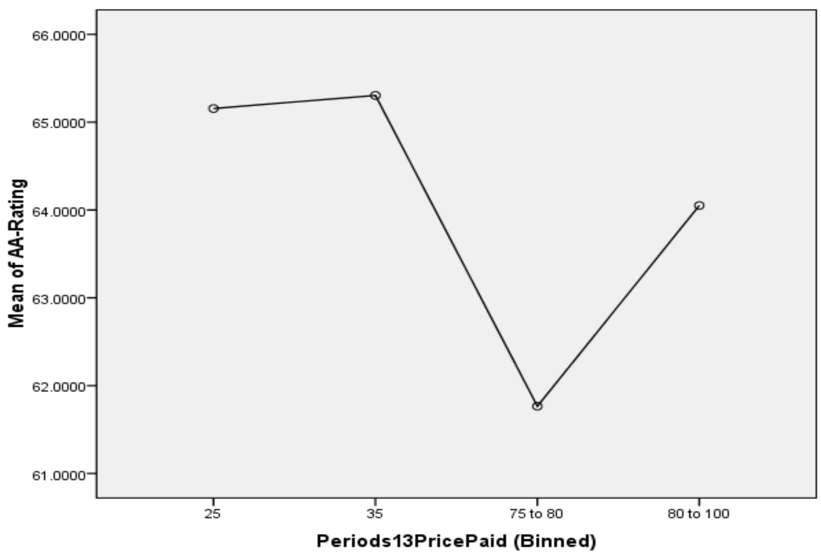


Figure 7.3 Mean Energy Rating by Price Paid in Information-Only Periods

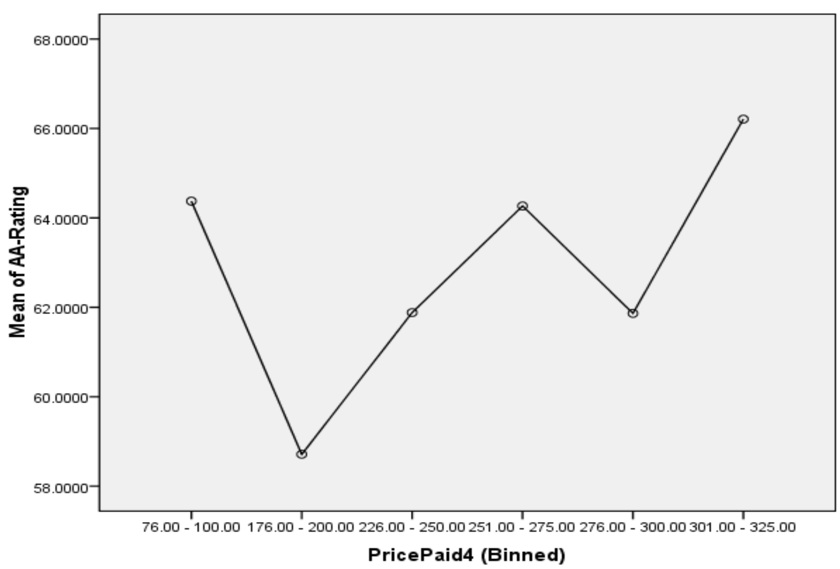
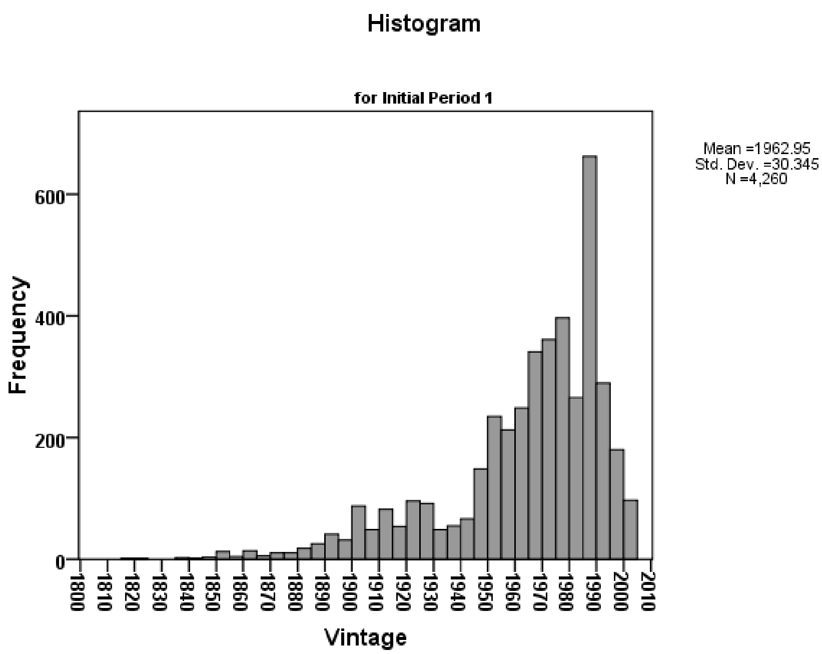
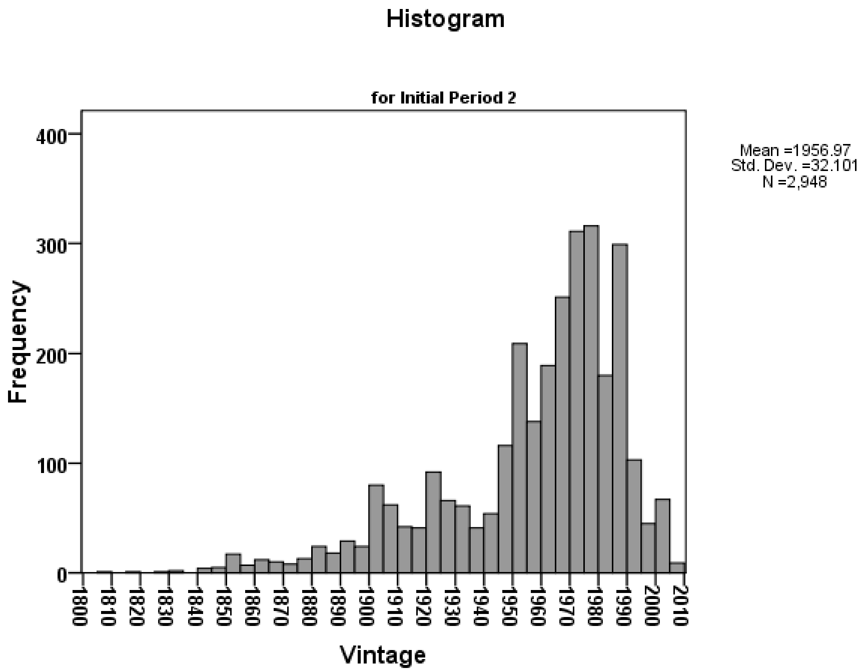


Figure 7.4 Mean Energy Rating by Price Paid in Period 4

Appendix K

Distributions of Material Characteristics of Initial and Follow-Up Groups by Period

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Frequency
Vintage
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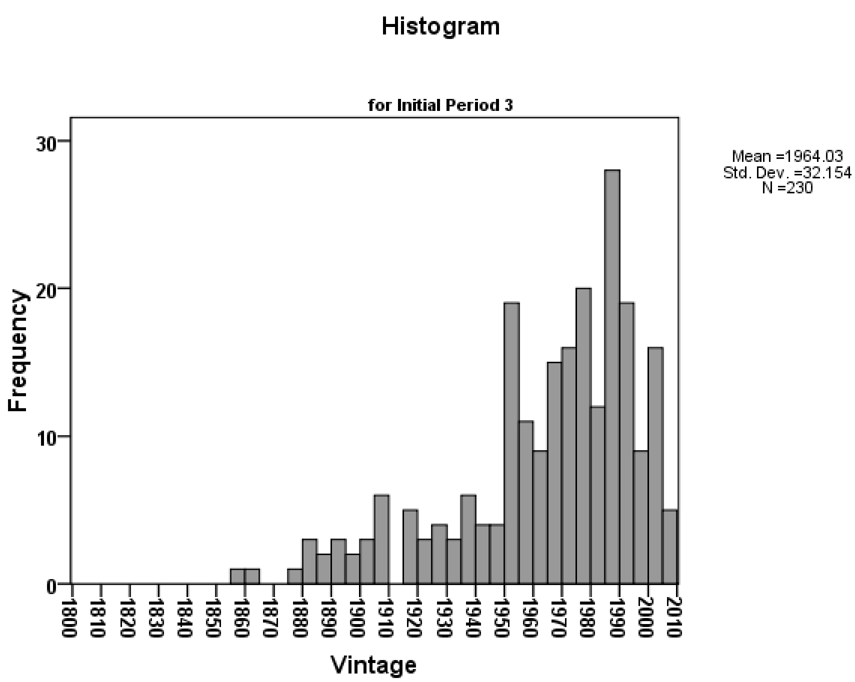
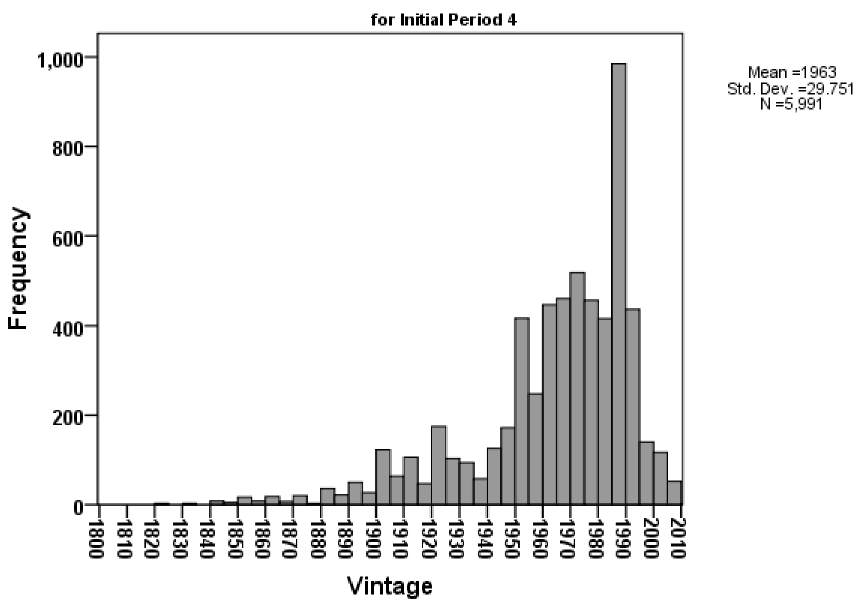
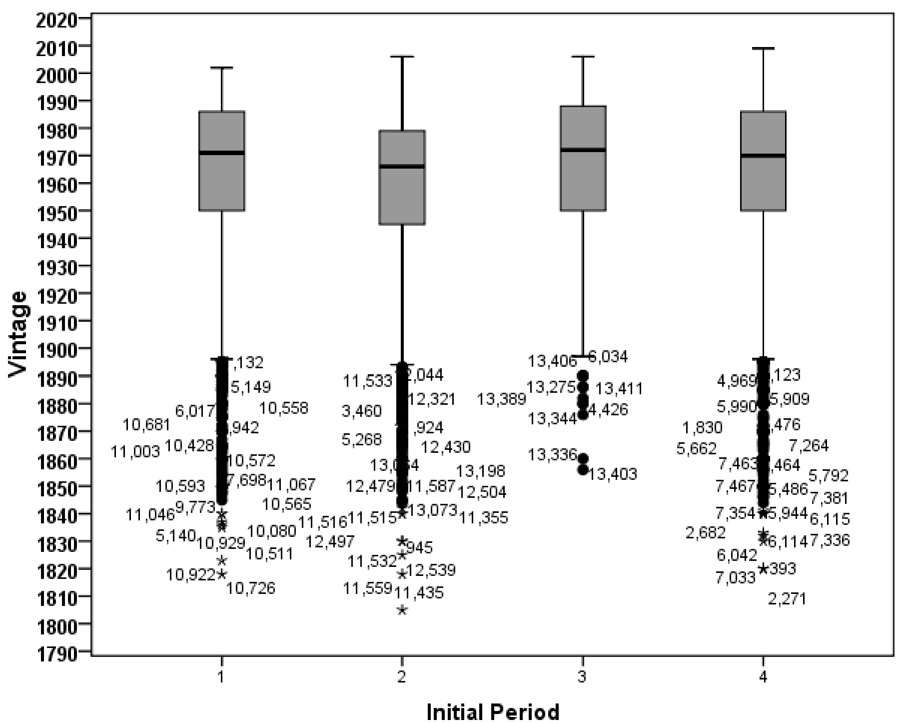
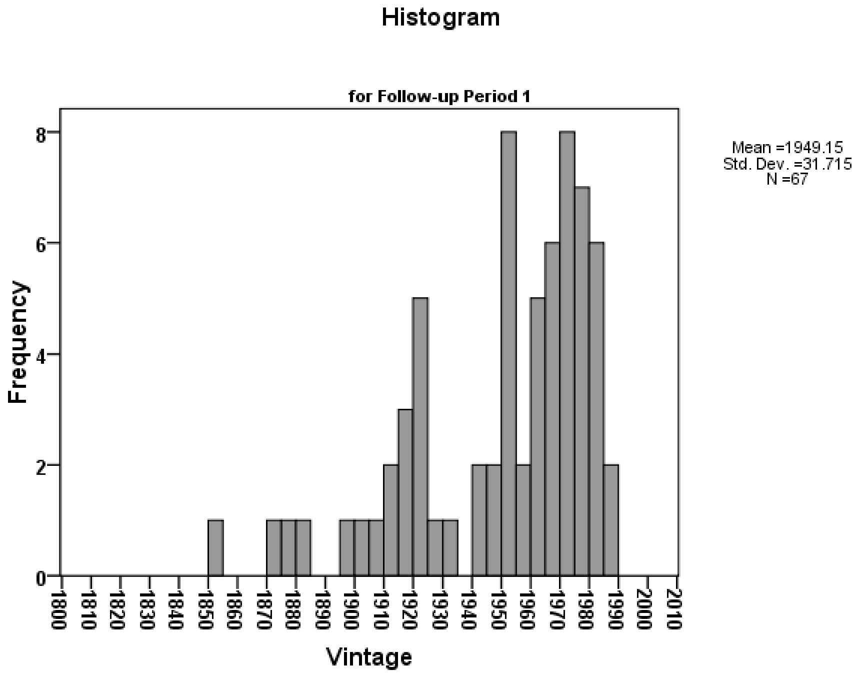
Std. Dev. =32.101
N =2,948


Histogram
for Initial Period 3
Frequency
Vintage
Mean =1964.03
Std. Dev. =32.154
N =230

Histogram


for Initial Period 4
Mean =1963
Std. Dev. =29.751
N =5,991
Frequency
Vintage


Vintage
Initial Period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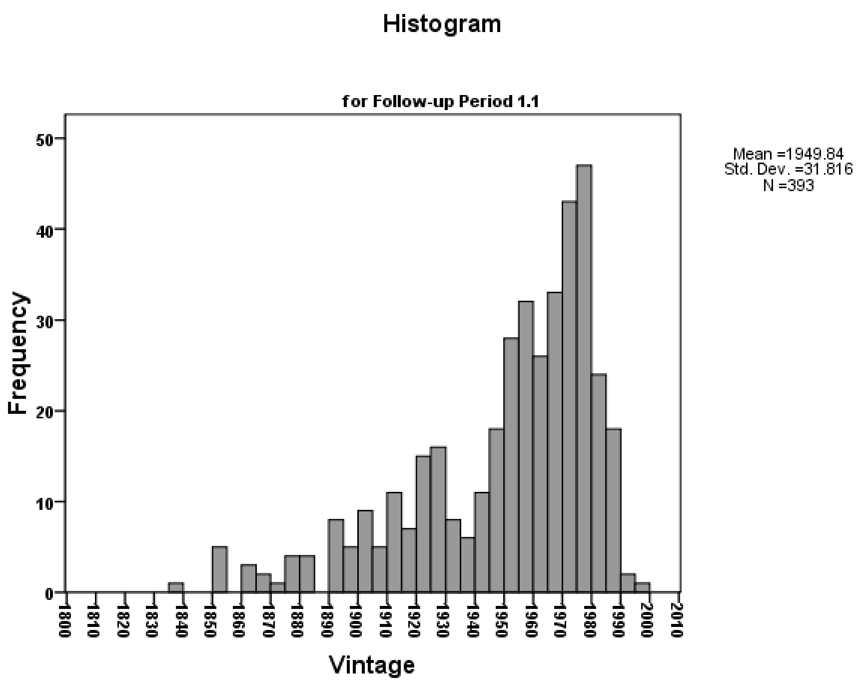
Std. Dev. =31.715
N =67
Frequency
Vintage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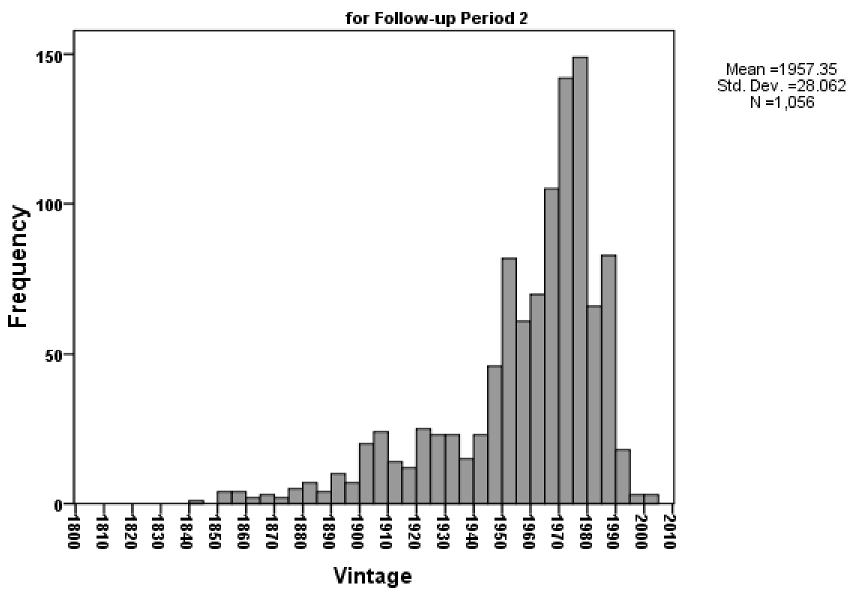
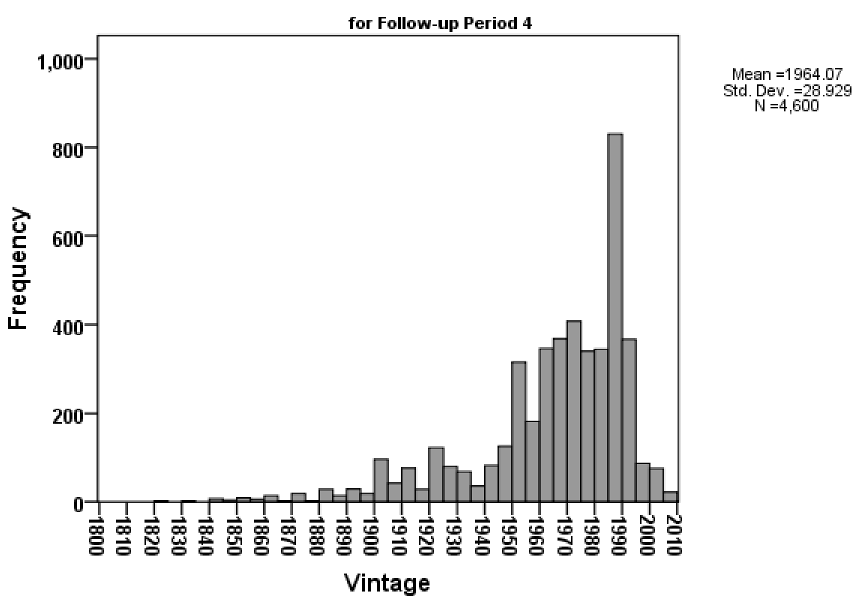
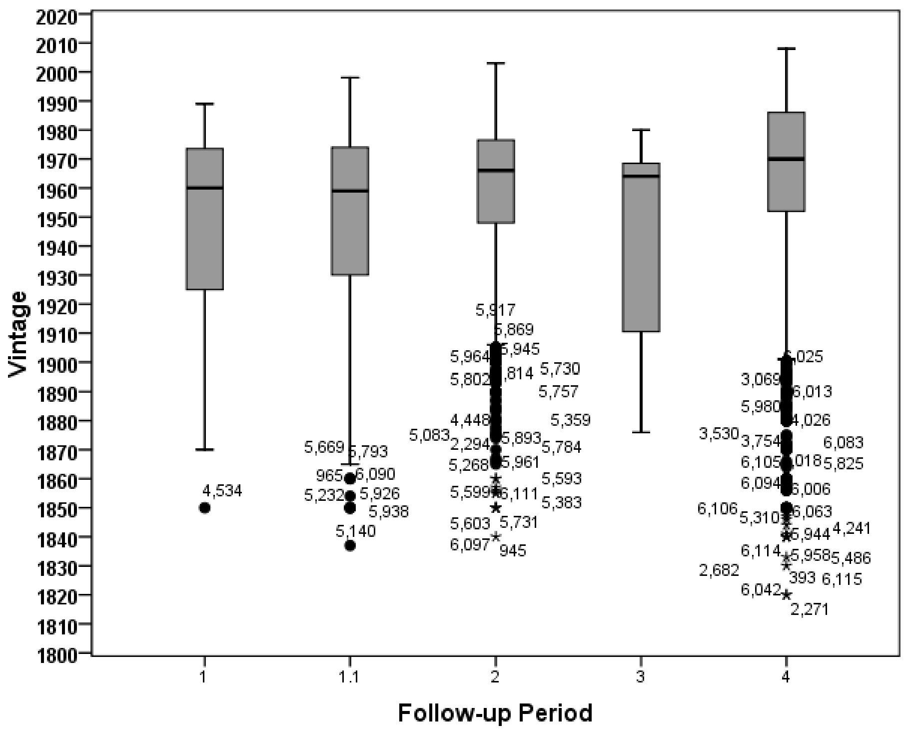
N =393
Frequency
Vintage

Histogram

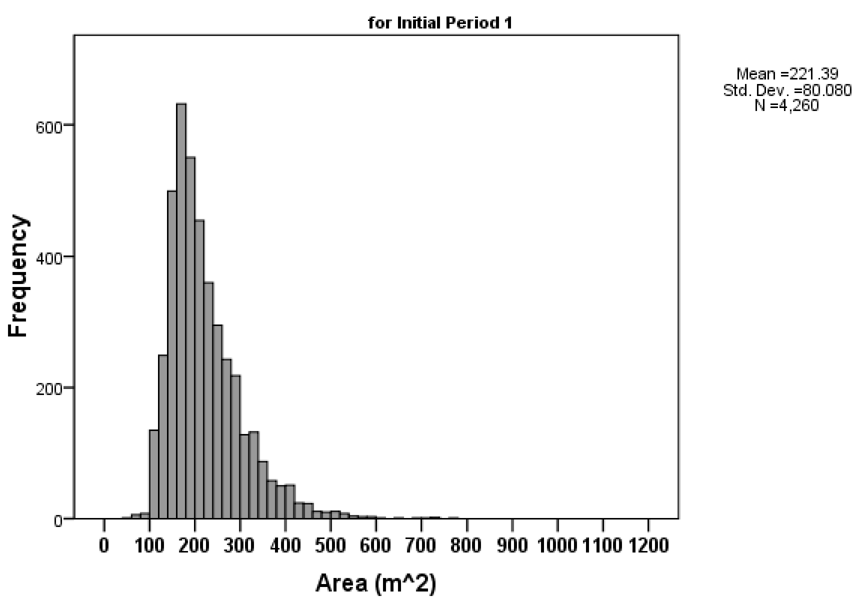


Histogram




Vintage
2020
2010
2000
1990
1980
1970
1960
1950
1940
1930
1920
1910
1900
1890
1880
1870
1860
1850
1840
1830
1820
1810
1800
1
1.1
2
3
4
Follow-up Period

Histogram


for Initial Period 1
Mean =221.39
Std. Dev. =80.080
N =4,260
Frequency
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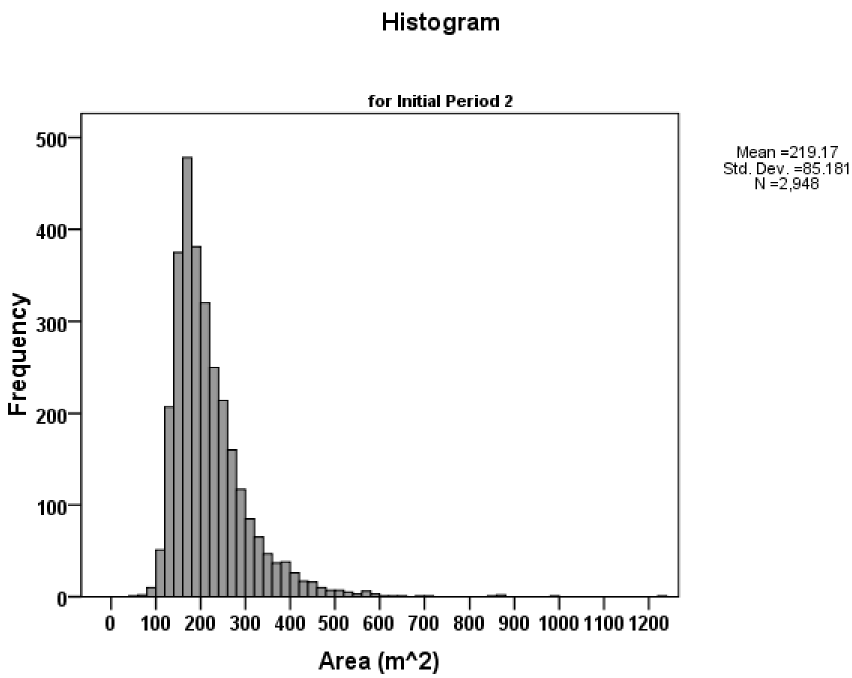
200
0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
Area (m^2)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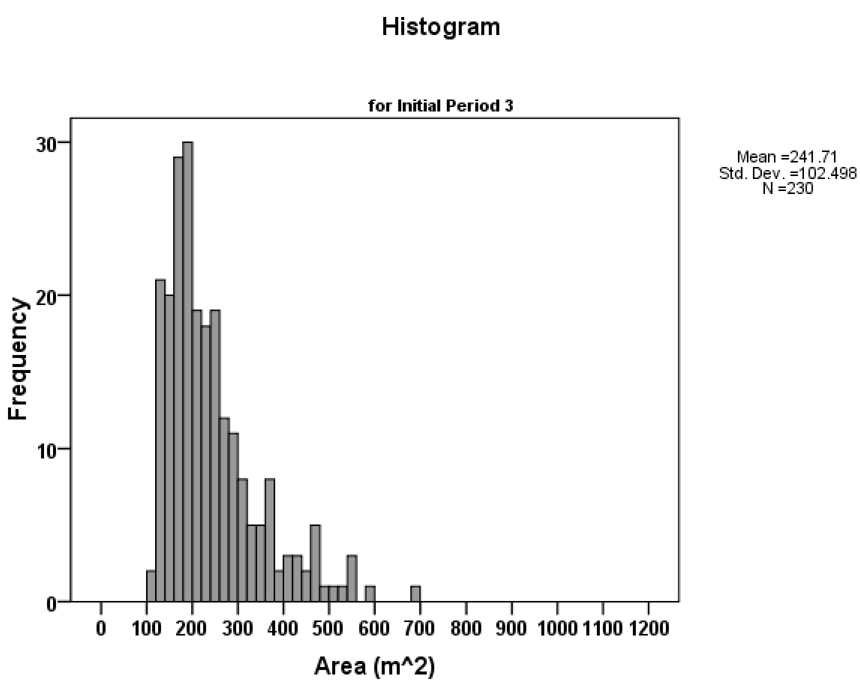
Std. Dev. =85.181
N =2,948
Frequency
Area (m^2)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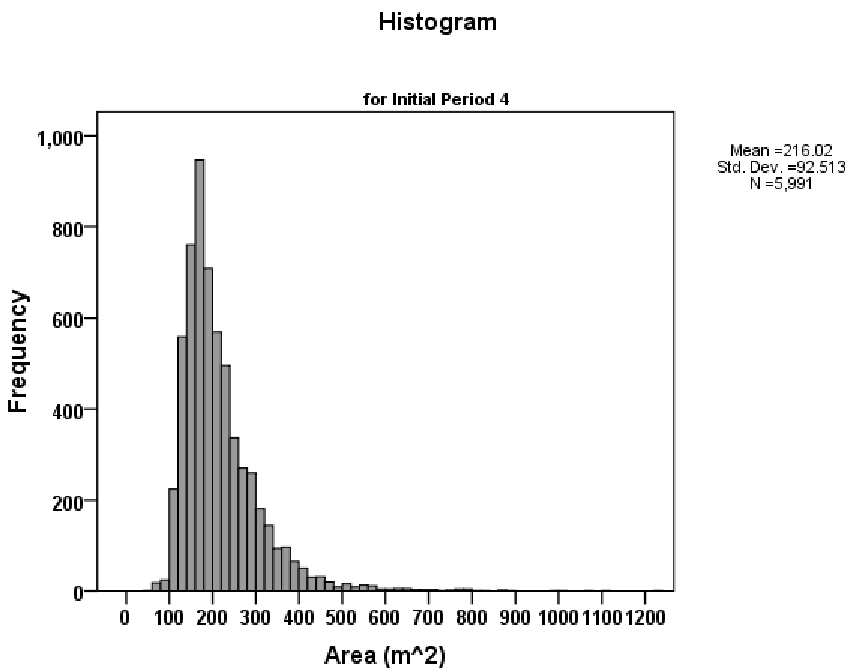
Frequency
Area (m^2)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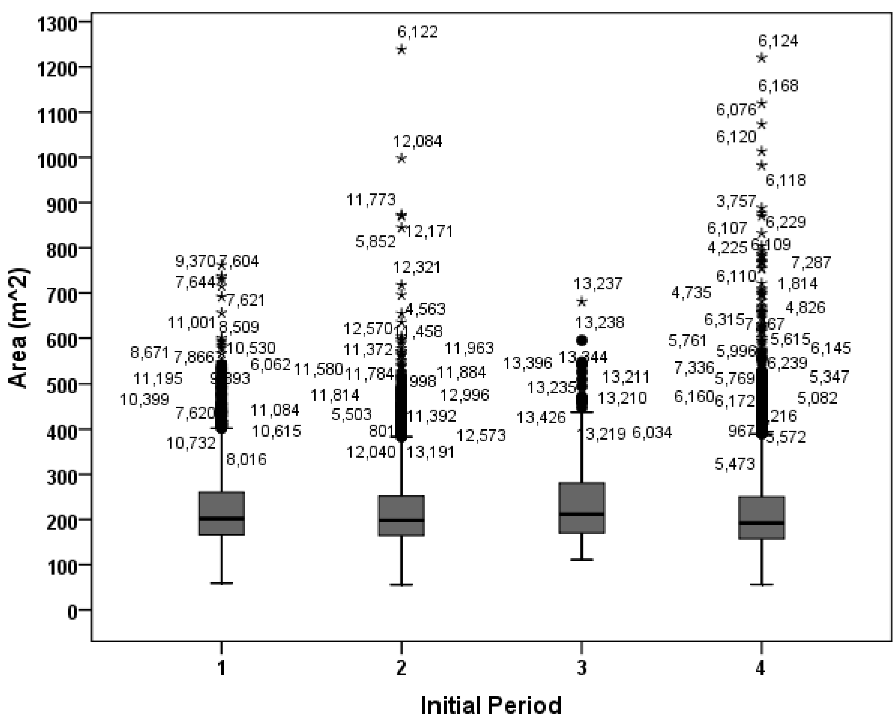
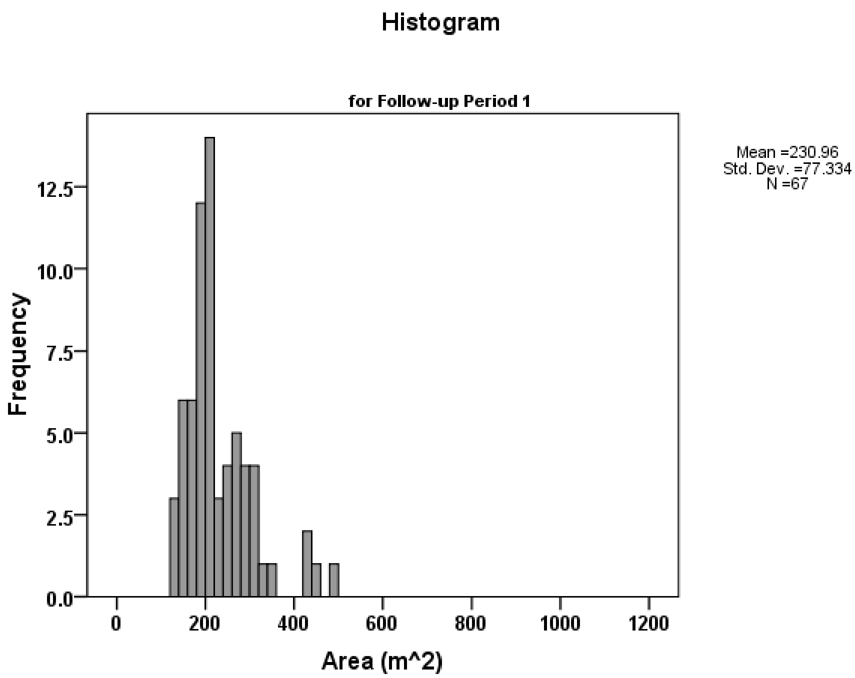
Frequency
Area (m^2)


Area (m^2)
Initial Period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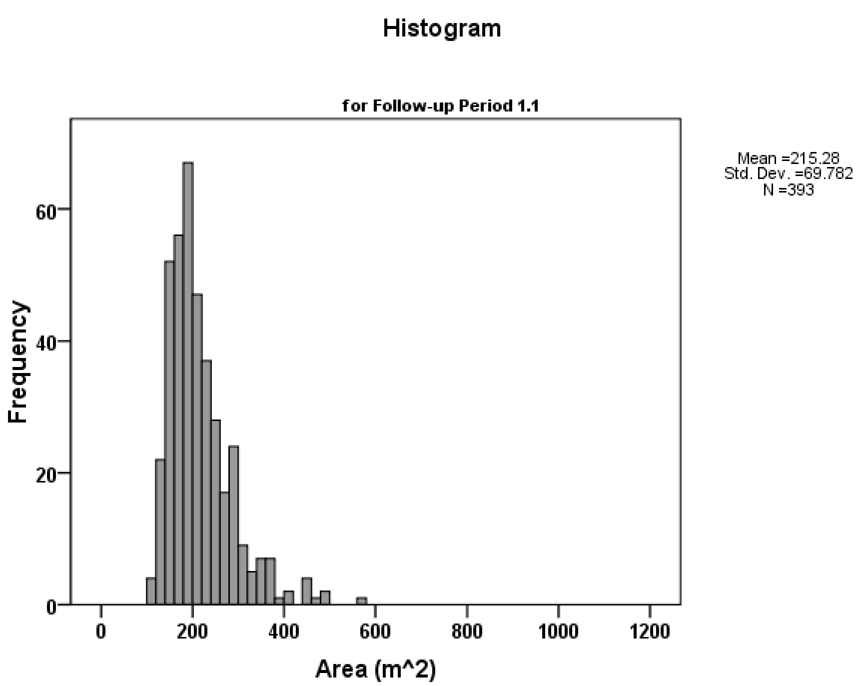
Frequency
Area (m^2)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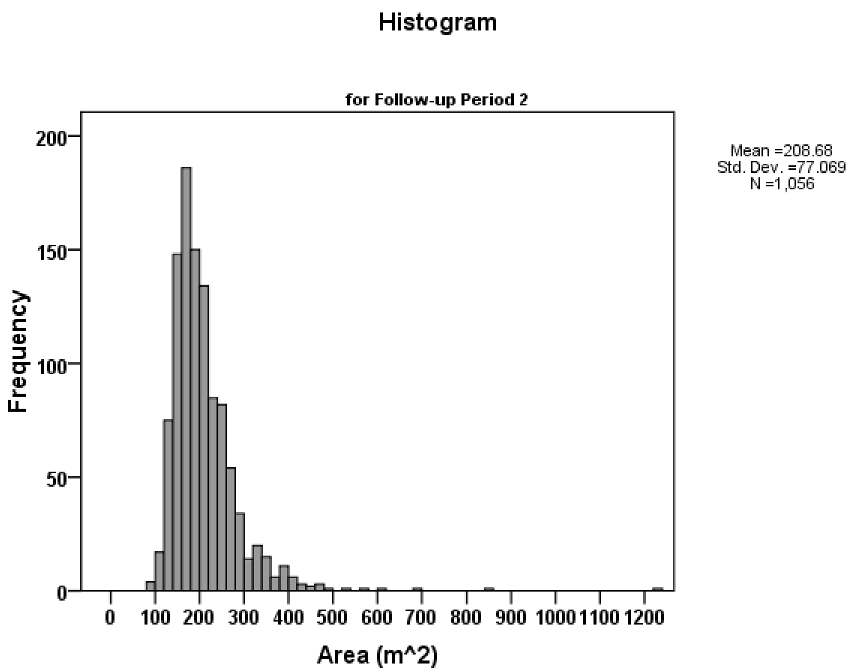
N =393
Frequency
Area (m^2)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Std. Dev. =77.069
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Frequency
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100
150
200
Area (m^2)
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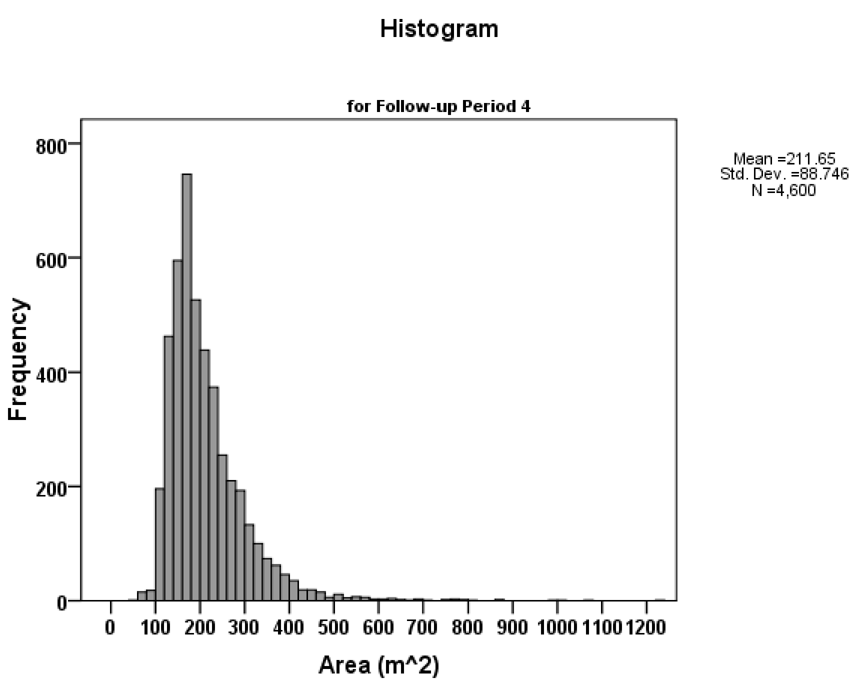
100
200
300
400
500
600
700
800
900
1000
1100
1200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Mean =211.65
Std. Dev. =88.746
N =4,600
Frequency
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600
800
Area (m^2)
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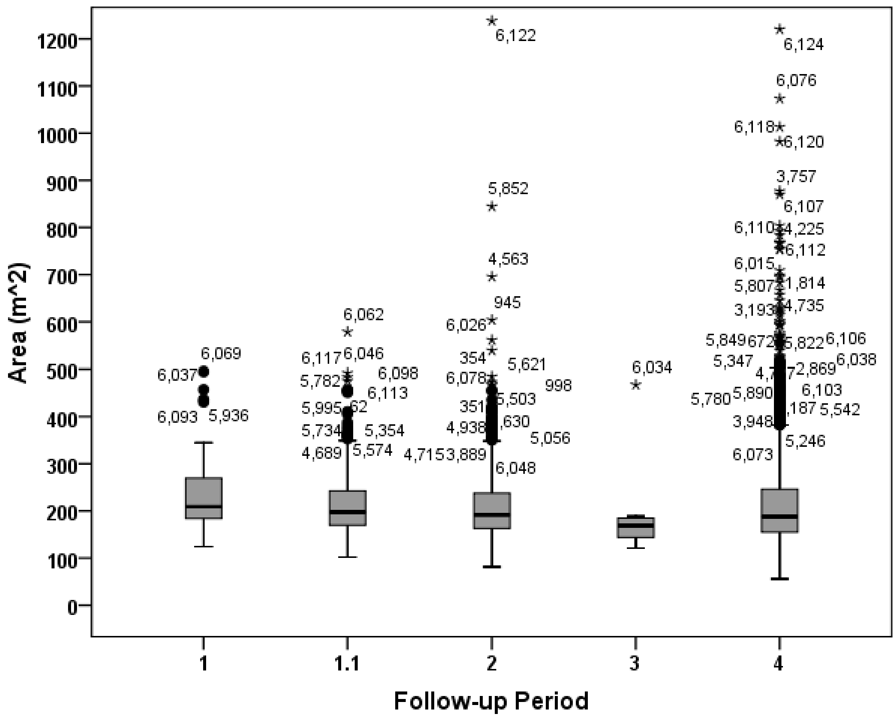
800
900
1000
1100
1200


Area (m^2)
0
100
200
300
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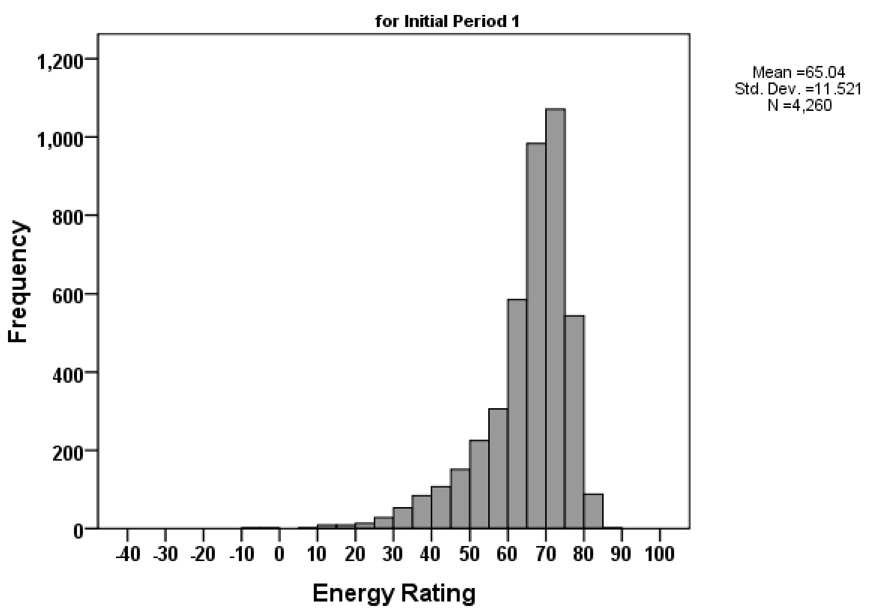
500
600
700
800
900
1000
1100
1200
1
1.1
2
3
4
Follow-up Period

Histogram


for Initial Period 1
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Std. Dev. =11.521
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600
800
1,000
1,200
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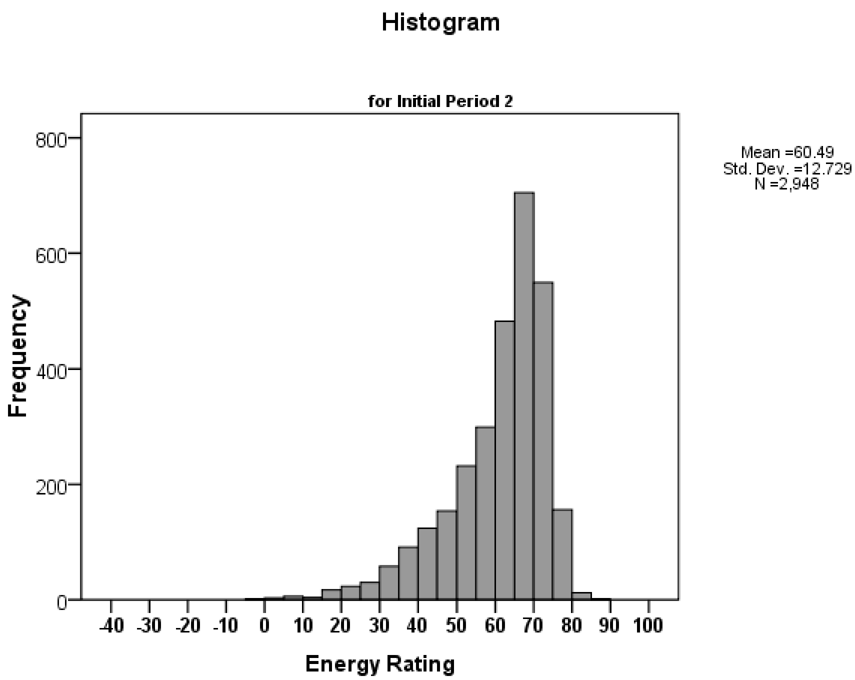
Energy Rating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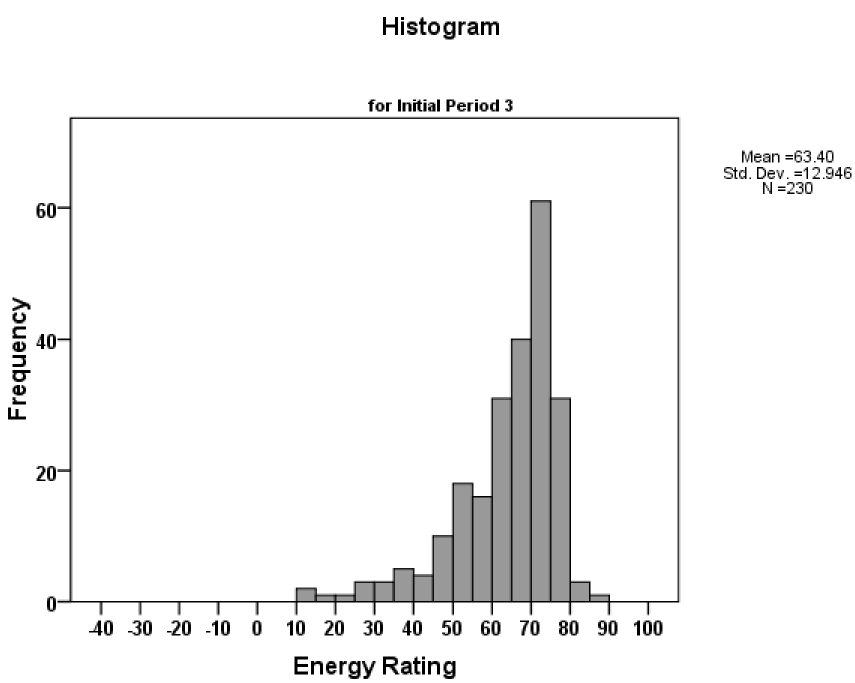
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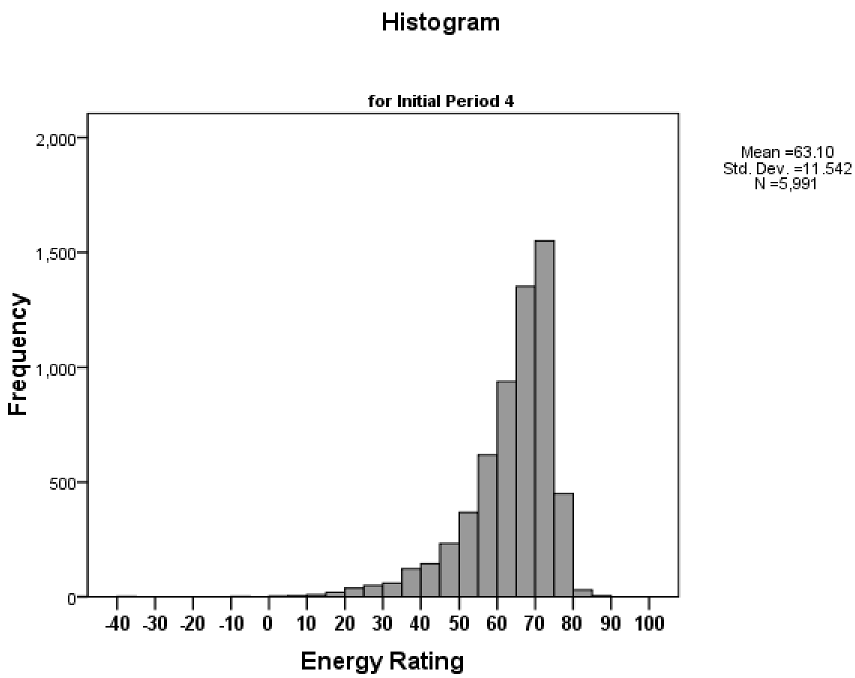
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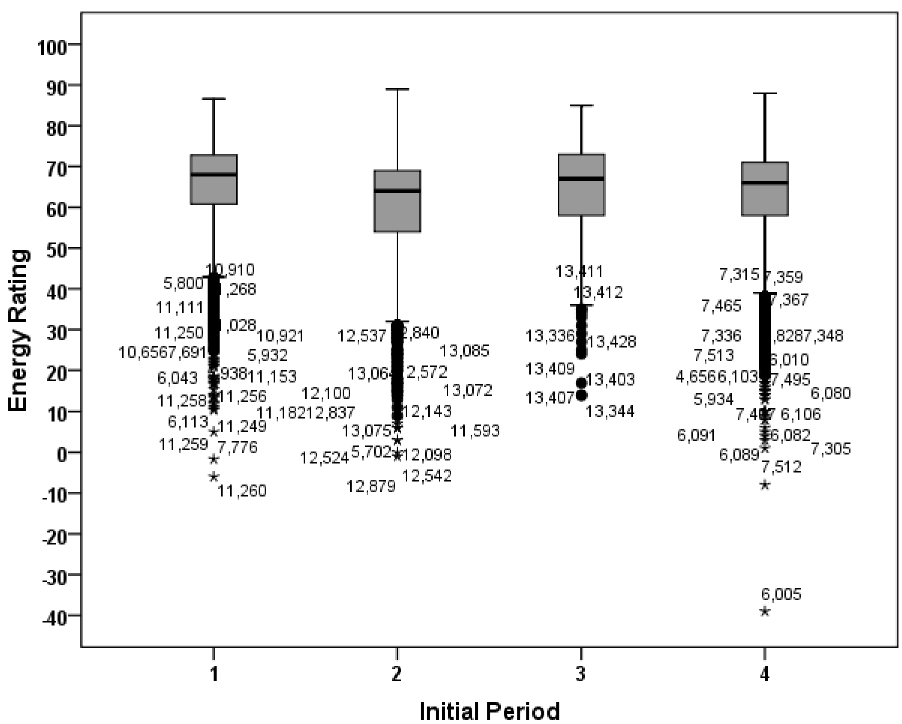
Energy Rating


Energy Rating
100
90
80
70
60
50
40
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0
-10
-20
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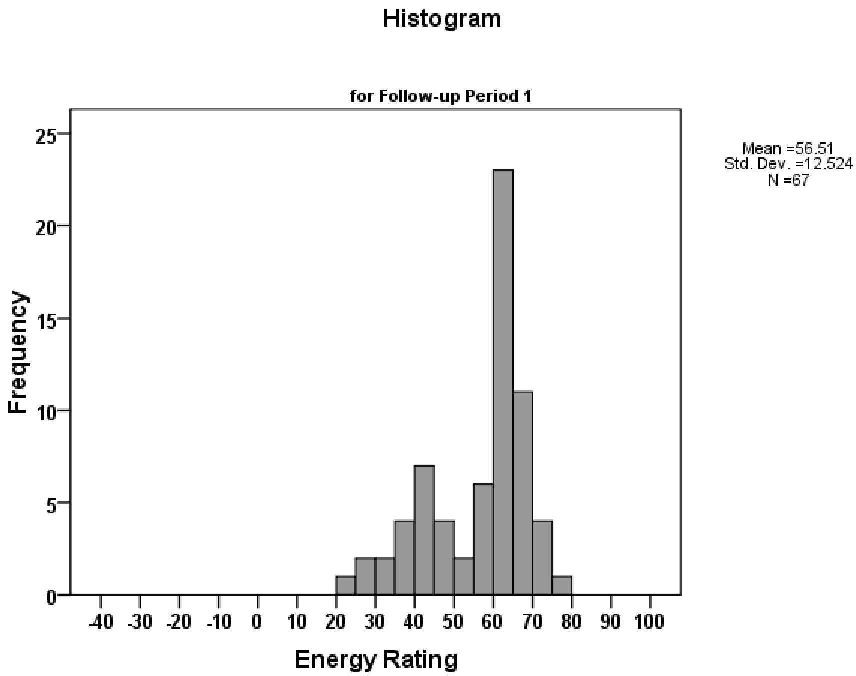
13,412
13,344
6,005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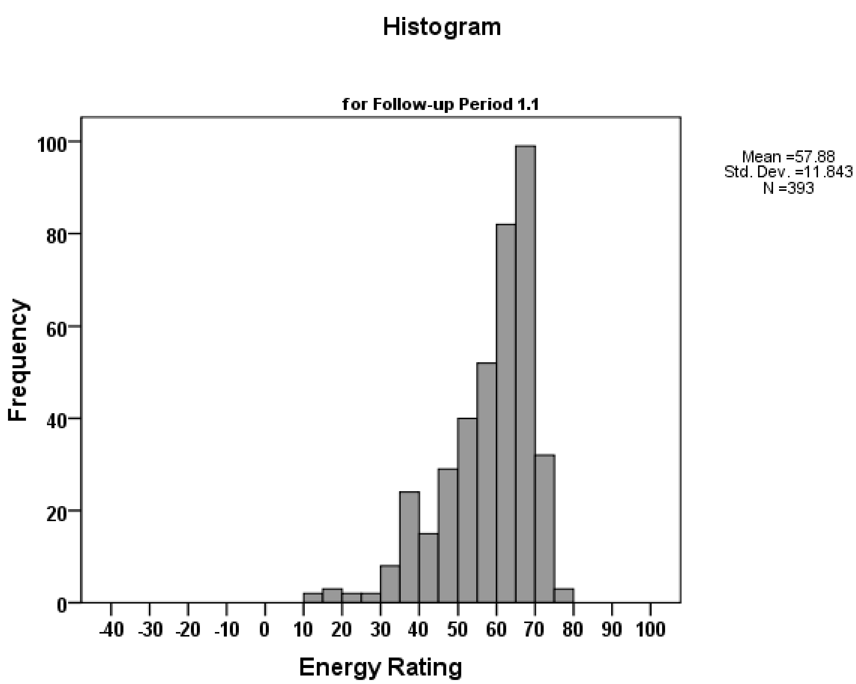
Energy Rating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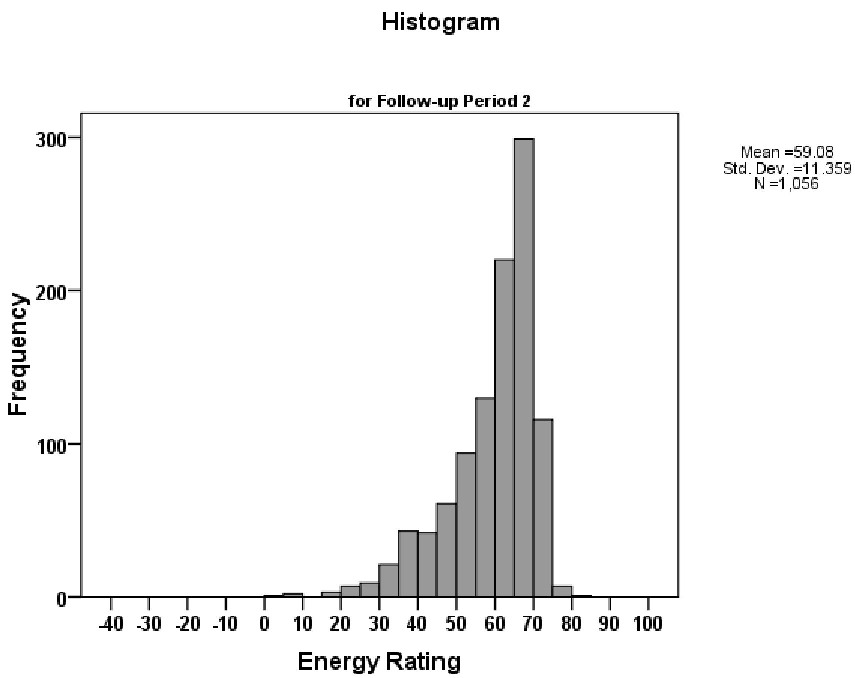
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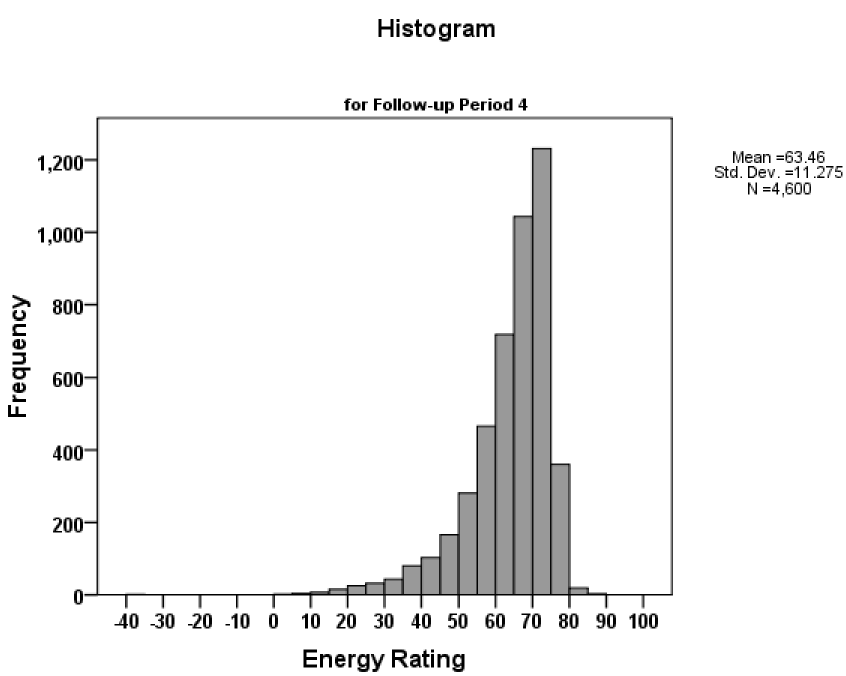
Energy Rating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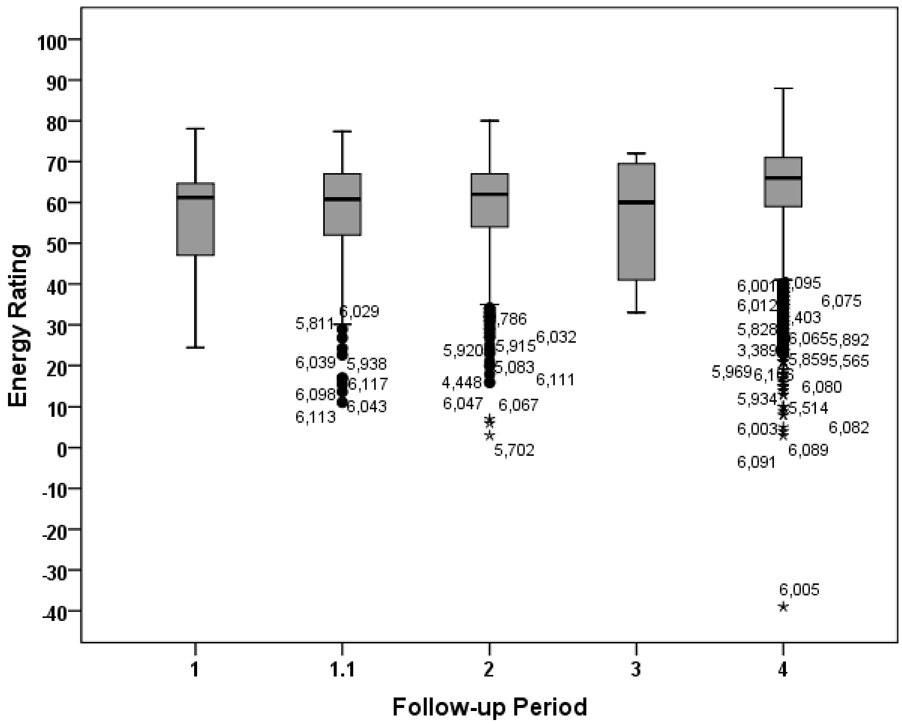
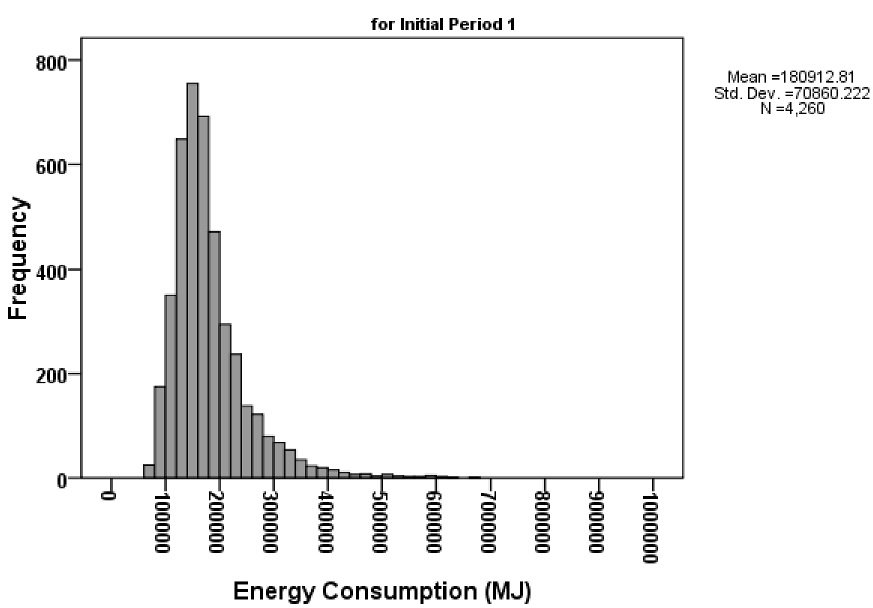
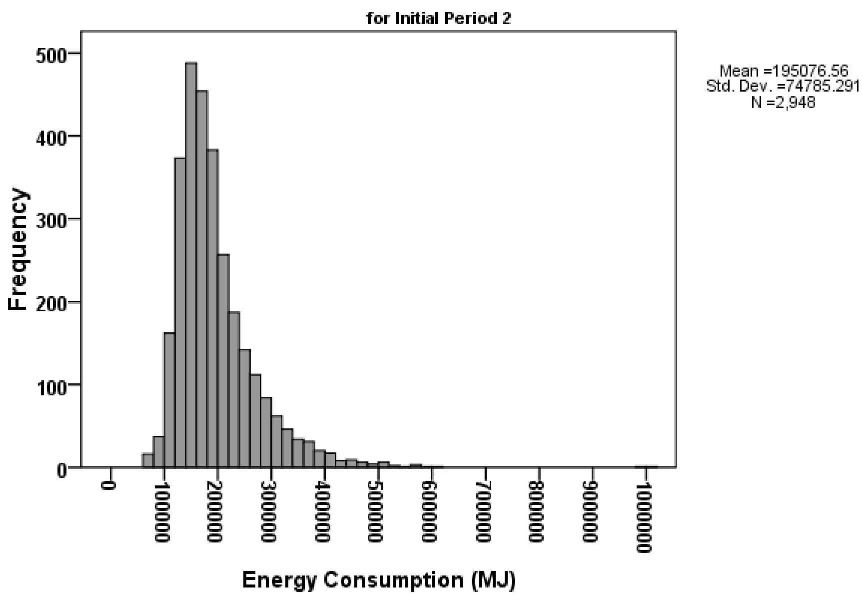
-40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
Energy Rating


Energy Rating
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
1
1.1
2
3
4
Follow-up Period
6,005

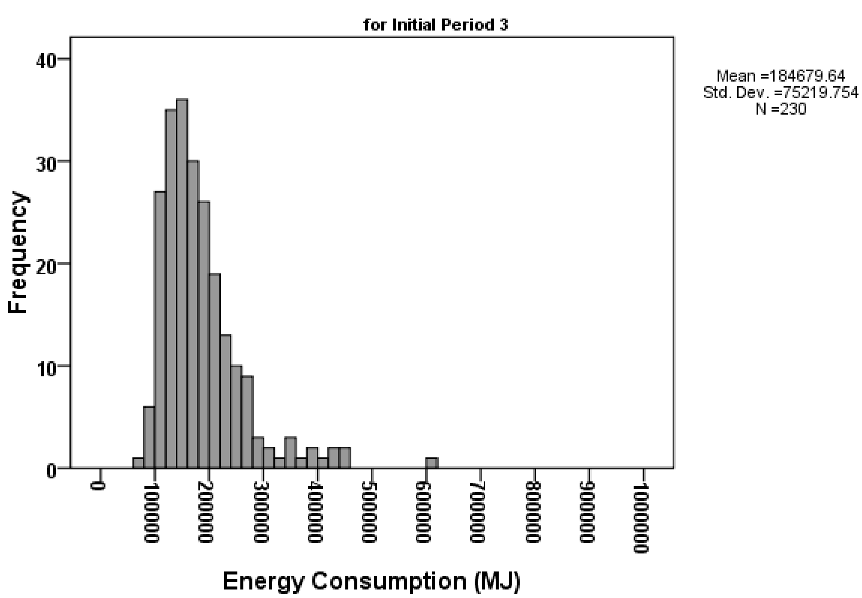
Histogram

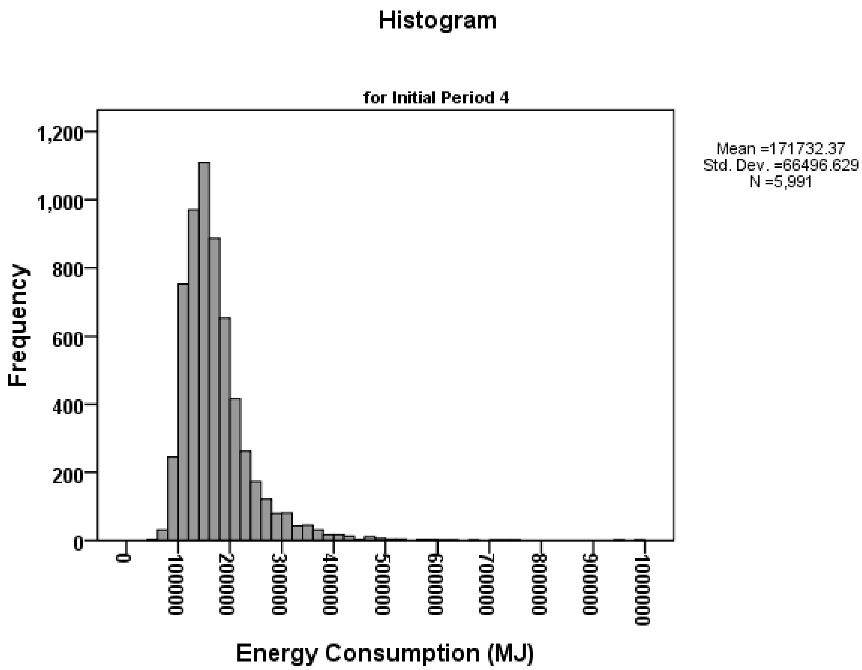

for Initial Period 1
Mean =180912.81
Std. Dev. =70860.222
N =4,260
Frequency
800
600
400
200
0
0
100000
200000
300000
400000
500000
600000
700000
800000
900000
1000000
Energy Consumption (MJ)

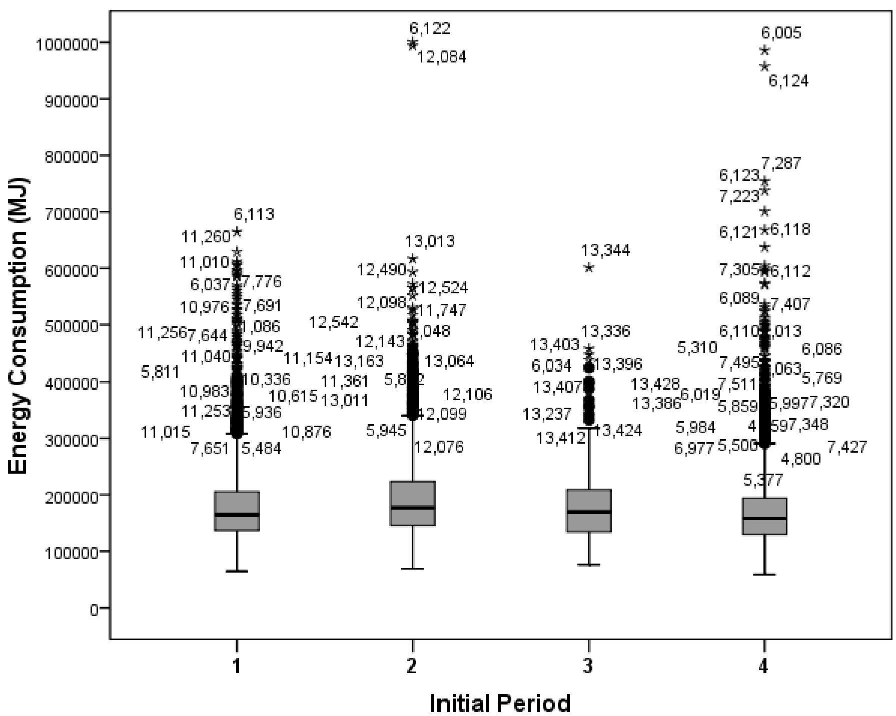
Histogram

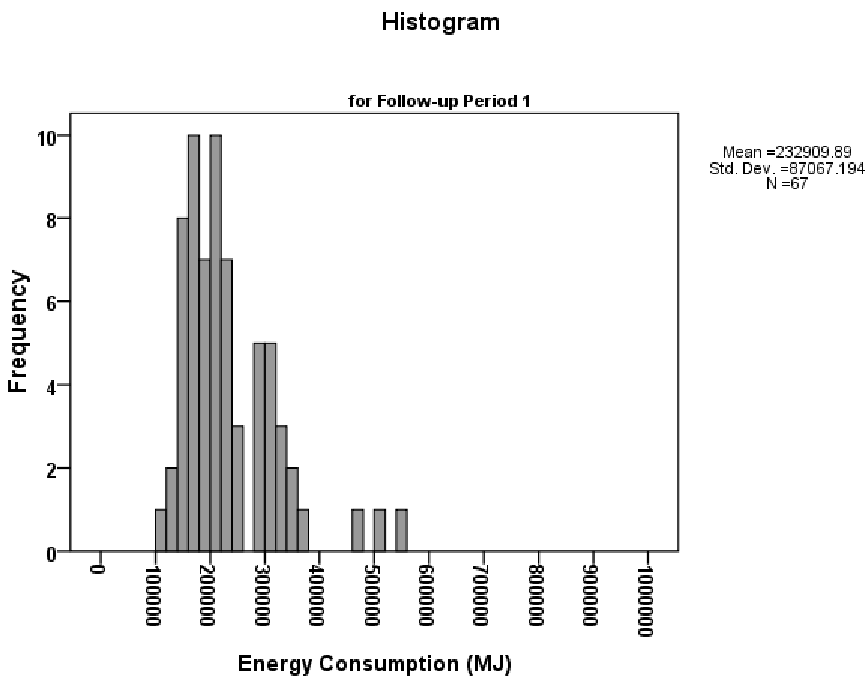


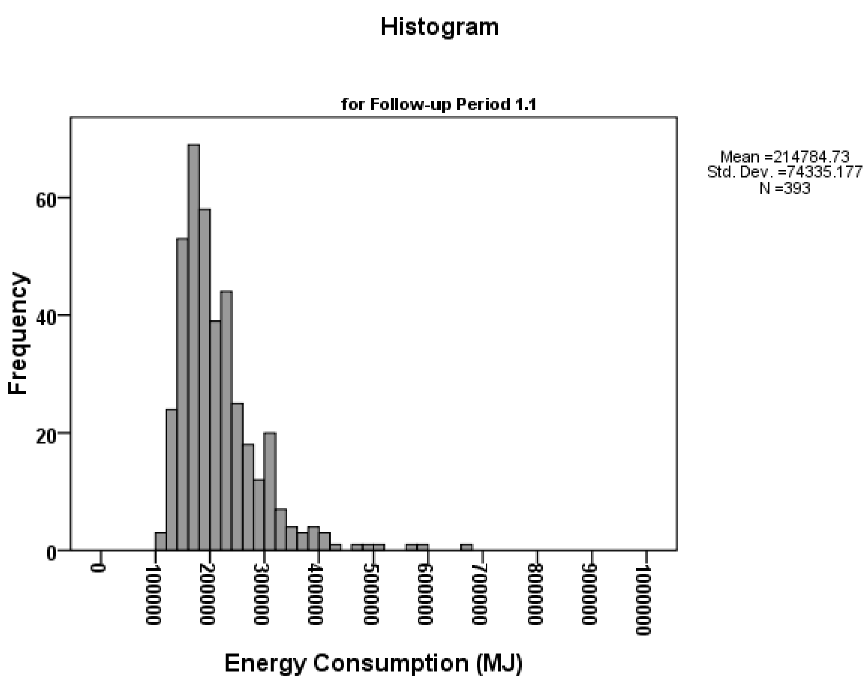
Histogram



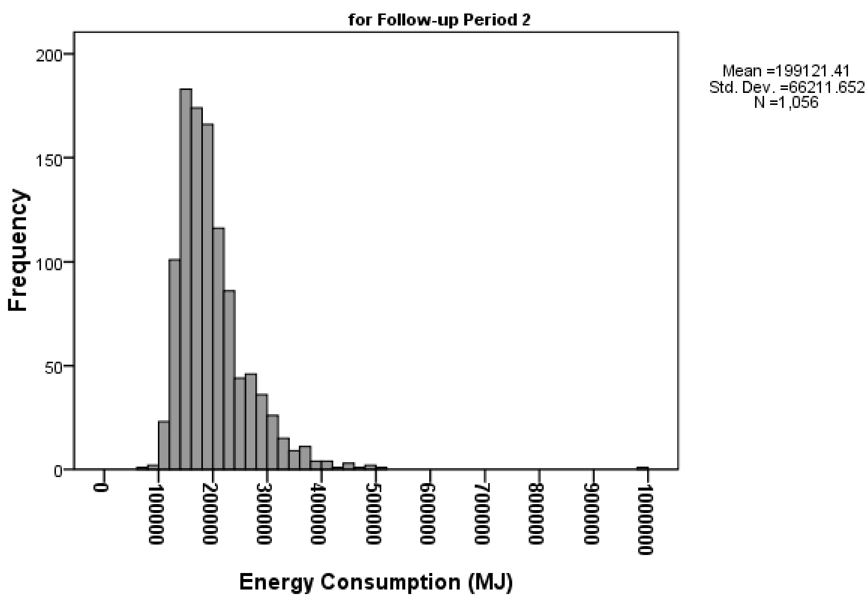

Histogram
for Initial Period 4
Mean =171732.37
Std. Dev. =66496.629
N =5,991
Frequency
Energy Consumption (MJ)


Energy Consumption (MJ)
Initial Period

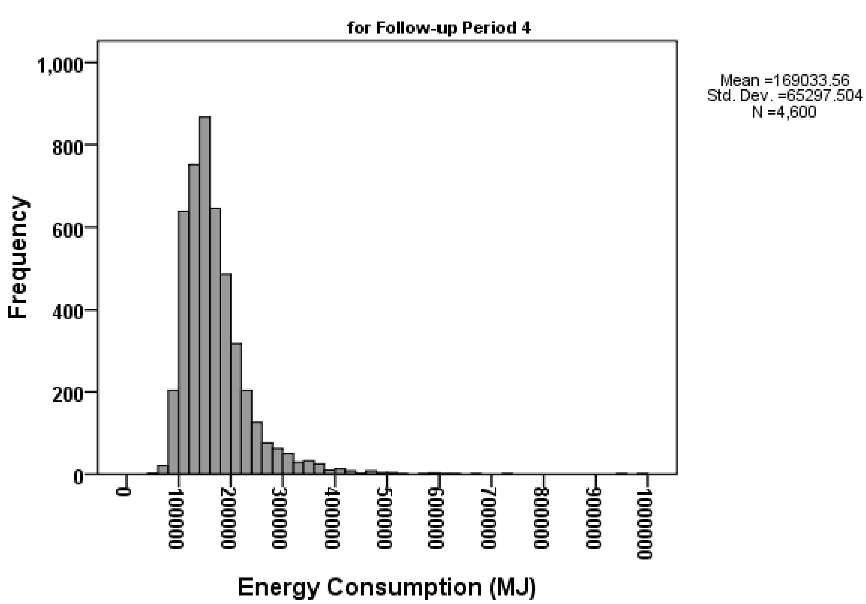

Histogram
for Follow-up Period 1
Mean =232909.89
Std. Dev. =87067.194
N =67
Frequency
Energy Consumption (MJ)

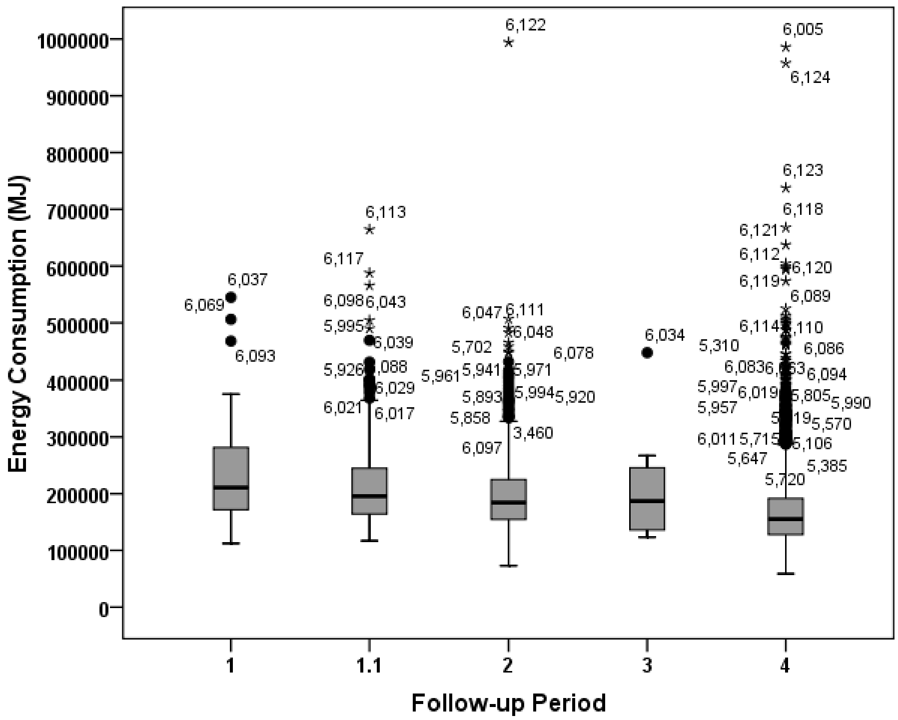

Histogram
for Follow-up Period 1.1
Mean =214784.73
Std. Dev. =74335.177
N =393
Frequency
Energy Consumption (MJ)

Histogram



Histogram





Energy Consumption (MJ)
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
1
1.1
2
3
4
Follow-up Period

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