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An Empirical Investigation of Consumer Resistance to Green Product Innovation

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Für meine Eltern

Abstract

Responding to the sustainability imperative has emerged as a key challenge and opportunity for businesses. Developing and marketing innovative “green” products in particular can be a vital strategy for businesses to increase productivity, develop new markets, improve corporate image and ultimately attain competitive advantage. But despite consumer sensitisation towards environmental issues, many sustainable products face slow rates of diffusion in mainstream markets as consumers’ green preferences regularly fail to translate into adoption behaviour. In this thesis we take a consumer resistance perspective to investigate empirically the so-called attitude–behaviour gap in the context of green product innovation. The aim of this thesis is to advance theoretically and empirically our understanding of consumer resistance, to identify consumers’ motives for resisting green innovation and to highlight strategic implications for marketers and policy makers.

The research was conducted in the context of microgeneration – innovative technologies that can be adopted by households to produce heat and electricity from renewable energy. Microgeneration technologies are green innovations, which have experienced slow rates of diffusion and thus provide a suitable context for this research. Two national consumer surveys (n = 1010; n = 1012) were conducted to investigate specifically three research issues including consumers’ passive resistance (i.e. awareness), active resistance (i.e. postponement, rejection and opposition) and willingness to pay for microgeneration technologies.

The theoretical contribution of this study is thus threefold. First, the findings contribute to innovation literature by highlighting the importance of passive resistance in the innovation adoption process and by stressing methodological implications for the design of adoption of innovation studies. Second, the thesis contributes to the resistance literature by developing, testing and validating a new measure of active resistance behaviours. The design of the measure was built on a recent conceptualisation by Kleijnen et al. (2009) and our scale is shown to be a robust measurement instrument that accounts for more variance in consumers’ resistance behaviour than conventional measures such as intention to adopt or attitude towards adoption scales. Third, this dissertation contributes to a growing body of literature in the energy policy domain, which questions the predominant economic perspective and gravitates towards alternative explanations of human decision making to explain and encourage behavioural change.

In conclusion, the analysis significantly fills the paucity of empirical research in the area of consumer resistance, shedding light on consumers’ motives to resist green product innovation and providing strategic recommendations for innovation managers and policy makers.

Declaration

I certify that this thesis which I now submit for examination for the award of ______________________, is entirely my own work and has not been taken from the work of others, save and to the extent that such work has been cited and acknowledged within the text of my work.

This thesis was prepared according to the regulations for postgraduate study by research of the Dublin Institute of Technology and has not been submitted in whole or in part for another award in any Institute.

The work reported on in this thesis conforms to the principles and requirements of the Institute's guidelines for ethics in research.

The Institute has permission to keep, lend or copy this thesis in whole or in part, on condition that any such use of the material of the thesis be duly acknowledged.

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Candidate

Declaration of authorship

The research presented in the coauthored articles constituting Chapters 5 and 7 has primarily been developed, executed and written by Marius C.C. Claudy. The co-authors have assisted the research process and provided helpful input and ideas in relation to methodology and data analysis.

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Claus Michelsen

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Publications from this research

Journal articles

Claudy, Marius C., Claus Michelsen, and Aidan O'Driscoll (2011), "The diffusion of microgeneration technologies – assessing the influence of perceived product characteristics on home owners' willingness to pay," Energy Policy, 39 (3), 1459–69.

Claudy, Marius C., Claus Michelsen, Aidan O'Driscoll, and Michael R. Mullen (2010), "Consumer awareness in the adoption of microgeneration technologies: An empirical investigation in the Republic of Ireland," Renewable and Sustainable Energy Reviews, 14 (7), 2154–2160.

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Conference papers and reports

Claudy, Marius, Aidan O'Driscoll, and Aidan Duffy (2011) "Home Owners' Attitudes, Perceptions and Willingness to Pay for Microgeneration Technologies," Sustainable Energy Authority Ireland (SEAI) (Ed.). Forthcoming.

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Claudy, Marius, Aidan O'Driscoll, and Rosanna Garcia (2010), "Exploring antecedents of Consumer Resistance towards Microgeneration Technologies in Ireland." Conference Paper, 2nd Annual Social Marketing Conference, Galway, 2010.

Claudy, Marius (2009), "Towards Sustainable Housing – A Consumer's Perspective. Presented at: EMAC – Marketing PhD Colloquium, Nantes, France, 24–26 May 2009.

Abbreviations

ABC Model	= Attitude-Behaviour-Context Model
AC	= Adverse consequences
AIC	= Akaike's Information Criterion
AR	= Attribution of responsibility
ATM	= Automated teller machines
AVE	= Average variance extracted
CATI	= Computer assisted telephone interviews
CC_I	= Compatibility-related cost index
CER	= Commission for Energy Regulation
CFA	= Confirmatory factor analyses
CFI	= Comparative fit index
CHP	= Combined heat and power units
CI	= Confidence interval
C_I	= Complexity index
CO_2	= Carbon Dioxide
COEF	= Coefficient
COHAB	= Compatibility with habits and routines
COINF	= Compatibility with infrastructure
COMX	= Complexity
COST	= Cost
COVAL	= Compatibility with values
CR	= Composite reliability
CSO	= Central Statistics Office
CV	= Contingent valuation
DBCV	= Double-bounded contingent valuation
Df	= Degrees of freedom
DIT	= Dublin Institute of Technology
EFB_I	= Benefit index: environmental friendliness
EIPRO	= European Environmental Impact of Products
EM	= Expectation maximisation algorithm
EPEA	= Environmental Protection Encouragement Agency
ETS	= Emissions Trading System
EU	= European Union
EV	= Electric vehicle
GDP	= Gross domestic product
GFI	= Goodness of fit index
GM	= Genetically modified
GMO	= Genetically modified organism
H-L test	= Hosmer-Lemeshow test
HRC_I	= Compatibility index: habits and routines
IB_I	= Benefit index: independence
IPS	= Intelligent Product System
K_I	= Knowledge index
KMO	= Kaiser-Meyer-Olkin

kWh	= Kilowatt hour
kW_{th}	= Kilowatt thermal
LR test	= Likelihood ratio test
ML	= Maximum likelihood
MWp	= Megawatts peak
NFI	= Normed fit index
NOA	= Need-opportunity-ability model
NOAA	= US National Oceanic and Atmospheric Administration
OECD	= Organisation for Economic Co-operation and Development
OLS	= Ordinary least square
PEB	= Pro-environmental behaviour
PEOU	= Perceived ease of use
PM10	= Particles of 10 micrometres or less
Ppm	= Parts per million
PR	= Probability
PR_I	= Risk index: performance
PU	= Perceived usefulness
PV	= Photovoltaic
RDD	= Random digital dialling
RA	= Relative advantage
R&D	= Research and Development
REFIT	= Renewable Energy Feed-in Tariff
RISK	= Risk
RMSEA	= Root mean square error of approximation
RoHS	= Restriction of Hazardous Substances Directive
SD	= Standard deviation
s.e.	= Standard error
SEAI	= Sustainable Energy Authority Ireland
SUBNOR	= Subjective norms
SN_I	= Subjective norms index
SUR	= Standardized unemployment rates
SR_I	= Risk index: social
TAM	= Technology Acceptance Model
TBSS	= Technology-based self-services
T_I	= Trialability index
TPB	= Theory of Planned Behaviour
TRA	= Theory of Reasoned Action
UN	= United Nations
U.S.	= United States of America
VBN	= Value-belief-norm theory
VHS	= Video home system
VTR	= Video tape recorder
WCED	= World Commission on Environment and Development
WTP	= Willingness to pay
WWF	= World Wildlife Fund
WWW	= World wide web

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Chapter 1

"…we have to use marketing to work towards an infrastructure that allows the consumer to enact sustainable practices when they eventually come to embrace them."

(Burroughs 2010, p. 131)

1 Introduction

Politicians and scientists have widely accepted the notion that our production and consumption activities exceed ecological limits (UN 2005a; UN 2005d). The available scientific evidence suggests that human impact on the environment has reached levels that impose serious constraints on our future ability to meet our basic needs (UN 2005d; UN 2006). Issues like resource depletion, loss of biodiversity and the risks posed by accelerating climate change have become of paramount concern (Stern 2007).

While the human population is growing exponentially and with it the demand for goods and services, we concurrently experience a systematic accumulation of pollutants and waste in the world's biosphere, accompanied by a steady decline of natural resources, mainly resulting from the negative externalities of our economic activities (WWF 1998). However, human dependence on carbon-based energy sources is arguably the single biggest challenge. Over-reliance on carbon-based technologies and the burning of fossil fuels have led to an accumulation of greenhouse gases in the earth's atmosphere at a rate that is changing the climate. Over the past century the level of greenhouse gases (including carbon dioxide, methane, nitrous oxides and a number of gases that arise from industrial processes) in the atmosphere rose from about 280 parts per million (ppm) CO_2

to 430 ppm (Stern 2007). The scientific consensus confirms that as a result, incoming energy from the sun is trapped, which is causing the average global temperatures to rise, leading to potentially cataclysmic changes in our climate.

Scientists, politicians and marketers alike have come to realise that existing energy systems are unsustainable and that progress towards sustainability requires significant changes in the production and consumption of energy (e.g. OECD 2000). Household energy consumption is of particular interest as it provides one of the greatest potentials to reduce overall energy demand and greenhouse gas emissions. For example, in the United States households account for 27% of total primary energy requirements and for about 41% of energy-related CO_2 emissions (Bin and Dowlatabadi 2005). In Ireland, where this research was conducted, households account for about 25% of total energy consumption and 26% of CO_2 emissions (O'Leary et al. 2008).

Recent technological innovations have made it possible for home owners to retrofit their homes and to generate their own electricity and heat by the use of *microgeneration technologies* such as photovoltaic (PV) panels, micro wind turbines, solar water heaters, wood pellet boilers, geothermal heat pumps or combined heat and power units (CHP).[1] Previous studies have shown that investment in microgeneration can be an economically viable[2] way to reduce energy costs and CO_2 emissions and can help to trigger positive changes in energy consumption patterns (Allen et al. 2008). Hence, microgeneration has the potential to play an important part in reducing overall energy demand and CO_2 emission and to contribute towards more sustainable systems of energy production and consumption.

But despite consumer sensitisation towards sustainability issues, microgeneration faces slow rates of diffusion in mainstream markets as consumers' green preferences regularly fail to translate into adoption behavior (Prothero et al 2011). As a result, in many countries microgeneration technologies have been languishing for years in the chasm

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[1] CHP is technically not a "renewable" but is included here as it has the potential to save significant amounts of energy and reduce carbon emissions.
[2] The exact economic potential of sustainable energy systems is largely theoretical, based on discount rates, life-cycle evaluations and current or expected energy prices.

between early adopter and mainstream markets and are often dependent on policy support in the form of subsidies or tax incentive (Sijm 2002). Microgeneration thus shares a similar fate with green innovations like hybrid or electric vehicles, green detergents or organic foods, which all failed to develop significant shares in consumer markets (Boini and Oppenheimer 2008).

In this context, consumer response has been identified as a key challenge that companies are facing when developing and marketing sustainable new products like microgeneration (Dangelico and Pujari 2010). However, little is known about the factors that cause the mismatch between consumers' reported positive attitudes and their actual unwillingness to purchase, thus providing a clear mandate for further research in this area (Prothero et al. 2011).

Blake (1999) for example argues that the gap between values or attitudes and behaviours is 'clogged up' with barriers, which prevent consumers from enacting pro-environmental behaviours. For example, consumers might simply be unaware of the environmental benefits, whereas others might not be willing to pay a premium for environmentally superior alternatives. Further, green attributes are often in direct competition with more traditional product characteristics such as performance or design (e.g. Berchicci and Bodewes 2005; Dangelico and Pujari 2010; Ottman et al. 2006). Other green innovation might face resistance as it requires consumers to change their daily habits and routines or to break with entrenched traditions and norms (Kleijnen et al. 2009).

Understanding consumers' perception of green products and, more importantly, barriers consumers associate with adoption is therefore of critical importance for companies aiming to improve new product development processes and marketing strategies in order to overcome resistance in consumer markets (Antioco and Kleijnen 2010, p.1701). Identifying factors that constrain consumers' ability and willingness to adopt green products is also vital for public policy as it holds important implications for the adjustment of market structures, provision of incentives, and implementation of regulations (Press and Arnould 2009, p.102).

This thesis aims to empirically investigate the widely acknowledged but underresearched mismatch between reported pro-environmental attitudes and adoption-behaviour in the context of microgeneration technologies. The research contributes to a growing body of work in the green consumer behaviour domain (Jackson 2005) that investigates consumer response (i.e. resistance) to sustainable new products. In particular, this thesis draws on findings from the innovation (e.g. Rogers 2003 [orig. pub. 1964]) and consumer resistance literature (e.g. Kleijnen et al. 2009; Ram and Sheth 1989) to identify functional and psychological barriers that prevent consumers from adopting innovative green products like microgeneration. In seeking to explain the attitude-behaviour gap this thesis contends that much innovation research has suffered from a pro-change bias and focused too much on positive aspects of adoption. The empirical research presented in this thesis shows that, to the majority of consumers, green is clearly not a selling point *per se,* as environmental improvements often require consumers to accept trade-offs with conventional product characteristics such as price or performance.

The following section provides a brief overview of each chapter and its objective and how it relates to the overall body of research that was conducted in the scope of this thesis (Figure 1.1).

2 Thesis outline

The main objective of this thesis is to build on recent findings in the resistance literature and (i) to empirically investigate consumer resistance towards green innovation in the context of microgeneration, (ii) to better understand the underlying reasons and (iii) to provide strategic recommendations for marketers and policy makers on how to overcome consumer resistance to green product innovation. The thesis is structured in eight chapters, and the research process is illustrated in Figure 1.1.

Chapter 2 provides a discussion of the role of innovation in the context of sustainability. Although a rapidly increasing number of companies develop and market “green”, “sustainable” or “eco-friendly” products, there appears to be no clear understanding as to what constitutes a green product innovation. We first provide a definition of environmental sustainability and identify key conditions that provide the basis for sustainable development. Next, we apply these conditions to the notion of innovation and innovativeness and develop a coherent working definition of what constitutes a green product innovation. The definition allows us to classify green product innovations along three dimensions, including the (1) level of newness, (2) the stage of the product’s physical lifecycle at which an environmental improvement occurs and the (3) type of environmental improvement. Finally, we discuss how environmental sustainability is now a key driver of innovation and what challenges companies are facing when marketing green products in consumer markets.

In Chapter 3 we outline the research problem of consumer resistance to green products and discuss how it has been theoretically framed in the literature. The chapter sets out with discussing adoption of green innovation in a consumer behaviour context. In particular, it highlights the shortcomings of research within the dominant paradigm i.e. the adoption decision process, and makes the case for more resistance-focused research. Next, we outline the research context and discuss findings from an exploratory study around home owners’ resistance to microgeneration. Integrating the theoretical debate and the empirical context, we identify three research issues around consumer resistance – *passive resistance*, *active resistance* and *willingness to pay* – providing the rationale for the empirical studies presented in Chapters 5–7.

In Chapter 4 we outline the methodology that was employed to gather the empirical evidence required to explore the research topics presented in Chapters 5–7. The objective of this chapter is to first discuss the underlying research philosophy and implications for the discovery of knowledge. Second, we outline the research design and data collection methods and, finally, provide an overview of the data analyses that were implemented to answer the research questions set out above and assess them in light of reliability, validity and generalisability.

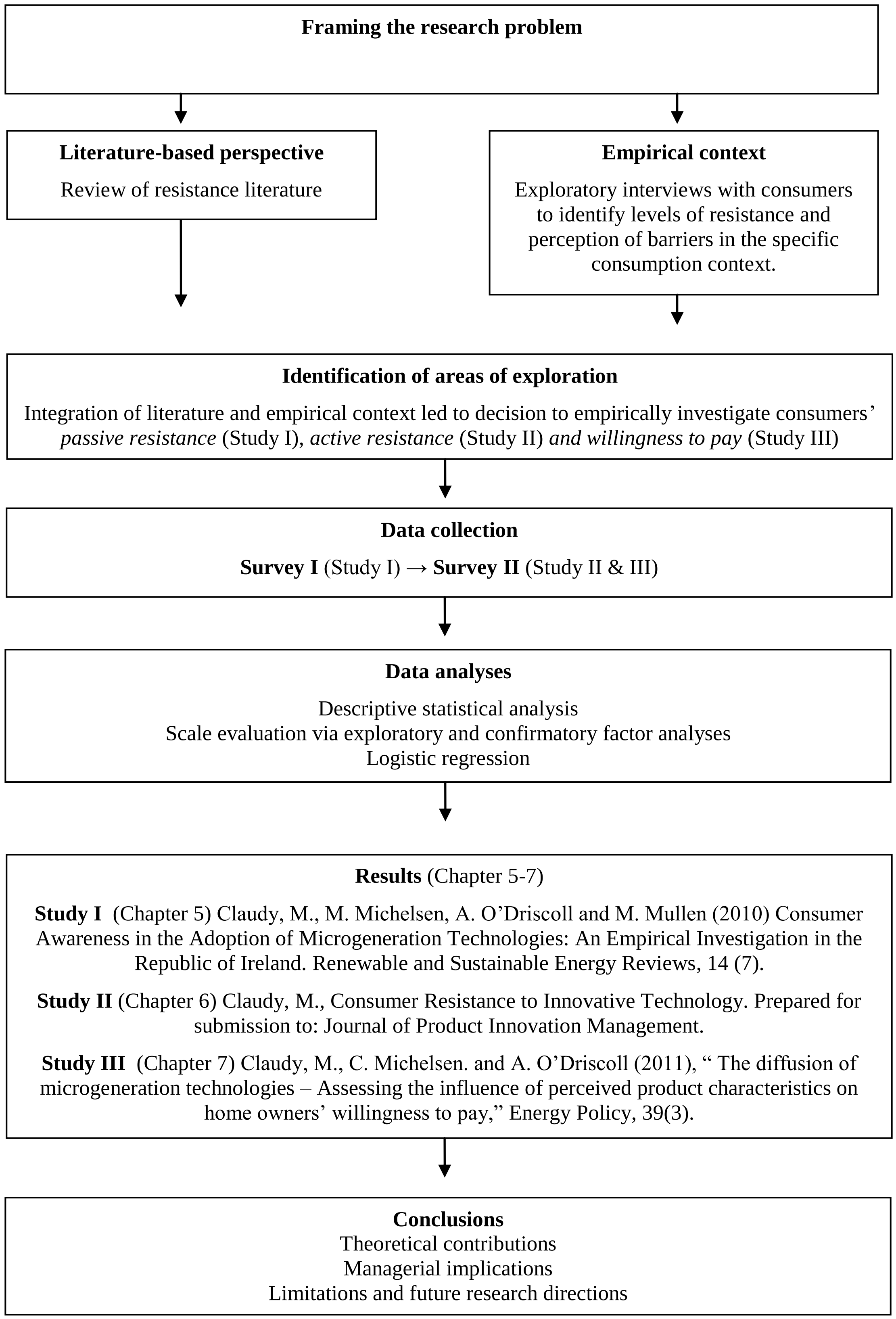
In Chapter 5 we discuss the first research problem and provide an exploratory study of passive consumer resistance (i.e. awareness) in the area of green product innovation (i.e. microgeneration technologies). Despite major policy and marketing efforts, the uptake of microgeneration technologies in most European countries remains low. Whereas most academic studies and policy reports aim to identify the underlying reasons why people buy these new technologies, they often fail to assess the general level of consumer awareness. The process of adopting an innovation, however, shows that awareness is a prerequisite that needs to be understood before adoption can be addressed. This paper takes a closer look at awareness of microgeneration and presents the results from a nationally representative study conducted in the Republic of Ireland. Findings from logistic regressions clearly indicate that awareness varies significantly between the individual technologies and customer segments. The paper concludes with implications for policy makers and marketers aiming to promote microgeneration technologies in consumer markets.

Chapter 6 addresses conceptual shortcoming in research around active resistance. Consumer resistance to green innovation is a critical problem that innovating companies encounter in their marketing effort. Resistant consumers are a varied group who differ in their behavioural responses to an innovation (e.g. postponement, rejection, and even opposition) and in their underlying motivations. However, the majority of empirical studies to date operationalise resistance dichotomously as adoption/non-adoption, thus effectively ignoring individual difference and behaviour among resistant consumers. In this study we build on recent findings in the literature (Kleijnen et al. 2009) and propose a consistent classification of resistant consumer categories. Further, we develop a new measure to differentiate between consumers' level of resistance toward technological innovation and, in a large-scale consumer survey (*n* = 761), empirically investigate the motives behind different levels of resistance. The results reveal that consumers who may seem to be 'non-adopters' actually vary significantly in their levels of resistance and in their perceptions of functional and psychological barriers. Our approach thus accounts for heterogeneity in this important segment and reacts valuably to the dearth of empirical studies around consumer resistance by developing a measure of resistance. The empirical findings provide useful insight for companies developing and introducing innovative products into a seemingly reluctant marketplace.

The study presented in Chapter 7 provides empirical insight into willingness to pay (WTP) for microgeneration technologies and the relative influence of subjective consumer perceptions. First, we apply a double-bounded-contingent valuation method to elicit Irish home owners' willingness to pay for micro wind turbines, wood pellet boilers, solar panels and solar water heaters. Utilizing findings from the adoption of innovation literature, in a second step, we assess the influence of different antecedents on WTP for each of the four technologies, including (1) home owners' perception of product characteristics, (2) normative influences and (3) sociodemographic characteristics. The study's results show that WTP varies significantly between the four technologies. More importantly, however, home owners hold different beliefs about the respective technologies, which significantly influence their WTP. The results provide worthwhile information for marketers and policy makers aiming to promote microgeneration technologies more effectively in consumer markets.

Finally, in Chapter 8 we discuss the theoretical contributions and managerial implications and highlight important limitations and potential avenues for further research. Again, the research process is summarised in Figure 1.1.

Figure 1.1: The research process



Chapter 2

"People generally are unfamiliar with the idea of 'sustainability' in its environmental sense. But once they understand it, they appear to identify positively with its values and priorities"

(MacNaghten et al. 1995, p.2)

1 Sustainability and Innovation

1.1 Environmental sustainability

The concept of sustainability originated in the early 1980s and grew widely in popularity with the publication of the UN's Brundtland Report (1987). The report was written by the World Commission on Environment and Development (WCED) under its Chair Gro Harlem Brundtland and famously defined sustainable development as *development that meets the needs of the present without compromising the ability of future generations to meet their own needs*. Since then countless attempts have been made to provide a more operational definition of sustainability and sustainable development, often leading to great confusion and ambiguity among politicians, business leaders, consumers and academicians. It is therefore helpful to step back and dissect the systems, conditions and science base that underlie the concept of sustainability.

Karl-Henrik Roberts, initiator of The Natural Step, a Swedish non-profit organization founded in 1989, developed a systematic principle-based definition of sustainability. Following the Brundtland Report, The Natural Step also defines sustainability as human societies' ability to continue indefinitely (Cook 2004, p. 13). However, as "there is probably no limit to the number of possible designs of sustainable societies, the definition must be searched for on the principle level – any sustainable society would meet such principles" (Holmberg and Robèrt 2000, p. 299). In light of fundamental science, Roberts identified human activities that led to non-sustainable societies, and developed the system conditions as principles that determine what humans must *not* do. The ecological challenges facing societies (e.g. loss of biodiversity, deforestation, over-fishing, climate change or peak oil) relate more or less directly to the same principal ways by which we destroy the ecosphere[3] and consequently undermine humankind's survival on the planet. According to Holmberg and Robèrt (2000), the negative impact of human activities on the planet can be divided into three key mechanisms.

The first mechanism relates to the unprecedented rate of extraction of materials from the earth's crust (lithosphere) – a rate that nature is not able to absorb within its normal cycles (Cook 2004, p. 29). Consequently, this leads to a systematic accumulation of substances in the earth's ecosphere. For example, the extraction and burning of fossil fuels causes an accumulation of gases in the earth's atmosphere at a rate that is changing the climate. Over the past century the level of greenhouse gases (including carbon dioxide, methane, nitrous oxides and a number of gases that arise from industrial processes) in the atmosphere rose from about 280 parts per million (ppm) CO_2 to 430 ppm (Stern 2007). The scientific consensus confirms that as a result, incoming energy from the sun is trapped, which is causing the average global temperatures to rise, leading to potentially catastrophic changes in our climate. Yet climate change is not the only consequence. A more directly noticeable effect is toxic heavy metals that are extracted

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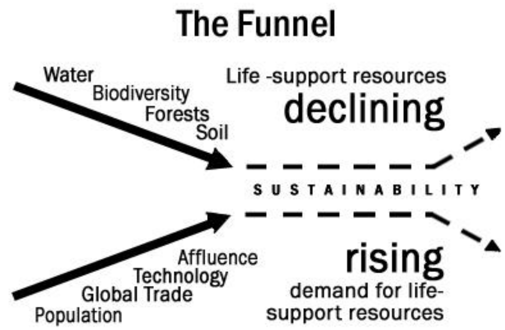
[4] Holmberg and Robèrt (2000, p. 308) define the *ecosphere* as "part of Earth which directly or indirectly maintains its structure and flow using the exergy (ordered energy, available work) flow from the 'sun/space battery'. With this definition the ecosphere contains the *biosphere,* the *atmosphere* (including the protective stratospheric ozone layer), the *hydrosphere* and the *pedosphere* (the free layer of soils above the bedrock). The *lithosphere* is the rest of Earth, i.e. its core, mantle and crust. Processes in the lithosphere are mainly driven by radioactive decays of its heavy elements. The formation and concentration of minerals in the lithosphere is so slow that these resources, as viewed from the society, can be considered as finite stocks. There is a natural flow from the lithosphere into the ecosphere through volcanoes and through weathering processes and there are reversed flows through sedimentation. However, compared to the turnover within the ecosphere, the exchange of energy and matter between the ecosphere and the lithosphere is often much smaller."

(often just as by-product) and released back into the biosphere, contaminating rivers and ground water, with often dire consequences for human health and the environment.

The second mechanism relates to the systematic increase of manmade substances, poisoning the system. Studies show that about 750,000 synthetic chemicals are on the market, many of which cannot be broken down by nature, accumulating in the earth's ecosphere and remaining there for future generations. Further, only few synthetic chemicals have been properly tested for their effects, and many have been linked to human ill-health and environmental degradation (Cook 2004, p. 30). One of the most vivid examples is the Aral Sea in Central Asia, which used to be one of the world's four largest lakes with an intact ecosystem and impressive fish stocks. Because of human activity, in 2001 the lake had shrunk to only 10% of its former size, and anthropogenic toxins left the entire region heavily polluted, causing high rates of certain cancers, respiratory illnesses and infectious diseases among the people living in regions around the lake. Further, the once plentiful fish almost entirely disappeared, destroying the livelihood of thousands of fishermen in the region (Micklin 2007).

The third mechanism refers to systematic physical destruction (harvesting and manipulation) of the earth's ecosphere, the "engine" of life. Human economic activity has lead to an accelerating decline of productive surfaces and biodiversity, often with unforeseeable knock-on effects. For example, it is estimated that since the 1950s about half of the Earth's mature tropical forests have been cleared, and some estimates show that, unless drastic measures are taken, by 2030 only 10% of healthy forests could remain (CSIRO 2007). As a result, many (sometimes undiscovered) species of plants and animals, which depend on the forest for survival, face extinction. The UN's Millennium Ecosystem Assessment (2005), for example, showed that the rate of species extinction is already running at between 100 and 1000 times the "natural" background rate. Also, deforestation is leading to soil erosion and desertification, further diminishing the planet's ecosystem services.

Figure 2.1: The funnel



Source: The Natural Step 2011

What becomes apparent is that humankind is running into a funnel. Whereas population growth is exponentially rising, unsustainable human activities are causing a rapid decline in the things we need to survive (i.e. food, clean air and water, productive topsoil and others). For example, Belz and Peattie (2009, p. 12) quote a study conducted by the WWF (1998) which estimates that around the mid-1980s:

> "humankind began to exceed the physical capacity of the planet to support our numbers, activities and lifestyles indefinitely. To use a financial analogy, at this point we stopped living off the 'income' provided by natural systems and began instead to use up 'natural capital' and therefore to reduce the productive capacity of natural systems. By the turn of the twenty-first century humankind's eco-footprint was exceeding the Earth's sustainable productive biocapacity by some 20%."

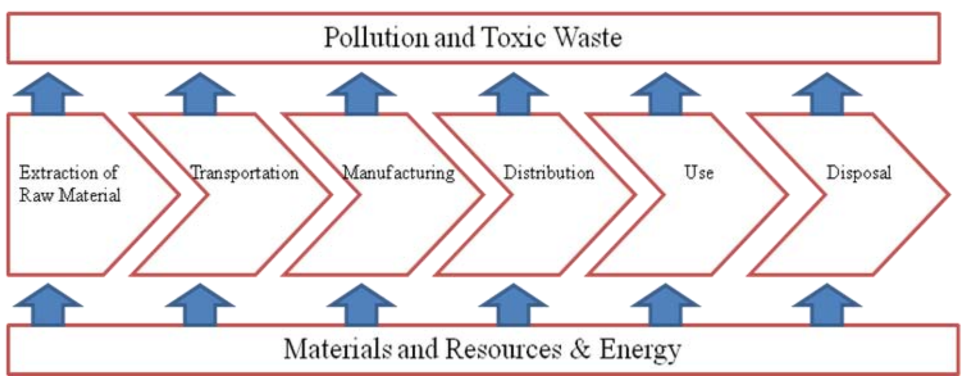
As we already experience some of the consequences of unsustainable levels of human activity and, more importantly, know about the basic mechanisms that cause it, the question arises: what does a sustainable society look like? Based on the discussion above, the Natural Step identified three systems–conditions, arguing that

> "in the sustainable society, nature is not subject to systematically increasing:
>
> 1. … concentrations of substances extracted from the Earth's crust,
> 2. … concentrations of substances produced by society,
> 3. … degradation by physical means;
>
> and, in that society

4. … people are not subject to conditions that systematically undermine their capacity to meet their needs." (Cook 2004, p. 14)

Our consumption and production activities clearly have the most direct impact on our ecosystem. In particular, the products that we produce, consume and dispose of on a daily basis contribute to the violation of the above-named systems conditions for sustainability. Technological innovation will thus have a pivotal role to play in "opening the funnel" and placing our development path on a more sustainable level. In particular, it needs *greener* products[4] that use less material and energy and create less pollution and waste throughout the product lifecycle, i.e. extraction, production, distribution, usage and disposal, as illustrated in Figure 1.2.[5]

Figure 2.2: Cradle-to-grave product lifecycle



More and more companies are commencing to respond to the sustainability challenge by developing and marketing new, greener, products or by introducing comprehensive sustainability campaigns (e.g. Luchs et al. 2010). Yet there appears to be no clear understanding as to what constitutes a green product. In the following section we thus incorporate the above-identified systems conditions for ecological sustainability into conceptualisation of innovation, allowing us to develop a coherent working definition of green product innovation.

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[4] The terms "green" and "sustainable" are used interchangeably throughout this thesis as they both refer to environmental sustainability, as explained above.
[5] It needs to be pointed out that the product lifecycle displayed here is a highly stylised model, as it ignores the network of suppliers and stakeholders from various industries that often provide factors of production, which represents product-lifecycles in itself (Belz and Peattie 2009).

1.2 Defining green product innovation

Before defining green product innovation, we need to clarify the term “innovation”. The literature provides numerous classifications and typologies of *innovation* and *innovativeness* of products, and previous studies have been accused of lacking consistency in the operationalisation of these concepts (Garcia and Calantone 2002). Prior studies in innovation research have used numerous terms such as “radical, incremental, really-new, imitative, discontinuous, architectural, modular, improving, and evolutionary” to define innovations, which “has led to incongruent categorisations of innovation typology and widespread confusion as to what empirical studies are actually reporting” (p. 110). In this dissertation we build on a typology developed by Garcia and Calantone (2002) and extend it to green product innovation.

1.2.1 Defining innovation

The literature provides several definitions of innovation. However, in a comprehensive meta-review of existing innovation typologies Garcia and Calantone (2002) apply a definition provided in a 1991 OECD report on technological innovation, arguing that it “best captures the essence of innovation from an overall perspective” (p. 112). According to the report:

> “innovation is an iterative process initiated by the perception of a new market and/or new service opportunities for a technology-based invention which leads to development, production and marketing tasks striving for the commercial success of the invention” (OECD 1991, p. 111).

The definition highlights two important aspects. Firstly, it suggests that a technological invention itself cannot be considered an innovation. Only when efforts go into both the technological development and marketing of that invention to end-users (i.e. firms or customers), and hence the diffusion into the market place, can an invention be called an innovation. In other words, a discovery that goes no further than the laboratory remains an invention (Garcia and Calantone 2002).

Secondly, the definition refers to the iterative nature of the innovation process which, as will be discussed shortly, ultimately leads to different types of innovations. Utterback and Abernathy (1975, p. 642), for example, argue that "a basic idea underlying a proposed model of product innovation is that products will be developed over time in a predictable manner with initial emphasis on product performance, then emphasis on product variety and later emphasis on product standardisation and costs." Thus, depending on the stage in the product innovation process, different types of innovations can be defined. From that it follows that different types of innovations have different levels of innovativeness (i.e. newness). For example, in the early stages of the development and diffusion process, products are most likely to be perceived as radical or really new, whereas later in the process products might be classified as imitative or incremental. The roots of solar cells, for example, reach back into the 19th century, yet most people would consider solar panels as innovative or radical products as the diffusion among consumers is still in its early stages. Firms in the energy sector, on the other hand, might perceive them as less innovative, as the diffusion in energy markets is already in a somewhat matured state. Hence, in order to define the level of innovativeness, it first needs to be established from 'whose perspective this degree of newness is viewed and what is new' (Garcia and Calantone 2002, p. 112).

One of the most widely used definitions of innovation, provided by Rogers (2003, p. 12), partly sheds light on *whose perspective* newness is viewed from, defining innovation as "(…) an idea, practice, or object that is perceived as new by an individual or other unit of adoption." Aggarwal et al (1998) also point out that innovations can be examined from a firm's or a consumer's perspective.

As highlighted earlier, this research is concerned with the diffusion of green innovation in consumer markets, hence taking the perspective of the consumer. Although it highlights the importance of subjective perception of innovativeness, this definition fails to specify exactly the factors that define the concept of product innovativeness. The following section aims to define innovativeness and how it can be used to classify product innovations.

1.2.2 Defining innovativeness

Innovativeness is the most frequently used construct to measure the degree of newness of an innovation. Garcia and Calantone found 15 different measures and more than 51 distinct scale items that were used in 21 empirical studies to model innovativeness, again illustrating the inconsistency of conceptualisation in the literature. Yet in their meta-review they found one underlying theme across all studies and perspectives (i.e. firm, industry or consumer): innovativeness was always conceptualised as the “degree of discontinuity in the status quo in marketing and/or technological factors” (p. 118).

Discontinuity in marketing refers to the disruption an innovation causes in the market place, like the creation of new customer segments or new marketing channels. Likewise, from a firm’s perspective, highly innovative products might manifest themselves in the need to acquire new marketing skills. High technological discontinuities, on the other hand, are technological quantum leaps that require consumers and firms to acquire new technological knowledge. Marketing and/or technological discontinuity therefore provides the first reference point as to what defines the newness of product innovations.

Further, Garcia and Calantone’s analysis revealed that most studies evaluated product innovativeness form either a macro or a micro perspective. On the macro level innovativeness measures how new an innovation is to the world, market or industry. The factors defining innovativeness on the macro level are therefore exogenous to the firm. For example, innovativeness on the macro level concerns the “familiarity of innovation to the world and industry or creation of new competitors from the introduction of new innovations” (p. 118). Innovativeness on the micro level, on the other hand, concerns the newness perceived by consumers or firms. Thus, depending on the consumer’s or firm’s perspective, the perception of innovativeness is likely to vary. Further, it needs to be pointed out that innovations that are perceived as new on the macro level (e.g. markets) are automatically perceived as new on the micro level (e.g. consumers). Thus, the distinction between the macro and micro sphere allows one to identify by whom an innovation is perceived as new.

By applying the two levels of analysis, i.e. “macro versus micro” and “marketing versus technology perspective”, one can distinguish between three clearly distinct types of innovative products: radical, really new and incremental innovation.

Table 2.1: Typology of innovativeness of product innovations

Level of Disruption	Micro Level	Macro Level (Complete on Micro Level)	Both
Marketing	Incremental	Really New	Really New
Technological	Incremental	Really New	Really New
Both	Really New	Radical	

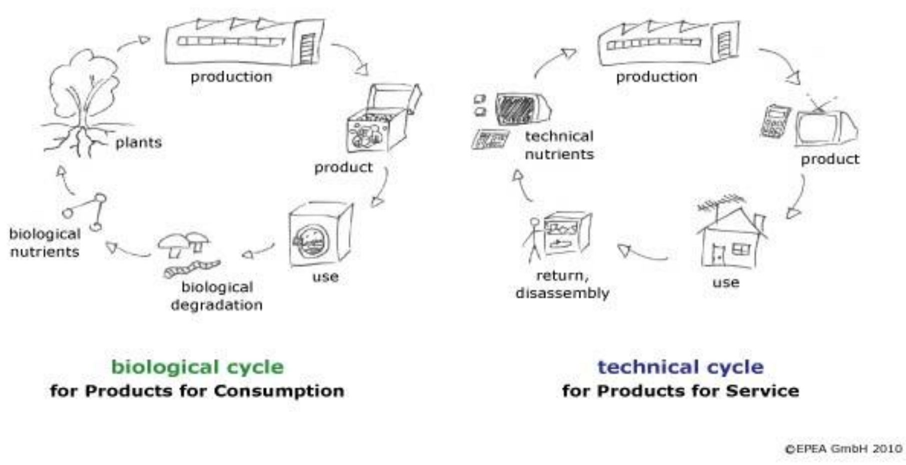
Source: Garcia and Calantone (2002)

Radical innovations are defined as innovations that cause technological and marketing disruptions on both a macro (e.g. market level) and a micro level (e.g. consumers). The world wide web (www) is a classical example, as it changed ways of communication, knowledge sharing and even shopping on a global scale and not only required consumers to familiarise themselves with a new technology but also offered whole new marketing channels for firms. Incremental innovations are product innovations that only cause marketing or technological disruption on the micro level. The iPhone can be considered an incremental innovation, as it provides technological improvements over existing products (e.g. mobile phone with internet access and mp3 players were around for years), yet only on the micro level. All other product innovations can be defined as really new products and fall between radical and incremental innovations. Digital cameras, when they were first introduced, fell into this category as they changed an entire industry, yet mainly on a technological level.

1.2.3 Defining “green”

Before providing an operational definition of what *green* or *sustainable* product innovation means in the scope of this work, we briefly introduce a more holistic concept of green products, which provides a useful or benchmark for the more operational definition. Michael Braungart, the founder of the Environmental Protection Encouragement Agency (EPEA), and his colleagues developed the vision of an “Intelligent Product System” (IPS) (e.g. Braungart et al. 1990; Braungart and Engelfried 1992) The IPS aims to minimise the negative consequences of production and consumption activities by transforming our current linear systems (i.e., cradle to grave products) into circular systems (i.e., cradle to cradle products). In IPS all materials are either fed back into the “natural” cycle (i.e., biological nutrients such as biodegradable products) or into the “technical” cycle (i.e., technical nutrients such as metals or polymers). The IPS therefore allows for only three types of product.

Figure 2.3: The nutrient cycle



Source: EPEA 2010

The first category comprises products that can be literally consumed or are made of materials that are 100% biodegradable and can thus be fed back into the natural cycle. The second group is durables, made from technical nutrients, which, after they provide a service to the user, get recycled and fed back into the technical cycle. These products always remain the responsibility of the maker and can therefore only be rented or licensed to consumers. The third category consists of unmarketable products that are made from toxic materials that should not be sold at all. Unmarketable products cannot be consumed in a sustainable way and thus need to be replaced completely. Within IPS entirely green products are thus made of substances that are either 100% biodegradable or completely recyclable and contain no toxins or other harmful substances. However, Braungart acknowledges that there are shades of grey and that certain substances in manufacturing processes cannot be substituted yet, implying that "greening" of products is a continuous process, often driven by innovation.

In this study we therefore build on a less rigid explanation of green products provided by Ottman et al. (2006, p. 24), who state that:

> "although no consumer product has a zero impact on the environment [as yet], in business the terms 'green product' or 'environmental product' are used to describe those that strive to protect or enhance the natural environment by conserving energy and/or resources and reducing or eliminating use of toxic agents, pollution and waste."

The definition highlights two important points. First, it emphasizes that companies develop products that strive to be more environmentally friendly, implying that the "greening" of products is an *iterative* process driven by innovation. Second, Ottman et al. highlight three areas for environmental improvement, including materials/recourses, energy and pollution/toxic waste. Thus, in accordance with our earlier definition of sustainability, green products should help to reduce the

- concentrations of substances extracted from the Earth's crust;
- concentrations of substances produced by society;
- degradation by physical means; and
- thus not undermine societies' capacity to meet their needs.

It is also important to note that the greening of products via innovation can occur at various stages of a product's physical lifecycle, i.e., at the extraction, manufacturing, distribution, usage, and disposal stages (e.g. Belz and Peattie 2009; Dangelico and Pontrandolfo 2010; Dangelico and Pujari 2010). Building on the typology of product innovation provided above, we thus add two dimensions in order to classify green product innovation. First, we specify the type of environmental improvement an innovation provides (i.e. a reduction in materials, energy or pollution) and, second, we specify the stage(s) in the physical lifecycle at which the improvement(s) occurs.

Table 2.2: Green product innovation typology

Level of Innovativeness	**Stage in Product's Physical Lifecycle**	**Type of Environmental Improvement**
Incremental Really New Radical	Extraction Production Distribution Usage Disposal	Materials/Recourses Energy Pollution/Toxic waste Behavioural Change

Developed after Garcia and Calatone 2002 and Dangelico and Pujari 2010

Building on the above discussion we propose the following definition:

> "Green product innovation is an iterative process, initiated by the opportunity for environmental improvement of the product's physical lifecycle via a technology-based invention, which leads to the development, production and marketing tasks striving for the commercial success of the invention."

Our definition implies that not all green product innovation offers environmental improvements in all three areas (i.e., materials/recourses, energy and pollution/toxic waste). Moreover, they are likely to occur at different stages in the product's physical lifecycle and can be incremental, really new or radical. For example, innovative packaging designs can be defined as incremental green innovations. Kenco coffee (2011), for example, introduced a refill pack for instant coffee. This innovation was by no means groundbreaking, yet it allowed the company to reduce packaging weight by 97%, significantly decreasing material and waste. Other innovation resulting in environmental improvements causes more disruption. For example, Dyson (1992) was the first company to design and market vacuum cleaners that needed no replacement bags and filters. Dyson's "bagless" vacuum cleaners are a good example of a really new product, which not only meant significant changes for end-users (i.e., no buying of replacement bags) but also reduced the amount of non-recyclable materials such as plastic or chemically treated paper.

Further, microgeneration technologies can be classified as radical green innovations, since they cause technological and marketing disruptions on both a macro (e.g. market level) and a micro level (e.g. consumers). Although some microgeneration technologies have been around for decades (e.g. solar panels) or even centuries (e.g. wind mills), commercialisation and marketing of these technologies within consumer markets is a relatively new phenomenon. Technological literacy around microgeneration appears to be still very low in consumer markets, providing challenges for companies and public policy aiming to inform homeowners about the benefits of microgeneration. Further, the promotion of microgeneration often requires companies to deviate from traditional marketing strategies and, for example, co-operate proactively with key stakeholders in the industry. More importantly, microgeneration technologies have only recently created new industries and target markets. For example, microgeneration is beginning to change the structure of conventional energy provision, shifting the market from a centralised system of energy provision towards a more decentralised energy supply where the generation of energy occurs close to the point of usage (Allen et al. 2008).

In the following section we briefly outline some of the forces that drive companies to invest in green product innovation, before highlighting some of the key challenges they face.

2 Sustainability: Driver of innovation

The management guru Peter Drucker (1954, p. 37) famously stated that “because the purpose of business is to create and keep a customer, the business enterprise has two – and only two – basic functions: marketing and innovation”. Innovation, as an organisational function, is defined by Drucker as “the provision of better and more economic goods and services”. What defines *better* depends to a large extent on consumer needs and wants. Innovation is therefore a primary source of competitive advantage (e.g. Day and Wensley 1988; Hurley and Hult 1998; Porter 1985) and central to marketing strategy (Varadarajan and Jayachandran 1999), as it allows innovating companies to satisfy consumer needs and wants more effectively than their rivals (Hauser et al. 2006).

Innovation can occur in product and services (technical) and in the various skills and activities that are needed to supply them (non-technical), for example, the marketing and management practices within the organization (e.g. Drucker 2007). As outlined above, in this study we focus on technical innovation and in particular on product innovation. In line with the definition provided above, innovation can be incremental, really new or radical and can occur at any stage of a product’s physical lifecycle.

In a recent *Harvard Business Review* article, sustainability was identified as a key driver of product innovation, and Nidumolu et al. (2009, p. 2) state that “there is no alternative to sustainable development” and conclude that “sustainability is a mother lode of organizational and technological innovation (…).” Further, market data from Datamonitor’s Product Launch Analytics show that the number of companies introducing *green*, *sustainable* or *eco* products is rapidly growing – launches of green products in the US had doubled between 2007 and 2008 and were expected to triple in 2009 (Greenbiz 2009). McKinsey and Company also found in a global survey a growing concern for the environment and climate change among executives from various industries. The study shows that more than 60% consider climate change as an issue when developing overall strategy and more than 50% claim to take it into consideration when developing new products (McKinsey 2007). Yet growing environmental concern among executives is by no means the only driver of green product innovation (e.g. Dangelico and Pujari 2010; Peattie 2001).

2.1 Regulation and policy

A key motivation for companies to develop greener products is to simply comply with environmental regulations. In recent decades numerous new regulations and environmental legislations have been introduced on the national level and increasingly on regional (e.g. EU) or international levels (e.g. Kyoto Protocol), continuing to impact on industries and forcing companies to *green* their products. By September 2010 the European Union had implemented 681 acts in relation to the environment alone, with many of them having direct or indirect implications for companies across different industries (Europa 2010). A recent example is the binding limit of emissions of fine particles known as PM10. These particles are mainly released by cars and trucks and have been related to illnesses such as respiratory and cardiovascular diseases. As a result of the EU directive, new legal thresholds for tolerable PM10 levels forced the automotive industry to improve the environmental performance of its vehicles and introduce greener technology. Other regulations include the restrictions on CO_2 within the emissions trading system, which penalizes companies that exceed the limits of CO_2 (recommended by the Kyoto Protocol) and the European Community directives on restriction of use of hazardous substances (RoHS).

2.2 Competitive advantage

More and more companies are coming to realize that complying with the most stringent rules before they are enforced can yield first-mover advantages and ultimately improve competitiveness (e.g. Nidumolu et al. 2009). For example, HP anticipated the ban on lead solders, and by the time the European Union's RoHS was introduced in 2006, HP already had a solution, giving it an advantage over its competitors (HP 2011). This win–win logic was first popularised by Porter and van der Linde (1995) who argued that environmental regulations can provide companies with the incentives to reduce, for example, pollution or packaging, which can lead to cost reductions or efficiency gains and result in improved competitiveness and higher profits. Thus, Porter and van der Linde (1995, p. 98) argue, “properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them”.

2.3 Changing consumer preferences

Further, companies can utilize the greening of their products to improve their image and reputation and attract new customers by responding to and encouraging increasing environmental concerns and green consumer sentiment. Marks and Spencer (M&S), for example, has embarked on a journey to become the world’s most sustainable major retailer. In its so-called *Plan A,* M&S dedicates itself to achieve 180 sustainability commitments by 2015. However, M&S not only responds to changing consumer preferences but is actively trying to engage its customers in behavioural change. For example, it launched M&S Energy in cooperation with Scottish and Southern Energy, offering the provision of gas and electricity to private households. In order to attract new customers, M&S created incentive schemes that, for example, offer £30 M&S vouchers for all new customers who reduce energy usage by 10% in the first year, thus encouraging positive behavioural change.

Many trends seem to detect growing awareness of environmental issues and some studies even report that consumers might perceive “green as the new black” (e.g. Prothero et al. 2010). Responding to and encouraging these changing consumer preferences is therefore vital for business to attain market objectives and maintain a competitive advantage. However, Peattie (2001, p. 136) argues that the win–win logic of green product innovations, which are “environmentally superior, cost competitive, and technically as good as (if not better than) existing products” might prove difficult to realise. Dangelico and Pujari (2010) also highlight some controversy between consumers’ green sentiment and their unwillingness to, for example, pay higher prices for environmentally superior products. Further, companies sometimes do not get praise for engaging in "greening" their products, but instead get criticised for not doing enough. In this context an important problem companies and their stakeholders are facing is the lack of understanding of what constitutes a green or sustainable product innovation. Peattie (2001, p. 136) refers to it as the "green product controversy" and points out that

> "[i]t is not difficult to demonstrate which is the fastest or the safest or the most inexpensive car on the market. It is much more difficult to define the greenest."

A common way to communicate green product attributes to consumers is via eco-labels (e.g. the US's Energy Star and Energy Guide, the EU's Flower and Energy Label, Japan's Eco Mark), which allow companies to differentiate their products from environmentally inferior alternatives, thus creating a source of competitive advantage (Belz and Peattie 2009). Yet to believe that a green product attribute alone is a compelling selling point is fallacy.

Chapter 3

"Understandings of consumer behaviour…rest, either explicitly or implicitly, on certain kinds of 'models' of what behaviour is, what its antecedents are, how it is influenced, shaped and constrained."

(Jackson 2005, p.21)

1 The research problem

The discussion above shows that introducing environmental sustainability into products can provide companies with many benefits including "increased efficiency in the use of resources, return on investment, increased sales, development of new markets, improved corporate image, [and] product differentiation" (Dangelico and Pujari 2010, p. 480). Green innovation can be a key source of competitive advantage and allow companies to satisfy consumer needs and wants more effectively than their rivals. However, success of green innovation is largely dependent on an understanding of the consumer and developing "marketing strategies and mix that will meet consumers' needs more effectively (and more sustainably) than their competitors" (Belz and Peattie 2009).

But despite consumer sensitisation towards environmental issues, many sustainable products face slow rates of diffusion in mainstream markets as consumers' green preferences regularly fail to translate into adoption behaviour. For example, a study conducted under the United Nation Environment Programme (UN 2005b) found that 40% of consumers stated a willingness to purchase green products, yet only 4% followed up on their intentions. Further, Boini and Oppenheimer (2008, p. 56) report that organic foods only account for approximately 3% of overall food sales in the US, while green detergents and hybrid cars account for about 2% of sales in their respective markets. Studies have also shown that despite a widely articulated interest in locally produced or grown food, only a small proportion of consumers in the UK actually seek out locally sourced food alternatives (Weatherell et al. 2003). Other product innovations such as microgeneration have been languishing for years in the chasm between early adopters and mainstream markets and are often dependent on policy support in the form of subsidies or tax incentive (Claudy et al. 2011).

The widely acknowledged mismatch between articulated positive attitudes toward green innovation and consumers' actual unwillingness to purchase is commonly referred to as the *attitude-behavior gap* (e.g. Peattie 2002). Marketers have argued that, if left unaddressed, this gap "will continue to frustrate producers of sustainable product alternatives who rely on traditional attitudinal market research methods, only to find that actual demand often falls short of their initial projections" (Prothero et al. 2011).

Researchers have thus begun to investigate "how firms can improve new product development processes and company strategies in order to improve their innovation performance to overcome consumer resistance towards innovation" (Antioco and Kleijnen 2010, p.1701). Identifying factors that constrain consumers' ability and willingness to adopt green products is also vital for public policy as it holds important implications for the adjustment of market structures, provision of incentives, and implementation of regulations (Press and Arnould 2009, p.102).

Although widely acknowledged, little is known about the factors that cause the mismatch between consumers' reported positive attitudes and their actual unwillingness to purchase, thus providing a clear mandate for further research in this area (Prothero et al. 2011). Blake (1999) for example argues that the gap between values or attitudes and behavior does not constitute a void but should rather be interpreted as being 'clogged up' with barriers, which prevent consumers from enacting pro-environmental behaviours. This is also in line with Ottman et al. (2006) who argue that perceived sacrifices in terms of convenience, costs, or performance and a lack of trust in environmental benefits prevent consumers' from purchasing green products. In the domain of energy conservation, Gupta and Ogden (2009) found that a significant influence of reference groups and a perceived lack of efficacy partly explained the gap between attitudes and behaviours.

In the following section we discuss the adoption of sustainable innovations in the context of green consumer behaviour (e.g. Jackson 2005, Peattie 2010). In particular, we draw on findings from the innovation literature (e.g. Rogers 2003 [orig. pub. 1964]) to critically evaluate how innovation adoption has been conceptualised, modelled and empirically researched. In seeking to explain the attitude-behaviour gap we contend that much innovation research has suffered from a pro-change bias and focused too much on positive aspects of adoption. We thus draw on findings from the consumer resistance literature (Ram and Sheth 1989; Kleijnen et al. 2009) to provide an alternative theoretical point of departure for the subsequent empirical investigation of this critical phenomenon.

2 Literature-based perspective

2.1 Green consumer behaviour

The scope of the consumer behaviour literature, as pointed out by Gabriel and Lang (1995), borders on being ‘unmanageable’. Peattie (2010, p.199) for example defines consumption as “an economic, a physical, and a social process influenced by the nature, circumstances, and psychology of individuals and the geography, culture, laws, politics and infrastructure of society in which they live.” The definition implies the multifarious nature of consumer behaviours and the factors and influences that shape them. We therefore focus on “green” consumer behaviours and in particular on consumers’ decision to adopt green innovations.[6]

[6] For a comprehensive overview of the (green) consumer behaviour literature see Jackson (2005) or Gabriel and Lang (1995) among many others.

In a comprehensive meta-review entitled *Green Consumption: Behaviour and Norms* Peattie (2010) traces the first conceptualisations of green consumer behaviour back to studies from the 1970s around "societal marketing". Since then green consumer behaviour has steadily grown as a field of research with contributions from disciplines like marketing, psychology, sociology, anthropology, environmental economics and human geography. Peattie (2010) broadly subdivides green consumer behaviour research into studies rooted in marketing, which examine consumer intentions and behaviour, and research rooted in industrial ecology and environmental economics, which are primarily concerned with ecological outcomes of green consumer behaviours. This thesis clearly falls into the former category, since it aims to empirically investigate consumers' adoption intentions and, more importantly, identify factors and barriers that prevent consumers from adopting microgeneration technologies.

Generally, green or pro-environmental behaviours (PEBs) can be defined as

> "purchase choice, product use and postuse, household management, collective, and consumer activism behaviours, reflecting some degree of environment-related motivation" (Peattie 2010, p.198).

The definition suggests that green consumer behaviour is not restricted to green purchases, but involves the acquisition, use and disposal' of products, services, and practices (Bagozzi et al 2002**)**. Pro-environmental consumption thus encompasses a wide range of behaviours like recycling of household wastes, using public transport, conserving energy or water, purchasing green products, investing in 'ethical funds', buying organic foods or pursuing 'voluntary simplicity', amongst many others (Jackson 2005, p.3).

Stern (2005, p. 10786) provides a useful classification of the vast number of environmentally significant behaviours, distinguishing between four types of behaviours, "which differ both in how they affect the environment and in the combination of causal factors that shape them." Firstly, Stern identifies two behaviours, which both affect the environment *indirectly* through changes in public policy. Consumers can, for example, engage in committed activism (e.g. actively supporting policy or organisations that affect the environment) or non-actively support environmentally relevant policies (e.g. via financial contributions or voting). Although both behaviours affect the environment only indirectly, they can have significant effects on the environment. For example, changes in public policy like the provision of public transport systems can trigger widespread behavioural changes. A third type of behaviour, which affects the environment *directly* relates to "the influence individuals can have on the environment by affecting the actions of organisations to which they belong" (Stern 2005, p. 10786). For example, managers complying with environmental regulations or engineers' incorporating environmental sustainability in the design of new products both affect the environment directly through the actions of their organisations. The final, and for this research most relevant class of behaviours, are privatesphere environmentally significant behaviours. Stern (2005, p. 10786) broadly distinguishes between purchase, use and disposal of major personal goods and services that have significant environmental impacts in their manufacture or use (e.g. cars, heating systems, recreational travel) and everyday consumerism (e.g. recycling, purchasing organic foods, switching of lights). Privatesphere behaviours impact on the environment directly, yet they only make a significant different in the aggregate i.e. when many people adopt them.

However, it should be noted that green consumer behaviours can also have adverse effects on the environment. For example, Jackson (2005, p.3) points out that environmentally motivated behaviours "do not always result in net environmental gains for a variety of well-known reasons, including rebound effects, takeback effects, and the countervailing environmental costs of certain pro-environmental actions (such as the energy costs of recycling)." Yet, assessing the ecological impact of green consumer behaviours is beyond the scope of this thesis. This study will instead concentrate on the factors and influences that shape consumers' pro-environmental behaviours. In particular, we focus on the adoption decisions and critically discuss how the relationship between adoption behaviour and antecedent factors has been modelled in innovation and consumer behaviour studies.

2.2 Factors and influences of green consumer behaviour

Marketers and public policy makers are interested in factors that motivate and constrain pro-environmental behaviours, in order to utilise this knowledge in the design of interventions and campaigns, which aim to stimulate behavioural change. Researchers have thus developed models that serve as heuristic devices to explore particular types of pro-environmental behaviour and the factors that shape them. As pointed out by Jackson (2005, p.21)

> "Understandings of consumer behaviour…rest, either explicitly or implicitly, on certain kinds of 'models' of what behaviour is, what its antecedents are, how it is influenced, shaped and constrained. These models are generally built from a set of conceptual premises, and some form of causal relationship between dependent and independent variables."

The discussion above has shown that a wide range of factors can contribute to whether or not consumers engage in a particular type of pro-environmental behaviour. However, the literature broadly distinguishes between *contextual* influences and *personal* factors that shape green behaviours (Stern 2005, Jackson 2005, Peattie 2010). According to Jackson (2005) external conditions relate to factors like institutional constraints, social norms or the availability of fiscal or regulatory incentives, which can either facilitate or constrain pro-environmental behaviours. A term regularly used in this context is 'lock-in', referring to the external conditions, which circumscribe consumers' options to exercise certain behaviour. This implies that external factors like regulations, financial incentives or social norms can "leave little room for personal factors to affect behaviour" (Stern 2005, p.10786).

Personal influences relate to attitudinal factors, personal capabilities and habits or routines (Stern 2005). Research in areas like social psychology has helped to reveal the influence of these factors on consumers' pro-environmental behaviours and intentions (Jackson 2005). However, Stern (2005, p. 10787) argues that personal influences are of particular interest to policy makers and marketers when contextual factors cannot be changed and personal factors may provide the only levers on behaviour.

Generally, green consumption research applies (and sometimes adapts) established theories and models from consumer behaviour research in order to explain the influences of contextual and personal influences on particular pro-environmental behaviours (Peattie 2010). However, the distinction between personal and contextual factors suggests a disciplinary divide in green consumption research. Jackson (2005, p.23), for example, points out that the influence of external factors has been primarily researched in disciplines like behavioural analysis and institutional or evolutionary economics, whereas internal factors have received a lot of attention from researchers in areas like social-and cognitive psychology or marketing.

The disciplinary divide has also sparked a discussion about the comprehensiveness and realisticity of consumer behaviour models in general. Stern (2000, p.418), for example, argues that

> "[s]ingle variable studies may demonstrate that a particular theoretical framework has explanatory power but may not contribute much to the comprehensive understanding of particular environmentally significant behaviours that is needed to change them."

For example, research that only examines the influence of contextual barriers, such as restricted access to capital, limited information or strong subjective norms may find effects but fail to reveal their dependency on peoples' attitudes or beliefs. Similarly, studies evaluating only attitudinal variables are likely to find effects only inconsistently, because they are dependent on personal capabilities and context.

However, models that are comprehensive enough to reflect reality adequately often become empirically untestable (Jackson 2005). For example, the "Comprehensive Model of Consumer Action" (Bagozzi et al. 2002) is an integrative model that conceptualises affective, normative, habitual and social influences of consumer behaviour. As Jackson (2005, p.99) points out it "is perhaps the most elaborate attempt in recent years to incorporate the range of influences on consumer behaviour into a single composite theory of consumer action." Yet, the complexity of it has so far prohibited any empirical testing of this theory and studies have instead focused on individual relations proposed between certain variables. Other researchers have even gone further and argued that theories, which "incorporate virtually every know social-psychological construct and process, not only lack parsimony but, more importantly, they are likely to generate confusion rather than real understanding" (Jackson 2005, quoting: Ajzen and Fishbein 1980, p.15).

Yet, comprehensive models can provide an important heuristic map of a specific consumer behaviour and its influences and thus serve as a conceptual point of departure for empirical investigations around specific relationships between key variables (Jackson 2005). As outlined earlier, this thesis aims to investigate consumer resistance to green product innovation. In particular, it sets out to identify and investigate barriers that prevent consumers from adopting green product innovations (Prothero et al. 2011). In the following section we provide an overview of models, which have been applied to conceptualise and empirically research consumers' innovation adoption decisions and their underlying antecedents. In particular, we highlight the shortcomings of research within the dominant paradigm i.e. the adoption decision process, and make the case for more resistance-focused research.

2.3 Innovation adoption

Consumer response to innovation has been identified as a top research priority in marketing science. Marketing scholars have long sought "to describe, explain, and predict how consumers … respond to innovation", arguing that "successful innovation rests on first understanding customer needs and then developing products that meet those needs" (Hauser et al. 2006, p. 688).

In the literature, consumers' response to innovation has traditionally been conceptualised as the *adoption decision process* and is often referred to as a hierarchy of effects model (Gatignon and Robertson 1991). Rogers (2003 [orig. pub. 1964], p. 163) describes the innovation adoption process as "the process through which an individual or other decision-making unit passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision." The adoption of an innovation can thus be seen as the outcome of a cognitive process, which involves information search and processing on the part of the consumer (Gregan-Paxton and John 1997).

According to Rogers the adoption decision process commences when an "individual (or other decision making unit) is exposed to an innovation's existence and gains an understanding of how it functions." Persuasion is the next stage, at which a consumer, once aware of the innovation, forms a favourable or unfavourable attitude towards the new products. Attitudes are mostly dependent on the beliefs about product characteristics. Having evaluated the product characteristics, at the decision stage the consumer than makes a choice whether to adopt or reject an innovation. Rogers (2003, p. 177) defines adoption as the decision "to make full use of an innovation as the best course available". On the implementation stage the consumer actually adopts the innovation and assesses its usefulness. Finally, on the confirmation stage, the consumer decides whether or not to continue using it.

At the individual consumer level, much innovation research has focused on the evaluation and decision stages, aiming to evaluate the influence of consumer traits (e.g. Gatignon and Robertson 1991; Im et al. 2003; Rogers 2003 [orig. pub. 1964]) and/ or perceptions of product characteristics on people's likelihood to adopt (e.g. Mick and Fournier 1998, Rogers 2003 [orig. pub. 1964]; Moore and Benbasat's 1991).

2.3.1 Models of innovation adoption

The innovation adoption decision has been widely researched in disciplines like marketing and innovation studies, as well as social- and environmental psychology. Research in these areas focuses mainly on the influence of personal factors like the perception of product characteristics, attitudes or values and norms on the adoption of green innovation. However, Kaiser et al. 2005 argue that "despite the diversity of the specific applications of its models and despite the heterogeneity of the scientific endeavours, attitude-related theorising has converged into two frameworks for the understanding of conservation behaviour: (a) the value-belief-norm theory (Stern 1999); and (b) the theory of planned behaviour (Ajzen, 1991).” While the former focuses on values and moral norms, the latter is grounded in self-interest-based and rational-choice-based deliberation.

According to value-belief-norm theory, (VBN) moral and general altruistic considerations are the key explanatory variables of pro-environmental behaviour. VBN builds upon earlier work of Schwartz’s (1977) norm-activation theory, which has been applied to various pro-environmental behaviours like recycling or exploring alternatives to car use (e.g. Bamberg 2006; Black et al. 1985). It presumes altruistic values and that these, together with other values, underlie an individual’s personal norm (i.e. sense of obligation). The theory further emphasises people’s awareness of adverse consequences (AC) and threats to whatever objects are the focus of the values that underlie the norm (e.g. people, species or biosphere). Finally, the theory suggests that a person’s sense of obligation depends on the attribution of responsibility (AR) to self for the undesirable consequences to others or the environment - in other words, the belief that personal actions have contributed or can alleviate those consequences. For example, people who believe climate change is caused by human action (AR) might feel that they ought to reduce energy consumption to prevent CO_2 from adversely impacting on the environment (AC), because they value the environment. Stern (2005, p.10788f) summarises:

> “the model suggests that it is possible to influence individual behaviour, within the limits set by the context, habits, personal capability, and the like, by making people aware of the consequences, particularly adverse ones, for things they value, and by showing them that their personal behaviour is important enough to make a difference.”

However, the quote clearly suggests that the explanatory power of (altruistic) values might decline in situations where individuals are faced with external constraints (e.g. availability, social norms) or experience limited personal capabilities (e.g. financial resources, specific knowledge or ecological literacy). Thus, values might only be of limited use to explain pro-environmental behaviours, which are characterised as high-effort, high-cost, and high-involvement decisions (Gatersleben et al. 2002). Yet, many green innovations like microgeneration are costly and high-involvement products, and the adoption decision is likely to require consumers to rationally evaluate costs and benefits as well as potential (external) barriers, limiting the explanatory power of the VBN theory.

Consequently, innovation researchers have predominately utilised the theory of planned behaviour (TPB) to investigate the influence of personal factors on consumers' adoption decisions (e.g. Kaiser et al 2005; Paladino and Baggiere 2008; Schwartz and Ernst 2008). The TPB is the successor of the theory of reasoned action (TRA), which was developed by Martin Fishbein and Icek Ajzen (1975) and has its roots in social psychology and research around attitude formation. A class of theories commonly referred to as expectancy-value models (e.g. Fishbein 1963, Rosenberg 1956) provide a theoretical link between evaluative criteria and the concept of attitude. "These models formalised the widely held view that consumers' anticipated satisfaction with a product (and hence the adoption of that product) is determined by their beliefs that the product fulfils certain functions and that it satisfies some of their needs" (Pollard et al. 1999, p. 443). TRA suggests that people evaluate the consequences of alternative behaviours (i.e. adopt, not adopt) before engaging in them, and that they choose to engage in behaviours they associate with desirable outcomes (Bang et al. 2000) The TRA suggests that the intention to adopt an innovation depends on a person's attitude to the product and his or her subjective norms (i.e. the perceived expectations of relevant others). Attitudes (to purchase) can be understood as rational-choice-based evaluation of the outcomes of a behaviour (i.e. a behaviour's subjective utility), as well as an estimate of the likelihood of these outcomes. Subjective norms reflect the influence of social factors, i.e. a person's desire to act as others think he or she should act. However, behaviour is not always under a person's full volitional control. To overcome these problems Icek Ajzen (1991) proposed the theory of planned behaviour (TPB) as an extension of the TRA, which includes a third construct called perceived behavioural control, which is defined as the person's belief as to how difficult or easy the performance of the behaviour is likely to be (Ajzen and Madden 1986). Generally, the theory predicts that the stronger each factor (i.e. attitude, subjective norm, perceived behavioural control), the higher a person's intention or willingness to perform the behaviour.

Davis (1989) adapted the TRA and introduced the technology acceptance model (TAM), which was specifically developed to explain computer usage and adoption of new information technologies. Davis (1986) provided the theoretical link between two specific beliefs – perceived usefulness (PU) and perceived ease of use (PEOU) – and potential adopter attitudes, intentions and computer usage behaviour. PU measures the degree to which an individual believes that using a particular system would enhance his or her job performance, whereas PEOU reflects the degree to which an individual believes that using a particular system would be free of physical and mental effort. Whereas the technology acceptance model has been utilised exclusively in understanding and predicting people's usage of information technologies (e.g. Kim and Kankanhalli 2009), the theory of planned behaviour has been applied to a wide range of behaviours, stretching from condom use (Corby et al. 1996) to recycling (Knussen et al. 2004) as well as green innovation adoption (e.g. Schwarz and Ernst 2008).

The discussion indicates that both TPB and TAM are rooted in the assumption that consumers' evaluation of a new product or idea results in the formation of a negative or positive attitude towards it. "As such, people can be arrayed along a hypothetical […] beliefs continuum anchored by *strongly positive* at one end and *strongly negative* at the other" (Parasuraman 2000, p.309 [italics in orig.]). More importantly, research shows that people's attitudes tend to highly correlate with their propensity to adopt or reject[7] a new product (e.g. Cowles and Crosby 1990; Dabholkar 1996; Bruner and Kumar 2005; Dabholkar and Bagozzi, 2002). Attitude-based models like the TPB or TAM are thus the most widely applied models to predict consumers' innovation adoption-decision.

However, as noted earlier, in the context of green innovations consumers' attitudes appear to be only of limited use in explaining and predicting adoption (Prothero et al

[7] Rogers 2003 [orig. pub. 1964], p. 177) defines adoption as the "decision to make full use of an innovation as the best course of action available", whereas "rejection is a decision not to adopt an innovation."

2011). One key explanation is that TPB and TAM both neglect the importance of contextual barriers, which prevent consumers‘ personal motivations from translating into adoption behaviour (Peattie 2010; Stern 2005). Other models like the Attitude-Behaviour-Context Model (ABC) (Stern 2000) or Needs-Opportunity-Ability Model (NOA) (Gatersleben and Vlek 1998) have aimed to overcome these shortcomings, and conceptualise the influence of contextual and personal factors on consumers' behaviours. For example, the NOA model suggests that consumption is motivated by people's needs (e.g. comfort) as well as opportunities (e.g. availability of product), while (lack of) opportunities and abilities (e.g. financial) constrain consumption. Further, needs, opportunities and abilities are all influenced by contextual or societal factors, like subjective norms, culture, institutions or the economy. However, models like the NOA, which include contextual and personal variables, are generally too structurally complex to be tested empirically.

Other researchers have therefore taken a different perspective and argued to focus on consumers' subjective perceptions of (external) barriers that prevent them from adopting new green products (e.g. Garcia et al., 2007, Kleijnen et al., 2009, Ram, 1987, Ram and Sheth, 1989). Blake (1999) for example argues that the gap between values or attitudes and behavior is 'clogged up' with barriers, which prevent consumers from enacting pro-environmental behaviours. For example, green attributes are often in direct competition with more traditional product characteristics and sometimes require consumers to accept compromises in price, performance or design (e.g. Berchicci and Bodewes 2005; Dangelico and Pujari 2010; Ottman et al. 2006). Other green innovations require consumers' to change habits or routines or break with entrenched norms and traditions (Garcia 2007). In other words, " innovations mean change to consumers, and resistance to change is a normal consumer response that has to be overcome before adoption may begin" (Laukkanen et al., 2007, p.420).

The following sections provide an overview of the innovation resistance literature. In particular, it illustrates how resistance has been conceptualised as a behavioural response to innovation. It further discusses factors and influences of consumers' decisions to resist green innovations and finally identifies three research issues, which provide the rationale for the empirical studies presented in Chapters 5–7.

2.4 Consumer resistance to innovation

The discussion above has indicated that many (green) innovations experience resistance from consumers. Many of these innovations have clear advantages over existing products but fail to develop significant market shares (e.g. Rogers 2003 [orig. pub. 1964]). Estimates show that across product categories 40–90% of innovations never become a commercial success (Crawford 1977; Gourville 2006). Regularly used examples of unsuccessful diffusion are Dvorak's keyboard or Sony's BetaMax video tape recorder (VTR). Dvorak's keyboard, for example, was met with resistance from the designers of mechanical typewriters who wanted to prevent typists from hitting keys too quickly and thus jamming the machine. The inferior QWERTY keyboard was designed as an alternative to "slow down" typists, and is still the predominant English language default keyboard to date (Rogers 2003 [orig. pub. 1964]). Sony's BetaMax system also had advantages such as higher picture quality and lower video noise over competing systems. However, Sony failed to address important social issues such the length of its videocassettes, which were too short for consumers to watch a full-length movie at home, thus paving the way for JVC's Video Home System (VHS) (e.g. Cooper 2000).

Other products languish for years in the chasm between early adopters and mainstream markets (Moore 1999). For example, the dishwasher was first introduced in 1893 and it took more than 50 years for this innovation to develop into a mainstream product (Garcia et al. 2007). Other innovations such as screw-cap wines (e.g. Atkin et al. 2006), green detergents (e.g. Coddington 1993) or electric vehicles (e.g. Cooper 2000) are still facing slow takeoff times in consumer markets. For companies, "slow takeoff times mean delayed returns on investment, or in the worst case, negative payback if the product is pulled from the market before sales have a chance to take off" (Garcia et al. 2007, p. 82). In the context of green innovation, slow rates of diffusion also have wider societal implications, since delays in adoption can result in a continuous waste of resources and energy as well as excessive levels of toxic waste and pollution.

A key reason for the slow diffusion or failure of innovative products is *consumer resistance*. Clearly, many (green) innovations provide superior alternatives over existing products, yet they might require consumers to change habits and routines, or they conflict with people's belief structures or values (Bagozzi and Lee 1999; Ram 1987; Ram and Sheth 1989; Szmigin and Foxall 1998). For example, automated teller machines (ATMs) were first met with resistance by consumers, as people found them not to provide all the services (e.g. issuing cheques) available at a normal bank counter. Other technology-based self-services (TBSSs) such as self-check-outs in retail stores or ticket-purchasing machines in railway stations are often met with resistance, particularly when consumers are faced with a lack of payment alternatives (Reinerds 2008). Mobile banking is another example that initially met with resistance, mainly because many consumers associated high levels of risk with online transactions (Laukkanen 2008). Resistance to innovation can be seen as a more specific form of people's general resistance to change (Oreg 2003). For example, Ram and Sheth (1989, p.6) argue that

> "[i]nnovation resistance is the resistance offered by consumers to an innovation, either because it poses potential changes from a satisfactory status quo or because it conflicts with their belief structure."

It is important to note that consumer resistance can occur at different stages of the adoption-decision process. Scholars have broadly distinguished between *active* and *passive* forms of consumer resistance (Bagozzi and Lee 1999; Kleijnen et al. 2009; Ram 1987; Ram and Sheth 1989), depending on consumers' level of cognitive involvement in the adoption decision process (Nabih and Bloem 1997; Rogers 2003).

Passive resistant consumers are not aware of a new technology or have very little knowledge about how it functions or what it does. More importantly, these consumers have no intrinsic desire to change this state (Kleijnen et al. 2009). Researchers have argued that passive resistance is the most common form of resistance to innovation (e.g. Sheth 1981). Although most definitions acknowledge that passive resistance to innovation involves a lack of cognitive involvement on behalf of the consumer (i.e. no or low awareness), there is a debate in the literature around the underlying causes of passive resistance (Bagozzi and Lee 1999; Ram and Sheth 1989). Passive resistance can for example be a consequence of habit. Because of engrained habits and routines consumers might lack the motivation to engage in information-search or even to pay attention to innovation communication (Sheth 1981, p. 275). Similarly, people often strive for consistency and maintaining a status quo, causing a negative bias in the evaluation of new products. Research has shown that when consumers have to decide between a new and an existing product, people often weigh potential losses higher than potential gains, resulting in innovation resistance (e.g. Kim and Kankanhalli 2009; Samuelson and Zeckhauser 1988). Further, research suggests that passive resistance can result from information overload. When faced with too much information, consumers cannot evaluate the innovation against existing products and might thus not recognize the novelty of an innovation (e.g. Herbig and Kramer 1994; Hirschman 1987). Mukherjee and Hoyer (2001) for example showed that in the case of high-complexity products, novelty (i.e. innovativeness) can have a negative impact on consumers' evaluation of innovations.

Further, resistance behaviours that occur at the post-awareness stage in the adoption-decision process (i.e. persuasion, decision, and implementation or confirmation stage) can be classified as *active resistant*. Actively resistant consumers have already evaluated a new product's characteristics and are cognitively more involved, which allows them to make a more informed decision whether to adopt or resist an innovation. More importantly, research suggests that consumers can engage in *less* active/intense and *more* active/intense forms of resistance behaviours. In a comprehensive meta-review of the resistance literature and qualitative research, Kleijnen et al. (2009) identified three active resistance behaviours. According to their findings, the least intense form of resistance is *postponement*, which is defined as "an active decision to not adopt an innovation at that moment in time". This is, for example, similar to what Bagozzi and Lee (1999, p. 219) refer to as consumers' indecision, meaning that consumers "will most often continue information processing until the perception of opportunity and/or threat are subjectively addressed to satisfaction". A more intense form of resistance is consumers’ decision to reject an innovation. *Rejection* is defined close to Rogers’ definition as “an active decision to not at all take up an innovation”. The third and most intense form of resistance is opposition, which Kleijnen et al. define as an “active behaviour directed in some way towards opposing the introduction of an innovation”. *Opposition* behaviour can range from (e.g.) verbal complaints to negative word of mouth or even protest action (e.g. Bagozzi and Lee 1999).

Kleijnen et al.’s (2009) classification successfully addressed the lack of consistent terminology applied in previous resistance research For example, in Table 3.1 we apply the typology provided by Kleijnen et al (2009) to earlier studies in the area. The studies presented in Table 3.1 are, as far as the researcher is aware, a comprehensive list of innovation studies, which include a definition of consumer resistance. The table was created in order to investigate whether or not the definition provided by Kleijnen et al (2009) encapsulates previous conceptualisations of resistance. For example, the second and third columns compare the terminology applied in previous research with the classification proposed by Kleijnen et al. The fourth column provides the definition of resistance behaviours used in the respective studies. The findings clearly show that the definitions provided by Kleijnen et al. are in line with previous categorisations, providing clear evidence for the comprehensiveness of the conceptualisation of resistance behaviour applied in the scope of this thesis.

More importantly, the majority of studies conducted in the area of consumer resistance are of a conceptual nature, which created a paucity of empirical evidence about the underlying factors of different resistance behaviours. In general, research suggests that the barriers consumers associate with adopting an innovation determine their level of resistance (Kleijnen et al. 2009). Researchers have broadly distinguished between *functional* and *psychological* barriers (e.g. Kleijnen et al. 2009; Ram and Sheth 1989). Functional barriers refer to problems consumers may associate with the using a new product such as usage, value and risk, whereas psychological barriers refer to conflicts consumers may experience when innovations require them to change existing beliefs or break with traditions and norms (see Chapter 6 for a more comprehensive discussion).

In the area of green product innovation the majority of studies have aimed to identify factors that positively affect consumers' adoption decisions. Labay and Kinnear (1981), for example, analysed consumers' perceptions of solar panels. Their findings clearly show that adopters associated more relative advantages, lower complexity and higher compatibility with the technology than non-adopters. Berkowitz and Haines (1980) found similar results for solar water heating systems. A more recent study by Schwartz and Ernst (2008) appears to also confirm these findings, showing that compatibility, trialability and relative advantage(s) all had a significant impact on the adoption of innovative water saving devices. Other studies have shown that perceptions of product characteristics such as perceived reliability (Bang et al. 2000), cost advantages, independency (Hübner and Felser 2001), image and ease of use (Schwarz and Ernst 2008b) can also have a significant influence on consumers' attitudes, and ultimately the purchase decisions.

Table 3.1: Selected consumer resistance to innovation studies – typologies & definition in chronological order

Study	Original Typology	Applied Typology[8]	Original Definition	Subject	Object	Nature of Study
(Garrett 1987)	Consumer Boycott	Opposition	"(…) A boycott may be defined more specifically as the concerted, but nonmandatory, refusal by a group of actors (the agents) to conduct marketing transactions with one or more other actors (the target) for the purpose of communicating displeasure, with certain target policies and attempting to coerce the target to modify those policies" (p. 47).	Consumer groups	Other actors (companies)	Conceptual/ Qualitative Study
(Hirschman 1987)	Postponed Decision Making	Postponement	"I found that, in most instances, (…) the actual decision was postponed for as long as possible (…)" (p. 57).	Consumers	Complex innovations with technological and symbolic features	Conceptual
(Ram 1987)	Resistance to innovation	Rejection	"Innovation resistance is the resistance offered by consumers to changes imposed by innovations" (p.208).	Consumers	Innovations	Conceptual
(Ram and Sheth 1989)	Active and passive resistance to innovation: inertia (passive), postponement (active), attack, (very active)	Postponement Rejection Opposition	"Innovation resistance is the resistance offered by consumers to an innovation, either because is poses potential changes from a satisfactory status quo or because it conflicts with their belief structures. (…) Innovation resistance varies in degree. Resistance exists on a continuum increasing from passive resistance or inertia to active resistance. (…)" (p. 6).	Consumers	Innovations	Conceptual
(Gatignon and Robertson 1991)	Rejection and indecision	Postponement Rejection	"Some level of information relevant to the adoption decision is lost by grouping all non-adopters as a single category. (…) The decision process is clearly a continuous one. The decision maker goes through stages that lead to the decision to adopt the innovation, to reject it, or to gather more information, either actively or passively (…) Therefore, at a single point in time, organisations could be classified as belonging to one of three groups – adopters, rejecters, or undecided"(p. 42)	Organizations	Technological innovations	Empirical
(Herrmann 1993)	Group action and marketplace action	Opposition	"A variety of responses are available to consumers (…)" including, "(…) exit (refusal to buy), voice (complaining actions) and loyalty (continued patronage in hope of change). Exit responses can broadly be classified into "boycotts and the creation of alternative, consumer –controlled providers and goods and services" (p.130).	Consumers	Business practices	Discussion
(Penaloza and Price 1993)	Consumer resistance	Opposition	"(…) There are many forms of consumer resistance." Consumer resistance can occur on four dimensions. "One axis represents an organisational dimension and ranges from individual to collective action. A second axis represents a goals dimensions and ranges from reformist to radical. A third dimension represents tactics of resistance and varies from actions directed at altering the marketing mix (…), to actions directed at altering the	Consumers	Consumption	Conceptual

[8] The applied typology was taken from Kleijnen et al. (2009)

Study	Original Typology	Applied Typology[8]	Original Definition	Subject	Object	Nature of Study
			meaning of products (…). Finally, a fourth dimension recognises the importance of the consumer's relationship with marketing institutions and agents." (p.123)			
(Greenleaf and Lehmann 1995)	Decision delay time	Postponement	"(…) It is also important to study total decision delay time in consumer decision making, which we define as the total elapsed time between need recognition and purchase. Decision delay time includes both active decisions time and time the consumer spends on all other activities during the decision process" (p. 186).	Consumers	High-cost consumer products	Empirical
(Martinko 1996)	Rejection and reaction	Rejection Opposition	"While a variety of potential behavioural reactions to the implementation of new IT are possible, these reactions can be classified into three categories: acceptance, rejection, and reactance." (…) "Resistance behaviours are characterised by low levels of use, by a lack of use, or by dysfunctional, e.g. harmful, use." (…) "Reactance refers to behaviours which attempt to regain control" (p.321f).	Individuals	Information technologies	Conceptual
(Nabih and Bloem 1997)	Rejection, resistance (active and passive) and postponement	Postponement Rejection	"Adoption and rejection relate to the behavioural stage in the adoption decision model, while acceptance and resistance are located at the preceding evaluation and intention level. (…) The consumer may escape from the dilemma between adoption and rejection by postponing the decision. Postponers are unwilling to commit themselves at a given point in time. They are undecided as to whether they need more information or more information processing time, or are forced to delay adoption by external constraints such as, for example, product availability" (p. 191).	Consumers	Innovations	Conceptual
(Fournier 1998)	Consumer resistance	Opposition	"Broadly speaking, resistance involves an opposing or retarding force; it concerns activities that exert oneself so as to counteract or defeat (Webster's Dictionary) (…) we have yet to develop an integrative theoretical perspective of the phenomenon that considers the many and varied ways in which resistance of the marketplace and its offerings impacts consumer behaviour" (p. 88).	Consumers	Consumer markets	Discussion
(Szmigin and Foxall 1998)	Postponement Rejection Opposition	Postponement Rejection Opposition	"Resistance to an innovation can take the form of outright rejection, postponement or opposition" (p.90).	Consumers	Debit and credit cards	Qualitative study
(Bagozzi and Lee 1999)	Active resistance passive resistance and indecision	Postponement Rejection Opposition	"Sometimes the reaction of a consumer to the idea of an innovation is resisted actively. For example, an innovation may prompt a response of rejection, protest, or even active boycott. (…) Initial resistance occurs passively as well. One way this happens is as a consequence of habit. (…) (Indecision means) that consumers will most often continue information processing until the perception of opportunity and/or threat are subjectively addressed to satisfaction (p. 219).	Consumers	Innovations	Conceptual/ decision making process
(Coetsee 1999)	Apathy, passive resistance, active resistance, and aggressive Resistance	Postponement Rejection Opposition	"Apathy (…) can be labelled a neutral or transition zone, characterised by a lack of positive or negative emotions or attitudes (indicated by no demonstrated interest) (…) Passive resistance exists when mild or weak forms of opposition to change are encountered, demonstrated by the existence of negative perceptions and attitudes expressed by voicing	Stakeholders	Innovations in organisations	

Study	Original Typology	Applied Typology[8]	Original Definition	Subject	Object	Nature of Study
			opposing views (…). Active resistance is typified by strong but not destructive opposing behaviour such as blocking or impeding change by voicing strong opposing views and attitudes, (…), protests, and personal withdrawal. Aggressive resistance (a destructive opposition) (is) reflected in destructive behaviour such as purposefully committing errors and spoilage, subversion, sabotage, terrorism, destruction, and the most severe form of aggression – killing" (p. 216).			
(Ritson and Dobscha 1999)	Consumer rejection i.e. complaint, boycott and resistance	Opposition	"When an individual or group rejects a particular aspect of a marketing campaign or strategy three strategies are usually invoked. In the mildest form of consumer rejection the individual or group complains to the sponsoring organisation (…). Alternatively, the individual or group can boycott a specific manufacturer or retailer by completely withdrawing participation within a specific market (Garrett, 1987). Finally, in the most extreme mode of consumer rejection, the individual or group can actively engage in some form of consumer resistance which directly communicates their overt resistance and rejection of a particular marketing organisation" (p. 159).	Individual consumers and consumer groups	Marketing dogma and practices	Presentation summary
(Sen et al. 2001)	Consumer Boycott	Opposition	"A consumer boycott is 'an attempt by one or more parties to achieve certain objectives by urging individual consumers to refrain from making selected purchases [from one or more target organizations] in the marketplace (…)'. Boycotts are of two basic types: economic or marketing policy boycotts aim to change the boycott target's marketing practices (…) whereas the more recent political or social/ethical control (…) boycotts attempt to coerce their targets toward specific ethical or socially responsible actions, (…)" (p. 400).	Consumers	Organisations	Empirical
(Rogers 2003 [orig.pub 1964])	Rejection	Rejection	"Rejection (is) the decision to not adopt an innovation" (p. 177).	Consumers	Innovations	Conceptual/ decision making model
(Lapointe and Rivard 2005)	Apathy, passive resistance, active resistance, and aggressive resistance	Rejection Opposition	"Resistance behaviours exist across a spectrum, from being passively uncooperative to engaging in physically destructive behaviour (…). The taxonomy proposed by Coetsee (1993, 1999) is useful in this regard, allowing the classification of the resistance behaviours according to four levels of resistance: apathy, passive resistance, active resistance, and aggressive resistance" (p. 464).	Physicians, nurses and administrators	Clinical Information Systems	Conceptual/ qualitative study
(Garcia et al. 2007)	Resistance to Innovation	Rejection	"Resistant innovations (…) require consumers to incur psychological switching costs as well as economic switching costs. As a result, consumers have negative attitudes towards innovations and resist adopting them" (p. 83).	Consumers	Screw-cap wine closures	Empirical
(Laukkanen 2007)	Innovation Resistance	n.a.	"While majority of studies have focused on the success of innovations and reasons to adopt, the theory of innovation resistance aims to explain the reasons that inhibit innovation adoption" (p. 424)	Mature consumers	Mobile Banking	Empirical

Researchers also evaluated the effect of consumers' personal values, environmental concern or altruism on attitudes and intentions to adopt green innovation. Findings clearly show that environmentally concerned consumers are more likely to believe in the positive environmental consequences of green innovation, thus explaining their generally more positive attitudes to green products. For example, Nyrud et al. (2008) researched consumers' inclination to continue using woodstoves for heating and concluded that policy campaigns trying to promote the uptake of wood stoves should appeal to people's environmental concern. Paladino and Baggiere (2008) found similar results for Australia. Their results suggested that the decision to purchase green electricity can be explained by attitudes that in turn depend on consumers' environmental concern and altruism. In a study on adoption of water-saving devices, Schwarz and Ernst (2008) combined consumer values and sociodemographic characteristics to form consumer lifestyle segments (i.e. social milieux). Their results highlight significant differences in attitudes and intentions to adopt between social milieux. The findings also show that, depending on consumers' social background, the influence of significant others (i.e. social norms) varied significantly.

In general, the perceived influence of others, i.e. subjective norms, appears to have an important influence on purchase intentions and willingness to pay. Wiser (2003), for example, shows that the willingness to pay for renewable energy in the US was higher for respondents who believed that family and friends would generally be supportive of green energy. Paladino and Baggiere (2008) found similar results, showing that friends' support was a significant predictor of consumers' decision to buy green electricity. Nyrud et al. (2008, p. 3173) also shows that subjective norms "impacted significantly on both the intention to use bioenergy in the future and on overall satisfaction with using bioenergy". Consumers who experienced support from friends and family reported a higher level of satisfaction. The same appeared to be true for the influence of the local community and neighbours. However, in their study on the adoption of water-saving devices Schwarz and Ernst (2008) found that the direct influence of subjective norms on intention was mostly non-significant. Yet their findings show that subjective norms positively affect attitudes, which in turn influence purchase intentions.

However, none of these studies accounted for differences in resistance behaviours. Yet research suggests that the motives or barriers underlying resistance differ significantly between the types of resistance behaviours discussed above. Consumers who resist an innovation passively are likely to do so for different reasons than people who have already assessed an innovation's characteristics and decided to resist adoption actively. Further, the limited empirical evidence suggests that the motives between different intensities of active resistance can differ profoundly (e.g. Kleijnen et al. 2009; Laukkanen et al. 2007). For example, Kleijnen et al. show that the main motives for consumers to postpone adoption of new products were economic factors or perceived incompatibility with existing usage patterns, while consumers who rejected an innovation mainly associated higher levels of functional risk with an innovation. Consumers who opposed an innovation, on the other hand, believed that the innovation might cause physical harm or had a negative image.

Accounting for differences in resistance behaviours and, more importantly, understanding the underlying motives is thus of critical importance for marketers aiming to promote green innovations**.** Further, it needs to be pointed out that "scholars and practitioners should be careful about the simplistic conclusion that decreasing resistance calls for similar approaches to those used in increasing adoption" (Kleijnen et al. 2009, p. 353). For example, many consumers believe that non-chemical detergents are less effective than their toxic counterparts (e.g. Coddington 1993). Marketing strategies that simply focus on promoting the environmental superiority of green detergents are unlikely to overcome consumers' ingrained beliefs and deep-rooted traditions. Thus, marketing-resistant innovations require companies not only to promote a product's attributes but also to consider consumers' mindsets and their perceptions of barriers, as failure to address both is likely to result in slow takeoff times (Garcia et al. 2007, p. 83).

3 Research objective and questions

The discussion above shows that consumer resistance is a critical problem for companies and societies aiming to promote sustainable product innovation. The little empirical evidence available suggests that consumers often associate functional and psychological barriers with adopting new products. Adopting green innovations, for example, might require consumers to accept trade-offs between conventional product characteristics such as price or performance and environmental improvements. Further, green product innovation might require consumers to break with existing habits and routines or entrenched traditions, and in order to overcome resistance companies have to deviate from conventional marketing strategies. Yet consumer resistance is a widely under-researched area and empirical evidence about motives behind different types of resistance behaviours is scant.

The main objective of this dissertation is thus to build on recent findings in the resistance literature and (i) to empirically investigate consumer resistance in the context of green product innovation, (ii) to better understand the underlying reasons and (iii) to provide strategic recommendations for marketers and policy makers on how to overcome consumer resistance to green product innovation. In particular, the following areas provide scope for further research.

3.1 Passive resistance

Researchers have long argued that passive resistance is the most common form of consumer resistance (e.g. Sheth 1981). The majority of consumers are likely to be satisfied with the status quo and pay no or little attention to innovation. Passive resistance is often the consequence of habit and routines and as a result many consumers do not actively engage in information-seeking behaviour and simply remain unaware of innovation (Sheth 1981, p. 275). Yet passive resistance has received little empirical attention in the literature (Bagozzi and Lee 1999). This is somewhat surprising since awareness precedes attitude formation and adoption decisions and thus should be understood before purchasing decisions can be researched.

For example, ignoring levels of awareness in survey research around adoption of innovation can lead to non-response bias (e.g. Armstrong and Overton 1977), which can result in distorted findings and ultimately in the design of poor strategies. Further, "early knowers" of green product alternatives are an important segment that can be targeted by marketers and policy makers as agents of change, helping to raise awareness among the wider population. According to Rogers (2003, p. 174) these less passive-resistant consumers have a higher social status, are more cosmopolitan, experience more exposure to mass media and interpersonal channels. Yet, as far as the authors are aware, there is no empirical evidence to confirm these speculations. In this context, the study aims to answer two research questions:

1. Who are consumers that are passively resistant to (i.e., unaware of) green product innovation, and
2. How can we use this knowledge (i) in the design of surveys aiming to estimate to understand consumers' adoption decisions and (ii) in the design of strategies aiming to promote green product innovation?

The study presented in Chapter 5 addresses these questions and provides an exploratory study that investigates consumers' passive resistance, evaluating the effect of sociodemographic differences on consumers' awareness of innovative products. The findings show that awareness differs significantly between sociodemographic groups but also between different innovations, holding important implications for marketers and policy makers.

3.2 Active resistance

The discussion above has highlighted that active resistance to innovations can take various behavioural forms, i.e. postponement, rejection, opposition (Bagozzi and Lee 1999; Kleijnen et al. 2009; Ram 1987; Ram and Sheth 1989). However, the majority of empirical studies to date operationalize resistance dichotomously as adoption/non-adoption, thus effectively ignoring individual difference and behaviour among resistant consumers. Yet recent findings indicate that, for example, consumers' motives for postponing their decision to adopt are likely to be different from motives that lead to opposing innovation (Kleijnen et al. 2009). By ignoring differences in consumers' resistance intensity, researchers risk losing valuable information about consumers and their underlying motives for not adopting an innovation. From this three important research questions arise:

3. How can we better account for heterogeneity in consumer resistance behaviour,

4. Do the motives behind different intensities of resistance differ, and

5. How can marketers use this knowledge to address barriers to change and effectively overcome consumer resistance to innovations?

The objective of the empirical study presented in Chapter 6 is to propose and evaluate a new approach to empirically investigate consumer resistance to innovation. In contrast to previous studies, we measure consumers' resistance towards innovation directly in a two-step adaptive survey design, thus accounting for different intensities of resistance behaviour. We demonstrate that resistant consumers are a diverse group, which varies significantly not only in levels of resistance but also in their perceptions of product characteristics (i.e. barriers to change). The study thus addresses the paucity of empirical evidence around active consumer resistance and provides valuable information for marketers and product managers aiming to enhance the impact of their marketing mix in promoting green product innovation.

3.3 Willingness to pay

A key challenge companies are facing is selling green product innovations at a competitive price. Many industries have already developed green product alternatives, but relatively high development and production costs cannot be translated into higher prices, as consumers are often not willing to pay a premium for green attributes (Dangelico and Pujari 2010). Numerous companies are thus dependent on the support of public policies that offer consumers incentives to purchase environmentally superior products in the form of grant aid, tax breaks or subsidies (Dangelico and Pujari 2010). Despite the positive externalities of supporting green product innovation (e.g. reduction in CO_2 emissions), such policies can be costly, placing a burden on taxpayers and adversely affecting consumers' green sentiment (e.g. Frondel et al. 2010).

It is therefore important to design policies that promote green product innovation as (cost-)efficiently as possible. In this context, marketing has much to offer and its principles can be utilised to increase effectiveness of policies by, for example, designing supplementary campaigns that help overcome consumer resistance and positively influence buying behaviour (e.g. Hastings 2007). In relation to green product innovation two important questions arise:

6. How do consumers perceive green products and how do these perceptions affect their willingness to pay (WTP), and
7. How can policy makers and marketers use this knowledge to promote green product innovations, increase consumers' WTP and reduce the costs of public policy?

The empirical study presented in Chapter 7 investigates consumers' WTP for four green product innovations and assesses the influence of consumers' subjective perceptions of product attributes. The results show that consumers hold different perceptions about product characteristics, which significantly influence their WTP. The findings will provide potential leverage for policy makers to design (marketing) strategies that increase consumers WTP, thus lessening the gap between WTP and actual prices and ultimately reducing the cost of public policy.

4 Empirical context

As pointed out by Belz and Peattie (2009, p. 80) consumer behaviours are "not consistent across all types of purchase and all consumption contexts" and are "not equally important in terms of their sustainability impacts". Understanding the consumption context is thus of critical importance to embed the research objectives highlighted above in the empirical context and to evaluate our findings more accurately in light of their generalisability.

The research was instigated by and conducted under the umbrella of an interdisciplinary Technological Sector Research (Strand III) project called "Energy-Efficient Policy Research in Domestic Buildings". This government-funded project was run by researchers from various disciplines in the Dublin Institute of Technology and a key aim was to identify key barriers to sustainable energy uptake in the residential housing sector.

Housing is an important sector that offers one of the greatest potentials for reducing negative environmental impacts. For example, the European Environmental Impact of Products project (EIPRO 2006) estimated that about 70–80% of total environmental impacts relate to food and drink consumption, transport (including commuting, leisure and holiday travel) and housing (including domestic energy use).

In Ireland the housing sector accounts for about 25% of the total primary energy requirements and 26% of energy-related CO_2 emissions. It is thus the second largest source of CO_2 emissions after transport. The Irish housing stock in particular provides significant scope for improvement, since electricity usage per dwelling was 17% above EU-15 average and Irish houses emitted about 92% more CO_2 than the average house in EU-15 countries (O'Leary et al. 2008).

Recent innovations have made it possible for house owners to retrofit their homes and generate their own electricity and heat by the use of so-called *microgeneration*, which includes technological innovations such as photovoltaic (PV) panels, micro wind turbines, solar water heaters, wood pellet boilers, geothermal heat pumps and combined heat and power units (CHP).[9] These green product innovations provide electricity and heat close to the source of consumption. Further, studies show that investment in microgeneration can be an economically viable[10] way to reduce energy costs and CO_2 emissions and can help trigger positive changes in energy consumption patterns (e.g. Allen et al. 2008).

A key challenge for marketers and policy makers, however, is the slow diffusion of microgeneration technologies, which is often attributed to low social acceptance and consumer resistance (e.g. Sauter and Watson 2007; Wüstenhagen et al. 2007). The housing sector and in particular microgeneration technologies thus serve as an appropriate context for the empirical investigation of the research questions specified above. More importantly, because of Ireland's high level of home-ownership and relatively poor quality of housing, improvements in this sector are likely to yield high sustainability impacts.

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[9] CHP is technically not a "renewable"; however, it is included here as it has the potential to save significant amounts of energy and reduce carbon emissions.
[10] The economic potential of sustainable energy systems is largely theoretical, based on discount rates, life-cycle evaluations and current or expected energy prices.

4.1 Exploratory consumer study

In order to link theoretical findings from the resistance literature (section 4.2) to the empirical context (section 6) we conducted a series of qualitative interviews. The exploratory research served as an important first step to gain further insight into the problem situation. It thus complements and guides our primarily quantitative endeavours and helped to ground empirically the seven research questions presented above (e.g. Wilk 2001).

In particular, the exploratory study aimed (i) to gain a qualitative understanding of consumers' levels of resistance, (ii) to gain a qualitative understanding of their underlying reasons and motivations and (iii) to guide the development of the survey instrument(s) described in the subsequent sections. In order to achieve these objectives we conducted a series of semi-structured 20–40 minute interviews with a convenience sample of 20 adult home owners in Ireland (Kvale 1996). Participants were initially recruited randomly within the Dublin Institute of Technology and consisted of porters, administrative staff and academics. The sampling then followed a snowball approach, as new participants were recruited from existing subjects' acquaintances. The sample consisted of an almost equal number of men and woman and was spread across different age groups and income categories. In line with DIT's code of ethics,[11] all participants were provided with an explanation of the purpose of the interview in the form of a cover letter and a brief oral introduction (Appendix 1). The researcher also highlighted that all answers were treated confidentially and anonymously. All interviewees agreed that their answers be recorded.

The in-depth interviews consisted of five parts. In the first part, respondents were asked if they had heard the term *microgeneration* and if they were aware of the individual technologies. Second, participants were asked about their general attitudes and overall impression of microgeneration. Following from this, respondents were asked to name advantages and disadvantages they associate with microgeneration. In the final section, we questioned interviewees about their intentions to adopt microgeneration technologies in the near and distant future. Respondents who had no

[11] The research received ethical approval by the DIT's ethics committee November 2009 (see Appendix 1).

intention to buy microgeneration technologies were further prompted to explain whether they were postponing their purchasing decision or rejecting the idea completely. Finally we asked consumers what would be an acceptable period of return on their upfront investment.

4.1.1 Findings

Using similar procedures to Richins and Dawson (1992), we transcribed the interviews and conducted a content analysis. The findings provided an important first step in the design of the survey instrument (Chapter 4) and were also utilised during the scale development process in Chapter 6 as well as the willingness to pay experiment presented in Chapter 7.

In a first step, we evaluated consumers’ awareness of the individual technologies and familiarity with the term “microgeneration”. The interviews showed that only three participants were familiar with the term and that the level of awareness of the individual technologies varied significantly. For example, all respondents had heard about solar panels (PV) and wood pellet boilers but only 15 had heard about geothermal heat pumps, and only eight were aware of micro CHP (see Table 3.2).

Table 3.2: Awareness of microgeneration technologies (*n* = 20)

Wood pellet boilers	Geothermal heat pumps	Micro CHP	Micro wind turbines	Solar panels	Solar thermal heaters
20	14	8	15	20	18

In a second step we summarised the most frequently mentioned motivations and barriers to adoption (see Table 3.3). The findings match previous studies and helped to later identify appropriate multi-item scales for the survey instrument. For example, the findings show that economic, environmental and independence benefits are key motivations for home owners to adopt renewable energies and thus match previous research (e.g. Hübner and Felser 2001; Jakob 2007; Nyrud et al. 2008; Schwarz and

Ernst 2008a). Other studies around energy-saving measures and renewable energy also show that capital cost, fit with existing infrastructure and information appear to be key barriers to adoption (e.g. Jakob 2007; O'Doherty et al. 2008; Schleich and Gruber 2008; Scott 1997). Another barrier for consumers, for example, was the perceived reliability of the technologies and the ongoing maintenance costs, which again matched previous findings (e.g. Schleich and Gruber 2008)

Table 3.3: Perceived barriers and motivations to microgeneration adoption (*n* = 20)

Perceived Advantages	**Number of Respondents**	**Perceived Disadvantages**	**Number of Respondents**
Energy savings	18	Initial cost	19
Environmental benefits	18	Long payback	17
Independence	14	Fit with existing infrastructure	16
Reliability	12	Information	14
Profitable in long run	9	Reliability	12
"Feel-good"/Match with values	4	Disruption of daily routines	10
Aesthetics	4	Finding skilled providers	9
		Maintenance cost	8
		Visual impact	8
		Planning permission	5
		Personal age	4
		Noise	3
		Difficult to understand	1

Third, we evaluated consumers' levels of resistance. Again, levels of resistance expressed by respondents appear to match broadly the resistance categories identified in the literature, i.e. intention to adopt versus postponement, rejection and opposition (see section 4.2). For example, when asked how likely they were to install a microgeneration technology in the next 12 months, one respondent answered:

> "I would say very likely. Yeah, because it's a no-brainer! You know, once installed it will pay for itself eventually" (Respondent X, p. 6).

Other consumers had equally positive attitudes, but were clearly postponing the decision to adopt. One consumer for example stated:

> "Yeah, I think maybe in a year or so it might be something I would think about considering. You know, I've got other priorities at the moment. I've got

> cavity wall insulation and all these other little things but, you know, considering this is on my list at some point" (Respondent Y, p. 5).

Some respondents, however, clearly rejected the idea of adoption and when asked about their intention to adopt, one respondent stated:

> "Never is the answer. I think that there's a stage in families where you do house extension (…) and if I have to pay a bit more for having an [energy] inefficient house, so be it. Whereas the economics would have been quite different if my children were aged five, eight and twelve" (Ed.R. p. 7).

No consumer actually opposed microgeneration for ideological reasons. However, one respondent appeared to oppose microgeneration purely based on his/her perception of the technology's economic viability. When asked about his/her intention to adopt the respondent answered:

> "No. (…) The argument I was making with you is that you can make six per cent on your money, okay, so if you've €100,000 you'll get €6,000 a year. Now, if I invest in solar will I get six per cent? In other words will I get it payback in sixteen years? I'm just doing the commercial end of it (…) But what's not taken into account are repair costs, the maintenance costs and the ongoing charges, which haven't even been taken into account because people say 'Oh yeah, get into it now and you'll have free electricity for the rest of your life' – you will in your arse"[12] (Respondent Z, p. 10).

Overall, we found that two consumers had an intention to adopt, eleven were postponing their decision, six rejected the idea of adoption completely and one appeared to be (mildly) opposing microgeneration. Again, following procedures used by Richins and Dawson (1992) we later converted respondents' answers into items for the resistance scale.

Finally, when asked what would be an acceptable period for the return on upfront investment, consumers' answers ranged from 1 to 20 years. However, the median (mean) accepted payback period was 5 years (6.23 years). These answers proved valuable at later stages of this research when designing the willingness-to-pay experiment.

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[12] The researcher apologises for the use of strong language; however, he believes that it aids the argument and helps to illustrate consumer opposition to microgeneration.

4.1.2 Implications

The exploratory qualitative study provides several important findings, which had theoretical and methodological implications for the design of the quantitative studies presented in Chapters 5-7. Theoretically, the exploratory study contributed to the decision to apply a consumer-resistance lens and investigate barriers, which 'clog up' the gap between consumers' attitudes and their pro-environmental behaviours (Blake 1999).

The majority of homeowners in the qualitative study articulated a positive attitude towards microgeneration and associated environmental benefits with it. Yet, in most cases attitudes did not correlate with purchase intentions, mainly because of perceived functional barriers like initial costs, installation requirements or reliability (risk) issues (see Table 3.3). The qualitative study thus indicates the presence of an attitude-behaviour gap (Peattie 2001) in the context of microgeneration. Further, the findings imply that traditional models like the TPB or TAM may not adequately reflect microgeneration adoption decisions, since both theories neglect the importance of (contextual) barriers, which prevent consumers' personal motivations from translating into adoption (Peattie 2010, Stern 160). Overall, the findings reinforced the decision to apply a consumer resistance perspective (Ram and Sheth 1989) and empirically investigate the relative influence of barriers, which prevent consumers from adopting microgeneration.

Methodologically, the qualitative study had a significant influence on the conceptualisation of the dependent variable and the design and structure of the quantitative research (i.e. surveys). First, the exploratory study shows that some homeowners resist microgeneration passively (i.e. unaware), whereas others resist adoption actively (i.e. postponement, rejection or opposition). The discussion above has shown that passive and active resistance occur at different stages in the adoption-decision process and, from a methodological perspective, should be researched as two distinct dependent variables (Kleijnen et al. 2009). The researcher therefore decided to investigate passive resistance and active resistance independently in two surveys.

In regard to passive resistance (e.g. Sheth 1981), as far as the researcher is aware, there is no empirical evidence around influences or antecedents. The findings thus resulted in the decision to explore empirically awareness of microgeneration technologies and how passive and non-passive resistant consumers differ from each other (Study I).

Further, the exploratory study suggests that consumers' have different degrees or intensities of active resistance. This is line with findings from the literature, which suggests that consumers can engage in *less* intense and *more* intense forms of resistance behaviours, including postponement, rejection and opposition (e.g. Kleijnen et al. 2009).Yet, the majority of empirical studies to date operationalise active resistance dichotomously as adoption/non-adoption, effectively ignoring individual difference and behaviour among resistant consumers. The exploratory phase of this research thus resulted in the decision to develop a new dependent variable (i.e. consumer resistance), which accounts for more heterogeneity in resistance behaviours than conventional intention-to-adopt scales (Study II).

The exploratory study also proved an important first step to identify potential antecedents of consumer resistance. The findings indicate that consumers associate barriers with adopting microgeneration, which are likely to explain the discrepancy between positive attitudes and negative adoption intentions. Further, the exploratory study shows that barriers most frequently mentioned by houseowners correspond with constructs from the innovation and consumer resistance literature. For example, consumers identify perceived energy savings, environmental benefits and independence as *relative advantages* (Rogers 2003) of microgeneration over conventional energy systems. Likewise, homeowners mentioned barriers like *upfront capital costs* (Darley and Beniger 1981), *compatibility* with infrastructure (Schwarz and Ernst 2008) or *functional risk* (Ram and Sheth 1989) as key barriers, preventing them from adopting microgeneration. Although the decision which independent variables to include was largely determined by theory, the exploratory study aided the identification of theoretical constructs and measurement scales in the later stages of the research process.

Finally, the qualitative research shows that a key factor preventing consumers from adoption appears to be the perceived economic viability of microgeneration. The vast majority of interviewed consumers mentioned initial cost as a key barrier. On the other hand, more than two thirds of respondents stated that energy cost savings would be a main reason for adoption. Thus, the exploratory study led to the decision to focus particularly on the economics of this green product innovation and to empirically investigate consumers' willingness to pay, accepted payback periods, and influence of subjective perceptions of product characteristics on people's WTP (Study III).

In the following section we discuss the methodology that was employed to investigate the above identified research topics empirically.

Chapter 4

"Whether you can observe a thing or not depends on the theory which you use. It is the theory which decides what can be observed."

(Albert Einstein)

1 Research methodology

This thesis investigates the phenomenon of consumer resistance to green product innovations. In doing so, it seeks to extend our conceptual and empirical knowledge in this domain. Research conducted for this thesis is understood as "… a systematic, careful inquiry or examination to discover new information or relationships and to expand/verify existing knowledge …" in the area of consumer resistance (Smith and Dainty 1991, p. 68). In order to guide the process of scientific enquiry, however, we first need to clarify the underlying philosophical assumptions. The objective of this chapter is first to discuss the underlying research philosophy and implications for the discovery of knowledge. Second, we outline the research design and data collection methods and, finally, we provide an overview of the data analyses employed to answer the research questions presented above.

1.1 Research philosophy

This study follows a quantitative perspective as the enquiry into a social problem (i.e. consumer response to green product innovation) is based on testing a theory (i.e. resistance to innovation) that comprises variables (e.g. perceived barriers) that are measured numerically and are analysed via statistical methods to determine whether the predictive generalisations of the theory hold true (Creswell 1994). In effect, the research problem is made traceable by embracing a quantitative approach.

The choice to follow a quantitative approach originates from the researcher's belief about how the world is (ontology – the study of *reality*) and how this knowledge can be scientifically acquired (epistemology – the study of how we *know*). Generally, worldviews or belief systems guiding scientific inquiries are referred to as paradigms (Kuhn 1970). The social sciences provide competing paradigms such as positivism, post-positivism, critical theory or constructivism (Krauss 2005). The philosophy of science underpinning this study is *scientific realism*. Researchers have argued that (scientific) realism has replaced logical positivism as the dominant paradigm in marketing sciences (e.g. Easton 2002; Sobh and Perry 2006).

Scientific realism, as understood in this thesis, builds to a large extent on a body of work by Shelby Hunt (e.g. Hunt 1990, 1992, 1993; Hunt and Clark 2001). In the following sections we outline the ontological and epistemological implications of scientific realism for research conducted in the scope of this thesis.

1.1.1 Ontology and epistemology

Ontological questions refer to what reality is and what can be known about it. Philosophers have broadly distinguished between the nominalist assumption that (social) reality is a product of our minds and the realist view that a (social) world exists separate from people's perception of it. Epistemology on the other hand is concerned with how the (social) scientist can obtain knowledge about the world and how to distinguish between truth and falsity (Krauss 2005). However, epistemological issues cannot be addressed before the ontological question is answered, i.e. does the external world exist independently of our perceptions of it, or not? Scientific realism as proposed by Hunt (1990) falls into the realist category and rests on four key tenets, which have their roots in classical realism, fallibilistic realism, critical realism, and inductive realism. Whereas the first two tenets answer the ontological question, the critical and inductive elements shed light on epistemological issues.

First, scientific realism rests on the key assumption that the world exists independently of it being perceived or our representation of it (e.g. Searle 1995). However, like other realists (e.g. Bhaskar 1989), Hunt distinguishes between a reality that exists independently of being perceived (i.e. intransitive dimension) and people's concepts, theories and laws that are designed to describe that reality (i.e. transitive dimension). Scientific realism thus breaks with direct realism,[13] which postulates that reality is as it is perceived and is also contrary to the relativist assumption of socially constructed realities as there is a reality independent of our perception of it.

The important distinction between reality and our theories about it implies that structures between entities exist independently from our knowledge of them and, more importantly, that researchers can apprehend reality only imperfectly. Hunt thus incorporates a second tenet to scientific realism, arguing that any knowledge we discover about the world can never be known with certainty. Hunt and Hansen (2009) quote Siegel (1983, p. 82):

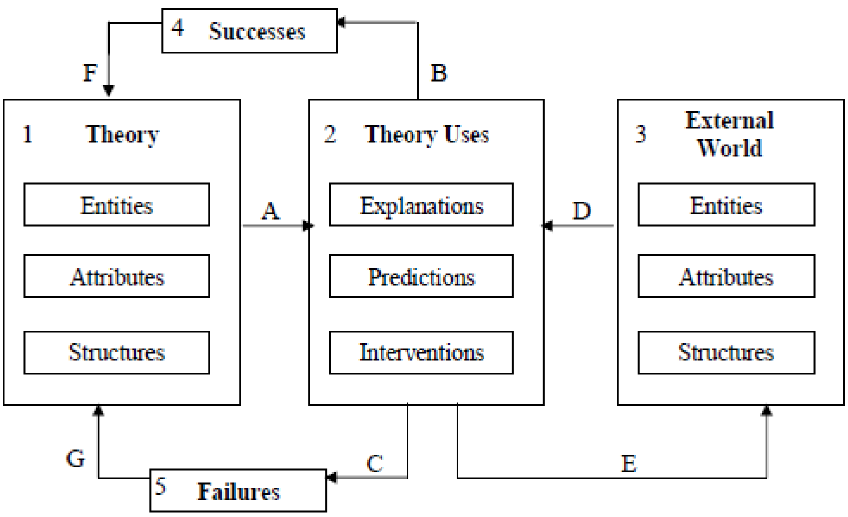
> "to claim that a scientific proposition is true is not to claim that it is certain; rather, it is to claim that the world is as the proposition says it is."

Third, recognising the fallibility of scientists' efforts to unearth and test knowledge claims requires researchers to be critical. The scientific realist perspective thus allows for competing theoretical frameworks to research the same social phenomena but since reality is only apprehendable imperfectly, knowledge claims made by theories can only be seen as provisional and are subject to constant revision on the basis of future scientific evidence. As pointed out by Hunt and Hansen (2009, p. 117), "critical realism stresses the importance of the continuing efforts of science to develop ever-better measures of constructs, research procedures for empirical testing, and epistemological norms for developing scientific knowledge." Thus, scientific endeavours have to critically "(1) evaluate and test its [science's] knowledge claims to determine their truth content and (2) evaluate and re-evaluate the methodologies and epistemologies that inform extant scientific practice" (Hunt 2009, p. 117).

[13] Direct realism suggests that (1) because our perceptual processes necessarily result in a veridical representation of external objects, (2) knowledge about external objects can be known with certainty.

Finally, scientific realism (as proposed by Hunt) has to follow an inductive approach in that the long-term success of scientific theories gives reason to believe that something like the entities (observable or unobservable) and structures (causal or non-causal) proposed by theories actually exists (e.g. McMullin 1984). Hunt and Arnett (1999) point out that when a theory is successful over a significant period of time, scientists have reason to believe in the entities and structure implied by the theory, but never conclusive warranty. Further, it provides reason to believe that “something like” (not “exactly like”) the entities and structures proposed by the theory actually exists. Thus, unlike in the positivist paradigm, it is appropriate to investigate unobservable concepts (e.g. resistance, attitudes, and beliefs) and to assume that empirical tests provide evidence of the truth content of their proposed theories (Hunt and Arnett 1999). Hunt and Hansen (2009) effectively explicate the scientific realist quest to acquire knowledge about (social) phenomena in a simplified model (Figure 4.1).

Figure 4.1: Scientific realism: Theory successes, failures, and truth



Source: Hunt and Hansen (2009)

Box 1 in Figure 4.1 is a representation of what realists commonly refer to as the transitive dimension, i.e. a scientific theory or conceptualisation of the external world. Every theory comprises *entities* (e.g. consumers), *attributes* of entities (e.g. resistance) and *structures* (e.g. propositions of relationships between resistance and perceptions of product characteristics). Thus, theory postulates to account for the entities, attributes and structures in the real world, i.e. intransitive dimension (Box 3). Path A illustrates that theories can be used to explain or predict (social) phenomena (e.g. consumer resistance to green technologies) and to provide the basis for interventions (e.g. aiming to overcome resistance). Yet it is important to note that the evidence provided by a theory (Paths B & C) can succeed (Box 4) or fail (Box 5), which in both cases is dependent on the entities, attributes and structures in the real world (Path D). In turn, the application of theory (Box 2) can have an influence on the external world (Path E) (e.g. when marketers or policy makers incorporate research findings in the design of strategies aiming to bring about behavioural change). Further, a theory's successes and failures allow scientists to make inferences about the truth content (Path F) and falsity content (Path G) of the theory. In other words, according to Hunt and Hansen:

> "[f]or scientific realism, a high proportion of successes, relative to failures, gives reason to believe that something like the entities, attributes, and structures posited by the theory in box 1… actually exist in the world external to the theory …"

Again, "something like" refers to an approximation of reality, meaning that a theory has some truth content. Likewise, if failure rates in proportion to success rates are high, researchers can infer that the theory is likely to be false. Thus, the model suggests that in order to achieve progress towards a true account of social phenomena, replication of studies and extensive and ongoing testing of knowledge claims is of critical importance.

The subjects of enquiry in this study are consumers (i.e. entities) and their resistance (i.e. attribute) to green product innovation. In line with the epistemological framework presented in Figure 4.1, the research aims to advance our understanding of consumer resistance to green innovation and to unearth the underlying reasons behind different forms of resistance (i.e. structures). In particular, we aim to provide explanations for consumers' passive resistance (Chapter 5), active resistance

(Chapter 6) and willingness to pay (Chapter 7), informing the design of interventions aiming to promote adoption of green technologies.

The following sections first present a general outlined of the research procedures, before discussing the methods that were employed to gather evidence necessary to make knowledge claims in light of reliability, validity and generalisation of findings. Table 4.1 provides an overview of the research design, data collection and analyses conducted in the scope of this thesis.

1.2 Research procedures

As outlined in the previous chapters, this thesis addresses the attitude-behaviour gap in the context of microgeneration technologies. The research process involved several steps, which will be outlined in chronological order before discussing the chosen research design and research methods in greater detail in the subsequent sections of this chapter.

Having defined the research problem, the first step involved a comprehensive review of the respective literature, which resulted in the decision to apply a consumer-resistance perspective (Kleijnen et al. 2009) in order to empirically investigate barriers that prevent consumers from adopting microgeneration technologies. In particular, the review of the literature revealed three areas, which provided scope for further research, including passive resistance, active resistance and willingness to pay.

In a second step, an exploratory qualitative study was conducted to ground the theoretical conceptualisations of consumer resistance in the empirical context of microgeneration. The discussion in Chapter 5 (section 4.2.1) shows that the exploratory study significantly influenced decisions about subsequent research procedures. In particular, the findings fortified the decision to investigate passive resistance, active resistance and willingness to pay as distinct dependent variables. Each dependent variable is researched separately in Chapters 5-7. Further, the findings provided a good indication of potential influences of resistance, and thus aided the identification of theoretical constructs and measurement scales.

The research procedures that were employed to empirically investigate influences of passive resistance, active resistance and WTP involved several steps. The research design is outlined in Table 4.1 and will be discussed in the subsequent sections. The table indicates that after the research problems had been framed theoretically and grounded empirically, the researcher decided to conduct two large scale surveys in order to investigate influences of passive resistance (survey I), active resistance (survey II) and willingness to pay (survey II). Due to a substantial amount of external funding both surveys were conducted by a professional market research company via computer assisted telephone interviews with *n*=1012 and *n*=1010 respondents respectively.

The design of the first survey began in December 2008 and it was finally conducted in March 2009. The survey aimed to measure consumers' awareness (i.e. passive resistance) of microgeneration technologies, including photovoltaic panels, micro wind turbines, solar water heating, biomass boilers, heat pumps and micro CHP). Further, it collected information about people's sociodemographic background to explore differences between aware and unaware consumers. The data were analysed via logistic regression techniques to test for influences of socio-demographic variables on consumers' levels of resistance. Study I (Chapter 5) provides an in depths discussion of methodology, data analytical techniques and findings.

From March to November 2009, the researcher then developed and designed the second survey, which aimed to investigate influences of consumers' level of active resistance (Study II) and their willingness-to-pay (Study III). The first step involved specifying relevant constructs for the dependent and independent variables and identifying respective measurement scales. In regard to the first dependent variable, the literature did not provide an adequate measurement scale for active resistance. The researcher therefore decided to develop a new scale, which aimed to capture consumers' resistance behaviours more accurately. The scale development process involved several pre-tests and is discussed in greater detail in Study II (Chapter 6). Over the same period the researcher developed a willingness-to-pay experiment, which constituted the second dependent variable of the survey. Again, an in-depth discussion of the willingness-to-pay experiment is provided in Study III (Chapter 7). The independent variables (i.e. perceived barriers) were established measurement scales from innovation, marketing and consumer resistance studies. However, the independent variables were pre-tested (n=100) and revised accordingly in September 2009. The pre-test also led to changes in the design, wording and structure of the questionnaire. The final telephone survey was finally conducted in the last two weeks of November 2009.

The data were analysed in three steps. First, they were tested for outliers, normality and missing values. In a second step, the researcher evaluated the internal and external validity of the measurement scales and finally tested causal relations via logistic regression techniques. Study II (Chapter 6) and Study III (Chapter 7) provide an in-depth discussion of methodology, data analytical techniques and interpretation of findings around influences of active resistance and willingness-to-pay respectively.

The following sections provide an in-depth discussion of the research design for all three studies. In particular, we discuss data collection methods and analyses in light of reliability, validity and generalisation of findings.

Table 4.1: Summary of research design

<table>
<tr><th></th><th>Study I (Chapter 5)</th><th>Study II (Chapter 6)</th><th>Study III (Chapter 7)</th></tr>
<tr><td>Subject of Study</td><td>Consumers’ Passive Resistance</td><td>Consumers’ Active Resistance</td><td>Consumers’ Willingness to Pay</td></tr>
<tr><td>Green Innovations</td><td>Photovoltaic Panels, Micro Wind Turbines, Solar Water Heating, Biomass Boilers, Heat Pumps and Micro CHP</td><td colspan="2">Photovoltaic Panels, Micro Wind Turbines, Solar Water Heating, Biomass Boilers</td></tr>
<tr><td>Research Design</td><td>Cross-sectional survey conducted in March 2009</td><td colspan="2">Cross-sectional survey conducted in November 2009</td></tr>
<tr><td>Method of Data Collection</td><td>Computer-assisted telephone interviews administered by professional market-research company.</td><td colspan="2">Computer-assisted telephone interviews administered by professional market-research company</td></tr>
<tr><td>Target Population</td><td>Representative sample of adult population (aged >15 years) in Ireland</td><td colspan="2">House-owners in Ireland, who are aware of the technology in question (i.e. non-passive resistant) and who are partly or fully responsible for making financial decisions regarding the house they currently live in.</td></tr>
<tr><td>Sampling Method</td><td>Non-probability, quota sampling approach (age, gender, region, social class)</td><td colspan="2">Non-probability, quota sampling approach (age, gender, region), divided into “technological” subsamples</td></tr>
<tr><td>Sample Size</td><td>n = 1012</td><td colspan="2">n = 1010, equally split across 4 samples</td></tr>
<tr><td>Survey Instrument</td><td>Set of questions run alongside a larger fortnightly telephone omnibus survey, yes/no format.</td><td colspan="2">Self-developed questionnaire consisting of several multiple-item scales, measured on 5-point Likert-scale format. Also includes a double-bounded contingent valuation experiment to elicit WTP.</td></tr>
<tr><td>Dependent Variable</td><td>Awareness, i.e. passive resistance</td><td>Active resistance</td><td>Willingness to pay</td></tr>
<tr><td>Independent Variables</td><td>Sociodemographic factors</td><td>Perceptions of functional and psychological barriers
Sociodemographic factors</td><td>Perception of product characteristics
Sociodemographic factors</td></tr>
<tr><td>Data Analysis</td><td>Descriptive statistics
Logistic regression (ordered logit model)</td><td>Descriptive statistics
Exploratory factor analysis
Confirmatory factor analysis
Logistic regression (partial proportional odds model)</td><td>Descriptive statistics
Confirmatory factor analysis
Logistic regression
(The random effects probit model)</td></tr>
</table>

1.3 Research design

1.3.1 Survey research

The above discussion has highlighted that scientific realism has emerged as an appropriate philosophy of science to guide research of social phenomena in marketing sciences. This study is concerned with understanding consumers' resistance to green product innovation and its underlying causes. The review of the literature clearly shows that empirical investigations of consumer resistance to date have reflected the actual phenomenon only insufficiently (e.g. Kleijnen et al. 2009). Key shortcomings of previous research are inconsistent conceptualisations, limited measures of the unobservable construct *resistance* and little empirical evidence about consumer resistance and its underlying causes. Guided by a scientific realist epistemology, we chose a survey research design as an appropriate strategy to answer the research questions presented above and to deepen our understanding of consumer resistance to green innovation.

Survey research can be defined as a research strategy that provides quantitative or numeric description of some fraction of the population, i.e. the sample, through the data collection process of asking questions of people (Fowler 1988). Generalising from a sample to a population allows making inferences about attributes of the population and their causal relations. Multivariate statistical procedures ultimately allow evaluation of validity, reliability and statistical significance of measurement of constructs as well as the relationship between variables (e.g. Hair et al. 1998).

Because survey research can be easily replicated and empirically tested at multiple points in time and in varying contexts, it allows researchers to evaluate knowledge claims of theories inductively by building up evidence that "something like" the entities and relationships postulated in the theory actually exist (Hunt and Hansen 2009). Survey research also holds several practical advantages, as surveys are relatively easy to administer and provide a rapid turnaround in data collection (e.g. Creswell 1994). Further, surveys allow collection of a wide range of information, yet data are believed to be reliable since responses are limited to the alternatives stated in the survey (e.g. Rindfleisch et al. 2008).

However, survey research is also subject to epistemological limitations or errors. Limitations from survey research broadly arise from two sources, classified as sampling error and non-sampling error. Non-sampling errors can have two causes. First, non-sampling errors can result from several forms of bias, including response bias (e.g. Baumgartner and Steenkamp 2001), non-response bias (e.g. Armstrong and Overton 1977) and problems of social desirability and context dependency (e.g. Robertshaw 2007). These errors can usually be minimised through careful research design and will be discussed in relation to the survey method in the next section. Another source of non-sampling error is related to unreliable measuring instruments, adversely affecting the ability to form empirical generalisations. Fortunately, scholars have devoted considerable efforts to improving the validity of survey research in areas such as reliability assessment of scales (e.g. Peter 1979) and construct validation (e.g. Gerbing and Anderson 1988). These issues will be discussed in greater detail in Chapter 5, 6 and 7 in sections relevant to each study. Sampling error, on the other hand, arises from observing only a sample rather than the whole population and will be discussed in relation to the sampling methods applied in this study. Overall, the research design and data analysis aimed to increase the *reliability* as well as the *internal* and *external validity* of this study, allowing us to draw conclusions and make claims about the generalisability of findings.[14]

1.3.2 Survey method

To collect the evidence necessary to shed light on the research questions presented above, data were collected via two cross-sectional surveys. The surveys were conducted in March 2009 and November 2009 respectively. The first survey was designed to collect data on *passive resistance* (Study I) and the second collected data to provide answers to research questions on both *active resistance* (Study II) and consumers' *willingness to pay* (Study III).

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[14] Reliability refers to the extent to which applied measuring procedures yield similar results on repeated trials. Validity is the degree to which a study accurately reflects the concepts researchers are attempting to measure.

Thanks to a substantial amount of external funding from the Sustainable Energy Authority Ireland (SEAI), both surveys were administered by a professional market research company via computer-assisted telephone interviews (CATI). Given the research objectives, time-frame and financial resources, CATI were identified as the most suitable survey method. In particular, CATI provide great control over the sample frame, which was vital to identify the “right” respondents (see section 1.2.3) and to minimise bias, ultimately improving the generalisations of findings (Malhotra 2007). For example, the relevant literature provides clear evidence that non-response bias increases as the response rate decreases, adversely affecting the generalisations that can be drawn from data (Groves and Peytcheva 2008). Telephone surveys have significantly higher response rates than, for example, postal surveys, thus reducing the chance of non-response bias. Further, telephone surveys allow the setting of quotas, providing an additional remedy against non-response bias of certain sociodemographic subgroups in the actual population (e.g. Groves 2006).

However, CATI can suffer from bias related to sample-framing, i.e. the exclusion of phone numbers that have only recently or never been registered. In order to overcome bias related to unpublished and recent numbers in the sample population, we applied random digital dialling (RDD), which included 40% mobile phones and further improved the reliability and validity of the data (e.g. Blair and Czaja 1982).

Another form of bias often found in surveys is related to issues of social desirability, i.e. when respondents provide answers that they believe are expected of them. Social desirability is particularly prevalent in face-to-face interviews and because of anonymity in phone surveys, respondents are more likely to provide honest answers, reducing bias (Malhotra 2007). In addition, interviewers highlighted at the beginning of the survey that all answers were treated totally confidentially and that they were looking for people’s personal opinions and not “right” answers.

Bias in survey research can also result from interviewers involuntarily leading respondents into certain answers. Potential bias stemming from the interviewer was clearly minimised by outsourcing the administration of the survey to a market research company that employed a large team of professional call-centre workers (e.g. Groves and Magilavy 1986). However, the researcher remained in control over the field force and interviewing process as he was able to “tap into” and listen to ongoing interviews from a separate room and provide feedback to the call-centre manager.

Overall, given the available resources, computer assisted telephone interviews provided an appropriate survey method, which held several advantages over face-to-face interviews, postal or web-based surveys. More importantly, the method allowed important sources of bias to be effectively minimised, thus reducing non-sampling errors and improving the generalisability of our findings.

1.3.3 Target population and sampling method

In the first survey (Study I) we collected responses from *a representative sample of the adult population (aged >15 years) in the Republic of Ireland*. The survey was run alongside a larger fortnightly telephone omnibus survey of the Irish adult population in March 2009 and resulted in a final sample of n = 1010 respondents. The market research company set strict quotas for age, gender, social class and region to ensure representativeness of the overall population. Quota sampling is a non-probability sampling approach which can obtain results that approximate probability sampling techniques in terms of representativeness (e.g. Sudman and Blair 1999). Thus, quota sampling provides an economically viable alternative to approaches such as simple random sampling (Malhotra 2007).

The second survey (Studies II and III) was conducted in November 2009 and the targeted population were *house-owners in the Republic of Ireland, who are aware of the technology in question (i.e. non-passive resistant) and who are partly or fully responsible for making financial decisions regarding the house they currently live in.* The final sample consisted of n = 1012 Irish home owners. We again applied a quota-sampling approach to identify the respective group of home owners within the overall population. The quotas were based on region, gender and age to ensure an overall approximation of the overall population. The objects of enquiry were four microgeneration technologies, i.e. wood pellet boilers, micro wind turbines, solar panels or solar water heaters, and each respondent was asked about only *one* of the technologies. Quota sampling allowed us to ensure that the sociodemographic profiles of the respective subsample were equal and approximated the overall population (Table 4.2). Although the figures are strictly speaking not nationally representative, each subsample reflects a close approximation of home owners in Ireland. More importantly the figures indicate that the overall spread between gender, age and region is fairly homogeneous between the four subsamples. Setting strict quotas for each subsamples thus allowed for direct comparative analyses, which was important later to establish reliability and validity of measures and to assess generalisability of findings (e.g. Gerbing and Anderson 1988).

Table 4.2: Comparison of subsamples with population of Irish home owners (%)

Variable		Wood Pellet Boilers (*n* = 253)	Micro Wind Turbines (*n* = 254)	Solar Panels (*n* = 254)	Solar Water Heaters (*n* = 251)	Population of Irish Home owners*
Gender	Male	55.2	51.2	46.7	51.3	50.0
	Female	44.8	48.8	53.3	48.7	50.0
Age Groups	15–24	0.8	3.0	2.6	2.2	20.0
	25–34	18.7	20.1	12.8	16.1	
	35–44	20.3	19.7	23.3	20.5	45.0
	45–59	36.9	34.6	33.0	31.7	
	60+	23.2	22.6	28.2	29.5	35.0
	Total	100.0	100.0	100.0	100.0	100.0
Region	Dublin	19.9	21.4	20.7	20.5	24.0
	Rest of Leinster	32.0	29.1	30.0	30.4	28.0
	Munster	27.4	29.5	28.2	28.1	28.0
	Connacht/Ulster	20.7	20.1	21.1	21.0	20.0

*The population data for home owners in Ireland stem from the market research company’s own calculations and data from the Central Statistics Office (CSO) in Ireland. Further, the age categories for the population data are 35–54 and 55+ cannot be compared directly.

Sampling error in both surveys could not be determined via statistical techniques, since the sampling method was non-random. However, the clear definition of the target population and the close approximation of the actual population via strict quotas give reason to believe that the overall sampling error is relatively small. Further, the sample sizes of n = 1010 and n = 1012 respondents respectively are in line with recommendations in the literature and are considered appropriate for causal research design (e.g. Malhotra 2007).

1.3.4 Format of questionnaires

Questionnaire 1

The aim of the first survey was to collect evidence about consumers' levels of passive resistance to green innovation and to investigate the underlying reasons. As highlighted above, the first survey was administered alongside a larger fortnightly telephone omnibus and the survey instrument simply consisted of one question that inquired about consumers' level of awareness of six microgeneration technologies, i.e. photovoltaic panels, micro wind turbines, solar water heating systems, biomass boilers, geothermal heat pumps and micro CHP. The previously conducted face-to-face interviews had revealed that the majority of people were not familiar with the term "microgeneration". Respondents in the survey were therefore provided with a short introduction referring to microgeneration as *"renewable energy technologies people can install in their homes for heating and electricity production"*. This brief explanation was followed by the questions about the individual technologies. Each question started with *"have you heard of, or seen anywhere"* followed by a short explanation of the technology such as *!solar water heaters or solar thermal collectors which are placed on a roof to produce hot water from sunlight?"* (Appendix 3). The responses were collected in a dichotomous yes/no format and were followed by various questions about sociodemographic factors including age, gender, marital status, social class, household size, geographic location and internet access. The sociodemographic categories were adapted from the CSO and the market research company's own classifications.

Detailed analyses of awareness levels and the influence of sociodemographic factors are provided in Chapter 5. However, findings show that the level of awareness for geothermal heat pumps and micro CHP was low and the two technologies were thus excluded from the second survey (Studies II and III). Awareness of the technology was a prerequisite to take part in the interview and including these technologies would have increased the costs and scale of the survey disproportionately. For this reason we decided to focus on only four microgeneration technologies in the second survey, i.e. solar panels, micro wind turbines, solar water heating systems and wood pellet boilers.

Questionnaire 2

The aim of the second survey was to research empirically consumers' levels of active resistance (i.e. dependent variable in Study II) as well as willingness to pay (i.e. dependent variable in Study III) and to evaluate consumers' underlying motives (i.e. independent variables in both Studies II and III). For this purpose the researcher designed a comprehensive structured questionnaire (Appendix 3). A general weakness of questionnaire design is the lack of theory and scientific principles to guide the process to arrive at an "optimal" questionnaire, and researchers often have to rely on rules-of-thumb, examples of best practice and somewhat anecdotal academic evidence (Malhotra 2007). When designing the questionnaire we incorporated academic evidence whenever available and also included advice we received from the market research company. Further, the majority of questions (i.e. multiple-item scales) were adapted from existing studies and are explained in greater detail in the subsequent chapters.

The final questionnaire consisted of five parts. The first part aimed to engage respondents and overcome their unwillingness to answer by explaining the objective of the interview in a conversational manner and assuring respondents that their answers were treated with total confidentiality (Malhotra 2007). Further, interviewers asked a series of questions to identify the target population defined above. Suitable home owners were randomly assigned to one of the four technologies, while the interview was closed for non-eligible respondents.

The second part aimed to measure consumers' level of resistance (i.e. dependent variable in Study II) to the respective technology. For this purpose we developed a new resistance measure, following steps recommended by DeVellis (2003), Richins & Dawson (1992) and Webb, Green & Brashear (2000), which is outlined in greater detail in Chapter 6.

In the third part consumers were asked about their perceptions of product characteristics (e.g. Rogers 2003 [orig. pub. 1964]) as well as their perception of functional and psychological barriers (e.g. Kleijnen et al. 2009), which served as independent variables in Studies II and III. The constructs were all well-established multiple-item scales adapted from the innovation literature (Appendix 2).

The individual items of the resistance scale as well as the independent variables were measured on five-point Likert scales, stretching from strongly agree (1) to strongly disagree (5), including a neutral midpoint. Likert scales are the most commonly used format in the marketing literature and most respondents are familiar with this measuring format (Cox 1980). A study conducted by Bandalos and Enders (1996) further shows that scale reliability only increases up to five-point scales. Representatives from the market research company also confirmed that respondents, particularly in phone interviews, would find scales beyond the five-point mark confusing and it was thus decided to adopt a five-point format. Further, items within each sub-section were randomly rotated to minimise order-bias (Ferber 1952) and included negatively worded items to prevent agreement bias (Malhotra 2007).

In section 4 of the questionnaire we employed a double-bounded contingent valuation (CV) approach to elicit respondents' willingness to pay for the respective technology (i.e. dependent variable in Study III). The format of the CV experiment and the motivation to choose a stated-preference approach is explained in greater detail in Chapter 7 (e.g. Hanemann et al. 1991).

The final part of the questionnaire collected information about consumers' sociodemographic background and energy-efficiency status of their dwelling. Again, the categories were adapted from the Central Statistics Office (CSO) and the market research companies' own classifications.

1.4 Data analysis

After completion of each survey the market research company provided us with consumers' responses in form of a fully coded SPSS dataset. The data from both surveys were first checked for completeness and missing values. In a second step we tested the data for normality and outliers. Since Studies II and III consisted of multi-item scales, in a third step we followed an approach recommended by Gerbing and Anderson (1988) and assessed the reliability and validity of the measuring instrument via confirmatory factor analysis (CFA). Finally we estimated causal relationships between independent and dependent variables via logistic regressions (e.g. Hair et al.

1998). The descriptive analysis was carried out via SPSS 17, while CFA was conducted in Lisrel 8.8 and the logistic regressions were conducted with STATA 10 software.

1.4.1 Missing values, normality assumptions and treatment of outliers

A close examination of the data showed that each dataset included responses to all pre-specified items. Further, a missing value analysis revealed that in the first survey only 0.24% of data was missing. The low rate of missing values is clearly the result of the market research companies' efficient mode of administration. Because of the relatively large number of respondents in comparison to relatively few questions, we decided simply to remove missing values via *listwise deletion*, which left us with a final sample of n = 984 respondents.

Missing values for items in survey 2 ranged from 0 to 1.2% per item. Despite the low percentage of missing values for individual items, listwise deletion across items would have led to a significant reduction in sample size. For this reason, we used the expectation maximisation (EM) algorithm to impute missing values and were thus able to use responses from all n = 1012 consumers (e.g. Schumacker and Lomax 2004).

An inspection of the variables' descriptive statistics, i.e. mean, standard deviation, kurtosis and skewness, did indicate moderate violations of the normality assumption. However, the values for skewness and kurtosis did not exceed 2.0, except for three items reflecting the constructs *perceived relative advantage* and two items reflecting *perceived social risk.* A test for multivariate normality conducted in Lisrel 8.8 revealed that the multivariate kurtosis index was below 3 for all constructs (Bollen 1989). It was therefore decided to not undertake any transformation at this stage because maximum likelihood estimation is seldom affected by low to moderate violations of the normality assumptions (e.g. Gerbing and Anderson 1988). This is particularly true for logistic regression analyses, which has proved to be very robust against moderate deviations from normality (Steenkamp and van Trijp 1991, p. 285). We also detected some outliers but again decided to not take any remedy at this stage and to wait for results of later analyses.

1.4.2 Validation of measuring instrument

As mentioned above, the independent variables used in this study, i.e. perceived functional and psychological barriers, are theoretical constructs that cannot be observed directly. It was therefore crucial to establish internal and external validity of these latent constructs via CFA before estimating their influence on the abovementioned dependent variables (e.g. Gerbing and Anderson 1988).

> "Confirmataory factor analysis (CFA) is a type of structural equation modelling (SEM) that deals specifically with measurement models, that is, the relationships between observed measures or *indicators* (e.g. test items, test scores, behavioural observation ratings) and latent variables or *factors.*" (Brown 2006, p. 1)

Unlike exploratory factor analysis, in CFA relationships between indicators and constructs are pre-specified by theory. All constructs used as independent variables in this study are well-established theoretical constructs from the innovation literature and have been validated in various empirical studies (e.g. Moore and Benbasat 1991; Rogers 2003 [orig. pub. 1964]; Tornatzky and Klein 1982). Since the theoretical foundation of constructs representing independent variables had been established and tested, our main aim was to confirm the constructs' unidimensionality in the consumption context specified above. Unidimensionality is given when a set of items (i.e. questions) are reflected by only one underlying latent construct (Steenkamp and van Trijp 1991). In order to do so, we assessed each construct's convergent and discriminant validity in Lisrel 8.8. According to Bagozzi et al. (1991, p. 427) convergent validity refers to "the degree to which multiple attempts to measure the same construct are in agreement" whereas discriminant validity refers to "the degree to which measures of different concepts are distinct." In other words, convergent validity is given when indicators of one construct are strongly intercorrelated, while discriminant validity can be established when items reflecting distinct constructs show low intercorrelation (Brown 2006).

Further, CFA has been proved to be the more accurate method to assess reliability of multi-item scales, since it avoids many problems associated with traditional approaches such as Cronbach's alpha that do not evaluate the unidimensionality of a scale (e.g. Cortina 1993). Reliability was thus measured by assessing each construct's composite reliability, which was estimated alongside the scales' convergent and discriminant validity (Jöreskog 1971).

1.4.3 Pre-test

All multi-item scales reflecting independent variables were first pre-tested with n = 90 home owners in Ireland. The aim of the pre-test was to confirm reliability and validity of the multi-item scales. As in the final study, items were measured on five-point Likert scales. The pre-test was conducted in September 2009 via CATI by the same marketing research company that conducted the final surveys. The pre-test also served for testing the general structure, lengths and wording of the questionnaire. The sample size of n = 90 exceeded the recommended item to response ratio of 1:4 for the individual scales and was thus found to be sufficient for pre-testing purposes (Floyd and Widaman 1995).

The results from the CFA, together with the descriptive statistics and the definition of the constructs, are presented in Table 4.3. In the pre-test, perceived functional barriers and psychological barriers were tested separately because of the relatively large number of items in relation to sample size. For the functional barriers, the results from the confirmatory factor analysis (GFI = .0.80, CFI = 0.95, NFI = 0.89, RMSEA = 0.076, χ^2/df = 1.68) indicate a satisfactory fit of the data (e.g. Bollen 1989). More importantly, all items loaded significantly on the corresponding latent constructs and showed high composite reliability (CR > 0.7). Further, the average variance extracted (AVE) explains the variance that is accounted for by the individual items. All constructs exceed the recommended threshold of .5, indicating their convergent validity (Fornell and Larcker 1981). To test the construct's discriminant validity we conducted a test suggested by Fornell and Larcker (1981), where we compared the average variance extracted and squared correlation (r) between all pairs of latent constructs. The results showed that AVE exceeded the squared correlations in all cases, confirming the construct's discriminant validity (Bollen and Long 1993).

In a second step we tested the perceived psychological barriers. Again, CFA indicated a good overall fit (GFI = .0.86, CFI = 0.95, NFI = 0.86, RMSEA = 0.065, χ^2/df = 1.39). However, a closer look at the individual constructs showed that the constructs social risk and subjective norms both experienced relatively low discriminant validity (AVE < 0.5), which led to a rewording of several items for the final questionnaire. Further, perceived financial risk was excluded as a construct, after unsatisfactory initial results led to a close examination of the correlation matrix, which showed a very high correlation between perceived financial and functional risk (r = 94). This finding is not surprising in the given research context, since a key advantage of microgeneration technologies is saving energy and any uncertainty related to functional performance is likely to affect uncertainty about the technologies' financial performance. For this reason perceived financial risk was excluded from any further analysis.

Overall, the pre-test helped to establish unidimensionality of the independent variables that were used in Studies II and III to explore consumers' motives for active resistance and willingness to pay (Gerbing and Anderson 1988). Further, the initial evaluation proved an important step, which led to rewording of several items, the exclusion of one construct and an overall improved understanding of the structure of the latent variables.

Table 4.3: CFA of pre-test: Latent independent variables (Studies II & III)

Construct	Definition	Source	Number of Items	AVE	CR	Mean (S.D.)
Perceived Functional Barriers						
Perceived relative advantage	Degree to which an innovation is perceived as ... (better than its precursor)	Rogers (2003)				
Energy savings	... saving energy costs	Schwarz and Ernst (2008)	3	0.70	0.88	12.24 (7.52)
Environmental friendliness	...being better for the environment		3	0.82	0.93	12.99 (2.99)
Independence	... making consumers more independent		3	0.51	0.76	10.51 (3.81)
Perceived compatibility	Degree to which an innovation is perceived as being compatible ...	Rogers (2003)				
Infrastructure	... with the existing infrastructure	Schwartz and Ernst (2008); Tornatzky and Klein (1982)	3	0.75	0.90	10.07 (3.44)
Habits & routines	... with consumers' habits and routines	Karahanna et al. (2006)	3	0.55	0.78	10.81 (3.86)
Perceived initial costs	The degree to which an innovation is perceived as being too costly to adopt	Tornatzky and Klein (1982)	3	0.84	0.94	11.10 (3.69)
Perceived Psychological Barriers						
Perceived risk	Perceived likelihood of …					
Financial	… suffering a financial loss	Stone and Grønhaug (1993); Peter and Lawrence (1975)	3	–	–	–
Functional	… adoption failing to meet performance requirements		3	0.53	0.77	9.18 (2.91)
Social	… adoption resulting in others thinking of the consumer less favourably		3	0.49	0.73	4.99 (2.80)
Perceived compatibility with values	Degree to which an innovation is perceived as being compatible with consumers' personal values	Karahanna et al. (2006)	3	0.74	0.89	11.43 (3.14)
Subjective norms	The influence of relevant others (i.e. friends, family)	Ajzen (1991)	3	0.46	0.72	7.28 (2.99)
Perceived complexity	Degree to which an innovation is perceived as being difficult to use and understand	Rogers (2003); Moore and Benbasat (1991)	3	0.59	0.84	7.77 (3.15)
Subjective knowledge	Consumers' self-beliefs about their own knowledge	Bang et al (2000)	4	0.67	0.89	7.71 (3.81)

1.4.4 Analysis of causal relations

This section aims to provide an overview of the multivariate methods that were employed to assess the causal relationships between the dependent and independent variables outlined above.[15] All three dependent variables are discrete in nature and it was therefore appropriate to employ logistic regression analyses (see discussion below). In particular, in Chapter 5 we apply an *ordered probit regression model* to estimate the influence of sociodemographic variables on consumers' level of passive resistance. In Chapter 6 we first develop a new scale to measure consumers' level of active resistance (e.g. DeVellis 2003). The resistance measure was, however, later collapsed into three categories and the impact of perceived barriers on resistance was analysed via a *partial proportional odds model*. Finally, in Chapter 7 we first elicit consumers' willingness to pay via a double-bounded contingent valuation (DBCV) approach and, in a next step, estimate the populations' mean and median WTP as well as the influence of perceived product characteristics via a *random effects probit model*. Since the three models specified in this thesis evolve from the binary response model, we first provide an overview of regression for binary dependent variables, followed by a brief discussion of the models presented in the subsequent chapters.

The binary response model

Empirical studies in social sciences most commonly analyse causal relations of social phenomena via ordinary least square (OLS) regression analysis. However, these linear regression models are generally unsuitable when analysing and predicting discrete outcome variables. A key reason is that, because of the dichotomous nature (0–1) of the dependent variable, the error-term of OLS regression is non-normal and highly heteroskedastic i.e. not constant across the data-range (e.g. Verbeek 2008, p. 200).

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[15] The development of the dependent variables used in Studies I (i.e. passive resistance), II (i.e. active resistance) and III (i.e. willingness to pay) is explained in greater depth in the respective chapters.

To overcome these problems, econometricians developed logistic regression models, which allow estimation of causal relationships between a discrete dependent variable (y_i) and predictor variable(s) (x_i). Like any other model-building technique, the aim is

> "to find the best fitting and most parsimonious, yet biologically reasonable model to describe the relationship between an outcome (dependent or response) variable and a set of independent (predictor or explanatory) variables" (Hosmer and Lemeshow 2000, p. 1).

Essentially, in logistic regression the dichotomous outcome variable y_i undergoes a logit transformation by taking the natural logarithm (ln) of the odds of y_i. The odds refer to the ratios of probabilities (p_i) of y_i happening to probabilities of y_i not happening (Peng et al. 2002, p. 4). The logarithmic transformation of the odds is essential to ensure a linear relationship between the discrete outcome and the predictor variables, which are most commonly linked by a standard logistic distribution function *F*(.) (i.e. logit model) or a normal distribution function (i.e. probit model). In its most basic form the binary logistic model can thus be expressed as:

$$\log(y_i) = \log(odds) = \log\left(\frac{p_i}{1-p_i}\right) = x_i'\beta \qquad (1)$$

where $p_i = P\{y_i = 1 | \mathrm{x}_i\}$ is the probability of observing outcome 1. The left-hand side can thus be denoted as the log odds ratio. For example, an odds ratio of 5 implies that the odds of $y_i = 1$ are 5 times those of $y_i = 0$ (Verbeek 2008, p. 202). Further, the model shows that the probability $y_i = 1$ depends on one or more independent variables (x_i). It needs to be noted that, unlike the outcome variable, explanatory variables can be continuous or discrete. As shown in equation (1), the β coefficient specifies the effect of x_i on the odds ratio, thus describing the relationship between the explanatory variables and the discrete outcome y_i. For example, $\beta > 0$ implies that a higher x_i leads to higher odds ratios, whereas $\beta < 0$ means that a higher x_i causes lower odds ratios (*ceteris paribus*). In order to estimate the regression coefficient(s) researchers generally use the maximum likelihood (ML) method (Haberman 1978). ML identifies the value of the parameter(s) that best fit the data, arrived at from the probability distribution of the outcome variable. In the framework of inferential statistics, the underlying null hypotheses (H0) in logistic regression is that all β values equal zero. Thus, rejecting H0 means that one or more coefficients have an influence on y_i and that the specified model predicts outcomes more accurately than the intercept-only model (i.e. the mean of the outcome variable) (e.g. Peng et al. 2002).

In situations where a logistic regression model is derived from an underlying behavioural assumption (e.g. consumer resistance), the underlying *latent* dependent variable is usually denoted as y_i^* and the overall model can be expressed as

$$y_i^* = x_i'\beta + \varepsilon_i \tag{2}$$

For example, in Chapter 5 we argue that a consumer is passive-resistant towards a *specific* green innovation if she/he is not aware of the respective product. Thus, we observe $y_i = 1$ (aware) if, and only if $y_i^* > 0$, and $y_i = 0$ if not aware (e.g. Verbeek 2008, p. 203). The cumulative probability function of the binary choice model can thus be expressed as

$$P\{y_i = 1\} = P\{y_i^* > 0\} = P\{x_i'\beta + \varepsilon_i > 0\} = P\{-\varepsilon_i \leq x_i'\beta\} = F(x_i'\beta), \tag{3}$$

where $F(x_i'\beta)$ is the distribution function of ε_i. For the first part of the analysis in Chapter 5 we choose the standard normal distribution with $\varepsilon_i \sim \text{NID}(0,1)$, resulting in a binary probit regression model, which we estimate in STATA 10.

Chapter 5: The ordered response model

In many situations the number of possible outcomes exceeds two. For example, in Chapter 5 we argue that a consumer's *overall* level of passive resistance is a function of observed sociodemographic characteristics (x_i) and some unobserved factors (ε_i). More importantly however, the latent variable passive resistance (y_i^*) is measured polytomously, with more than two outcome alternatives M, where $j = 1,2,...,M$.[16] In fact, underlying passive resistance is reflected by seven possible outcomes, which stretch from no (0) to high (6) awareness (i.e. M = 7). Since there is a logical ordering in the outcome variable, passive resistance is measured via an *ordered response model*, which can be formally expressed as:

$$
\begin{aligned}
&P(y_i = 1) = 1 - F(x_i^{'}\beta_1) \\
&P(y_i = j) = F(x_i^{'}\beta_{j-1}) - F(x_i^{*}\beta_j) \quad for \;\; j = 2,...,M-1 \\
&P(y_i = M) = F(x_i^{'}\beta_{M-1})
\end{aligned} \tag{4}
$$

Thus, the probability that, for example, a consumer has an awareness level of *j* is the probability that the latent variable y_i^* falls between two boundaries *j – 1* and *j*. The lower boundary of the model is normalised to zero in order to fix the location (e.g. Verbeek 2008). Again, the error term (ε_i) of the model applied in Chapter 5 has a standard normal distribution (i.e. *ordered probit model*) and the model coefficients (β) and boundaries (j) were estimated via maximum likelihood in STATA 10.

Chapter 6: The partial proportional odds model[17]

In Chapter 6 we measure consumers' level of active resistance, classifying respondents as *low*, *medium* and *high resistant*. Again, the latent dependent variable active resistance is reflected by polytomous outcome categories (*M*), where *j* = 1,2,…, *M* and *M* = 3, which can be formally expressed as shown in Eq. (3).

However, a key assumption for ordered response models (Eq. (4)) is that the effect of the explanatory variable(s) is equal for each level of the outcome variable. To illustrate this, one can imagine an ordered logit model as a set of *j – 1* binary regressions, assuming that the slopes of the regression coefficients are equal across outcome categories (e.g. DeMaris 1992; Long and Freese 2006). However, a

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[16] *M* = 2 would represent the binary model presented above.
[17] Ordered response models that apply a logistic distribution function (i.e. logit models) are sometimes called proportional odds model because the coefficients of the explanatory variable(s) can be expressed as odds ratios, and are independent of the categories of the outcome variable (e.g. Brant 1990)

likelihood ratio test (Long and Freese 2006) and Brant Test (Brant 1990) conducted in the analysis presented in Chapter 6 both revealed that the null hypotheses of parallel lines (i.e. regression coefficients are equal across level of outcome categories) was violated. Research clearly shows that ignoring violations of the parallel-line assumptions can result in distorted findings and using a standard ordered response model is therefore inappropriate (e.g. Williams 2011).

Other solutions like multinomial logit models, however, often estimate too many parameters (e.g. Williams 2006). An intermediate solution is the so-called *partial proportional odds* model which, like ordered response models, accounts for the ordinal nature of the dependent variable but allows for potential violations of the parallel-lines assumption by independent variables. The model is thus more flexible than ordered logit models and more parsimonious than multinomial regression as it allows some of the β coefficients to be the same for all values of *j*, while others can differ between categories.[18] For example, the cumulative probabilities of partial proportional odds model can be denoted as

$$P(y_i \leq j \mid \mathrm{x_j})F(a_j - x_1\beta_1 + x_2\beta_2 + x_3\beta_{3j}), \quad for \;\; j = 1,2,\ldots,M \tag{5}$$

where the β values for x_1 and x_2 are equal for all values of *j* but the β coefficient for x_3 is free to differ.[19] Thus, by fitting the partial proportional odds model the parallel-lines assumption is relaxed only for coefficients of explanatory variables that actually violate it (Soon 2010). The model was also estimated in STATA 10 using the ML method (e.g. Williams 2006).

Chapter 7: The random effects probit model

In the study presented in Chapter 7, we estimate consumers' willingness to pay via a double-bounded contingent valuation (DBCV) approach. DBCV is a stated

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[18] For a detailed discussion see Williams (2006).

[19] This compares to the ordered logit model $P(Y \leq j|X) = F(\tau_j - X\,\beta)$, for $j = 1,2,\ldots,M$, for which the β coefficients are equal across *j* and the (e.g.) generalized ordered model for $P(Y \leq j|X) = F(\alpha_j - X\,\beta_j)$, for $j = 1,2,\ldots,M$, which uses a different set of β values for each outcome category *j*.

preference method which estimates consumers WTP from survey data (e.g. Carson et al. 1986; Hanemann et al. 1991). In the survey consumers were presented with a valuation scenario, in which they were informed about benefits (i.e. energy cost savings) of the respective green technology. Each respondent was then presented with a potentially different bid amount and asked whether she/he would be willing to pay this amount or not. Since we applied a double-bounded approach, respondents were presented with a follow-up bid, which was higher (lower) if the initial bid was accepted (rejected), illustrated in Table 4.4.

Table 4.4: Payment vehicle

	Starting bid	Increased bid	Decreased bid
Scheme 1	€2,000	€5,000	€1,000
Scheme 2	€5,000	€7,000	€2,000
Scheme 3	€7,000,	€10,000	€5,000
Scheme 4	€10,000	€15,000	€7,000
Scheme 5	€15,000	€20,000	€10,000

"For each respondent we thus have an initial bid B_i^I and one of the follow-up bids B_i^L or B_i^U, where $B_i^L < B_i^I < B_i^U$ " (Verbeek 2008, p. 218). The bounds of the latent variable willingness to pay WTP^* can thus be denoted as

$$WTP^* < B_i^L \text{ (for a no–no response)} \quad (6.1)$$

$$B_i^L \leq WTP^* < B_i^I \text{ (for a no–yes response)} \quad (6.2)$$

$$B_i^I \leq WTP^* < B_i^U \text{ (for a yes–no response)} \quad (6.3)$$

$$WTP^* \geq B_i^U \text{ (for a yes–yes response)} \quad (6.4)$$

Several studies have shown that double-bounded approaches include more information about WTP than single-bounded contingent valuation experiments. In particular, researchers have detected improved efficiency of the WTP measures, including smaller confidence intervals of the mean and median WTP (e.g. Carson et al. 1986, Hanemann et al. 1991). However, a key problem researchers face when estimating WTP from DBCV approaches results from the interdependency of the two questions. Econometricians have shown that the follow-up question might in some way depend on the first question, increasing the complexity of the analysis significantly. Haab and McConnell (2003, pp.155ff.) for example provide a comprehensive overview of several models that researchers should consider and ideally nest and test against each other when eliciting respondents' WTP from DBCV experiments.[20] The following provides a non-formal explanation of these approaches, arguing that a *random effects probit model* is the most appropriate method to estimate WTP in the context of this thesis.

According to Haab and McConnell (2003), the general econometric model underlying double-bounded data can be denoted as

$$WTP_{ij}^{*} = \mu_i + \varepsilon_{ij} \tag{7}$$

where "WTP_{ij} represents the j^{th} respondent's willingness to pay, and i = 1,2 represent the first and second answer. The μ_1 and μ_2 are the means for the first and second responses" (p. 116). Further, we can argue that the mean of each question depends on individual covariates, i.e. $\mu_{ij} = z_{ij}\beta$, suggesting that the respondents' first and second answers are different from each other and might even be explained by different coefficients and/or random terms. However, since both answers depend on respondents' j^{th} underlying preferences they are likely to correlate. Thus, estimating the answers jointly via so-called *bivariate discrete choice models* is likely to result in efficiency gains (Greene 2008, p. 817). For example, Haab and McConnell (2003, p. 118) illustrate that if ε_{ij} of questions 1 and 2 are assumed to be normally distributed

[20] This section outlines three methods to estimate WTP from DBCV; however, for a more formal and more comprehensive representation of each model the reader is referred to Haab and McConnell (2003, pp. 115ff.).

with means 0 and variances of σ_1^2 and σ_2^2, then WTP_{1j}^* and WTP_{2j}^* have a bivariate normal distribution with means μ_{1j} and μ_{2j}, variances σ_1^2 and σ_2^2 and correlation coefficient p.[21] Since the binary responses to each question are normally distributed and correlated by p, this model is referred to as the *bivariate probit model*, which was first applied to DBCV approaches by Cameron and Quiggin (1994). Yet it needs to be noted that if the correlation between the first and second responses is zero (i.e. $p = 0$), a bivariate model would not provide any efficiency gain over simply estimating two independent probit models.

However, researchers have highlighted two problems when applying bivariate discrete choice models to elicit WTP from DBCV experiments. First, if the mean WTP (or variance, or both) differs significantly between the two questions, the researcher needs to decide which bid to use to ultimately calculate consumers' willingness to pay. Secondly, it raises important questions about the theoretical consistency of respondents' preferences as they should be constant across differing bids (e.g. Hanemann et al. 1991).

Hanemann et al. (1991) thus proposed the so called *interval-data model*, which restricts the means between the first and the second questions to be equal, $\mu_1 = \mu_2 = \mu$. From this it follows that the interval data-model for the j^{th} respondent has the same error and deterministic part of the preference for each bid

$$WTP_j^* = \mu + \varepsilon_j \tag{8}$$

thus eradicating the ambiguity about respondents' underlying preferences. Moreover, the interval model can yield significant efficiency gains, since both answers are used to estimate WTP, practically doubling the number of observations (Haab and McConnell 2003, p. 123). Yet econometricians have argued that a prerequisite for using interval-data models is the perfect correlation of the error term $p = 1$. However, the assumption that responses to the two bids follow the same true underlying valuation was questioned by Cameron and Quiggin (1994, p. 219), and empirical

[21] $P = \sigma_{12}^2 / \sqrt{\sigma_1^2 + \sigma_2^2}$, where σ_{12}^2 is the covariate of variances 1 and 2.

tests show that the assumption is in fact regularly violated (e.g. Aprahamian et al. 2007; DeShazo 2002; Ready et al. 1996).

Researchers therefore proposed a somewhat less restrictive third alternative called the *random effects probit model.* The model was first applied in the context of DBCV approaches by Alberini et al. (1997). Like interval data models, it assumes equal means ($\mu_1 = \mu_2 = \mu$) and equal marginal variances ($\sigma_1^2 = \sigma_2^2$) across the two responses. However, the model distinguishes between an error term that is specific to each question and an error term that carries across responses. In doing so, the model "… assumes that the marginal distribution of the responses for the two questions are identical, but the responses are not independent. Instead, the random effects probit accounts for possible individual specific effects that carry across the responses" (Haab and McConnell 2003, p. 122).

The *random effects probit model* thus ensures theoretical consistency of respondents' preferences, while accounting for differences in answers thatmight result, for example, from strategic bidding behaviour (e.g. Scarpa and Bateman 1998). The model is therefore theoretically more coherent than the bivariate probit and less restrictive than the interval-data model. Nevertheless, the researcher has to consider the empirical evidence when specifying the model. Haab and McConnell (2003), for example, recommend nesting and testing the two alternative models against the general bivariate probit described in Eq. (7) using likelihood ratio (LR) tests. The analyses presented in Chapter 7 revealed that the estimated correlation coefficient between questions was statistically significant different from zero, yet not equal to 1, and LR tests indicated that a random effects probit model was to be preferred over competing model specifications.

Another way to compare different estimation methods or functional forms is by evaluating confidence intervals (CIs) of WTP measures. CIs also play a vital role in answering policy questions by allowing researchers, for example, to test whether WTP for different goods is significantly different. Arguably the most widely accepted approach is the method that was originally developed by Krinsky and Robb (1986) to estimate CIs for elasticities and was later adapted by Park et al. (1991) to calculate CIs for WTP from DBCV. Park et al. (1991, p. 66) demonstrate that the

Krinsky and Robb method “can be applied to establish the empirical distribution of any estimator which is a nonlinear function of the estimated parameter”.[22] Further, Cooper (1994) found that the method was robust, particularly for small to medium sample sizes. We therefore estimated the CIs via the Krinsky and Robb algorithm, using a STATA program (wtpcikr) that had recently been developed (Jeanty 2007).

General model evaluation

Econometricians have developed various tests to evaluate logistic regression models. As outlined above, in logistic regression the logit of a dichotomous outcome variable (y_i) is a linear combination of one or more predictor variable(s) (x_i). In a first step, researchers thus need to assess whether the likelihood function that links the outcome and predictor variables has been specified correctly. In other words, we need to confirm that the correct distribution has been imposed on the data. Specification errors generally result from “the latent variable model and reflect heteroskedasticity or non-normality (in the probit case) of ε_i“ (Verbeek 2008, p. 210). Further, misspecification can be the result of omitted variables. If not addressed, specification errors can cause inconsistent estimators, undermining the validity of the findings. One of the most commonly used methods to detect specification errors is the *linktest.* “The linktest is based on the idea that if a regression is properly specified, one should not be able to find any additional independent variables that are significant except by chance” (StataCorp 2009, p. 849). A significant linktest thus indicates possible misspecification, prompting closer examination of the model, including specific tests for heteroskedasticity and multicollinearity as well as omitted or non-linear predictor variables (Greene 2008).

Once the model has been correctly specified, a next step usually involves comparing the specified model with the intercept-only model. Tests usually assess whether the maximum log likelihood function of the specified model exceeds that of the intercept-only model. The most commonly employed inferential statistics tests are the *likelihood ratio* (LR) test, *score* and *Wald-tests*, while the LR test is chosen over

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[22] For an extensive discussion see Park et al. (1991).

the other two in case of conflicting results (e.g. Menard 1995). Thus, a statistically significant LR test confirms that the specified model is more effective in predicting outcomes than the null-model.

However, unlike OLS regression, there is no single goodness-of-fit statistic for logit models (e.g. Long and Freese 2006). Goodness-of-fit tests generally “assess the fit of the logistic model against actual outcomes” (Peng et al. 2002, p. 6). Arguably, the most commonly used measure in logit regression is McFadden (pseudo) R^2, which is also referred to as the likelihood ratio index (McFadden 1974). The McFadden R^2 statistic ranges between 0 and 1. A value of 0 would indicate that the coefficients of the specified model do not add any explanatory power, while 1 would suggest that the estimated outcomes match the observed values perfectly (Verbeek 2008). Generally, values between and 0.2 and 0.4 are seen as highly satisfactory. However, the pseudo R^2 cannot be interpreted like an R^2 in OLS regression, which is the proportion of the total variability of the outcome that is accounted for by the model. In OLS an R^2 of .6 implies that the specified model accounts for 60% of the variation in the data. Higher pseudo R^2 values in logistic regression indicate a better model fit, yet they cannot be read like R^2 in OLS, since the predicted outcome value (i.e. ln odds) and the actual value (i.e. continuous) are measured on different scales. Thus, pseudo R^2 measures cannot be used to predict efficiency and they should be seen rather as complementary to more helpful indices such as the overall evaluation of the model and tests for individual coefficients (e.g. Long 1997).[23]

[23] Another commonly used goodness-of-fit measure is the Hosmer-Lemeshow (H-L) test, which is essentially a Pearson chi-square statistic that assesses whether observed and predicted frequencies of outcomes differ. The H-L statistic is “calculated from a $2 \times g$ table of observed and estimated expected frequencies, where g is the number of groups formed from the estimated probabilities” (Peng et al. 2002, p. 6). However, the H-L test might not be suitable when the estimated model contains continuous predictor variables, since there might not be sufficient observations in each cell of the frequency table. More importantly, H-L tests are only available for binary models and are thus irrelevant for studies presented in Chapters 4, 5 and 6, since the dependent variables are polytomous in nature.

Chapter 5

"There is nothing more frightful than ignorance in action"

(Johann Wolfgang von Goethe)

Study I: Consumer awareness in the adoption of microgeneration technologies: An empirical investigation in the Republic of Ireland[24]

[24] This chapter represents a slightly modified version of: Claudy, Marius C., Claus Michelsen, Aidan O'Driscoll, and Michael R. Mullen (2010), "Consumer awareness in the adoption of microgeneration technologies: An empirical investigation in the Republic of Ireland," Renewable and Sustainable Energy Reviews, 14 (7), 2154–60.

1 Introduction

In 2007 the European Commission laid out a comprehensive energy policy roadmap (EC 2007) for Europe which was later that year translated by the European Spring Council into ambitious targets for renewable energy, energy efficiency and greenhouse gas emission reduction. Overall, the council set a legally binding target of a 20% share of renewable energies in overall EU energy consumption by 2020. The Irish government further launched an Energy White Paper (DCENR 2007) in which it set out the country's energy policy directions and an additional target of meeting 40% of Ireland's total demand for electricity from renewable sources by 2020. In this context microgeneration technologies like photovoltaic panels, micro wind turbines, solar water heating, biomass boilers, heat pumps and combined heat and power generation (CHP)[25] will have an increasingly important role to play, as they provide a great potential to contribute to the reduction of greenhouse gas emission, ease fossil fuel dependency and stabilize energy costs (Element Energy 2005). Yet, to have a significant impact on the macro-level and help contributing to Ireland's ambitious energy targets, it requires the aggregate actions of individuals to undertake investments into these technologies.

Despite major marketing and public policy efforts the diffusion of these technologies in most European countries is slow and microgeneration technologies can be referred to as resistant innovations. Unlike receptive innovations, these products face slow take up times as they require consumers "to alter existing belief structures, attitudes, traditions or entrenched routines significantly" (Garcia et al. 2007, p.83). Market acceptance was recently identified as the most under researched angle in the area of renewable energies (Wüstenhagen et al. 2007). However, existing studies have pre-dominantly analysed consumers' intention to adopt (e.g. Bang et al. 2000; Nyrud et al. 2008; Schwarz and Ernst 2008b; Voellink et al. 2002) or willingness to pay (WTP) for microgeneration technologies or renewable energy (e.g. Banfi et al. 2008; Batley et al. 2000; Borchers et al. 2007; Nomura and Akai 2004; Wiser 2007; Zarnikau 2003). Although the two approaches vary in the conceptualisation of adoption, both implicitly assume that consumers are aware of the innovation in

[25] CHP is technically not a 'renewable', however, it is included here as it has the potential to save significant amounts of energy and reduce carbon emissions.

question. However, little or no research is available to help us understand consumer awareness of microgeneration technologies.

Many consumers might not have spent much time considering these green innovations or, more importantly, are not aware of their existence at all. Consumer awareness may vary depending on the backgrounds/market segment of the consumers and the specific technology in question.

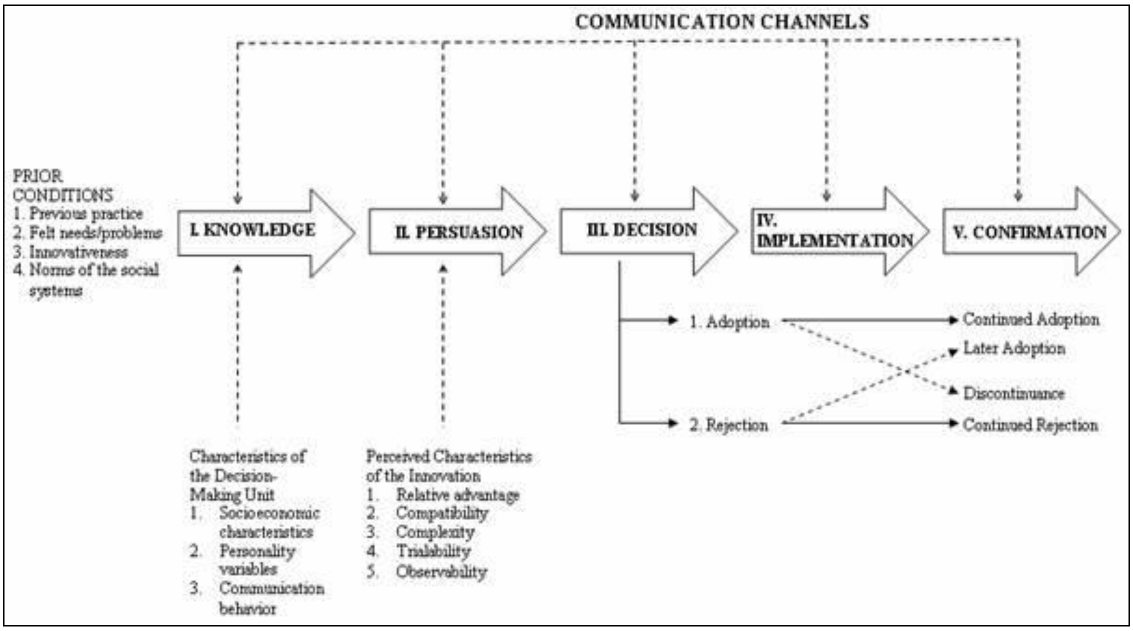
The purpose of this study is to address this gap in the literature with an exploratory study of the overall consumer awareness of microgeneration technologies and the effects of demographics on the awareness of six different technologies. In light of the diffusion of innovation process, the following section highlights the importance of understanding consumer awareness. We then present the results of a nationally representative survey of awareness of microgeneration technologies among the Irish population, showing great differences in awareness between technologies and consumer segments. The paper concludes with implications for policymakers and marketers and suggestions for further research.

2 Literature review

2.1 The adoption decision process

From a theoretical point of view, awareness precedes adoption in the adoption of innovation process (Rogers 2003 [orig.pub 1964]). In the innovation literature the adoption decision process is usually referred to as a “hierarchy of effects” model (e.g. Gatignon and Robertson 1991). Rogers’ model of the adoption decision process is the most popular, assuming that consumers go through five phases: knowledge, persuasion, decision, implementation, confirmation (Figure 5.1).

Figure 5.1: The adoption of innovation process



Source: Rogers (2003 [orig. pub. 1964])

The model suggests that the innovation decision process commences when an "individual (or other decision making unit) is exposed to an innovation's existence and gains an understanding of how it functions" (Rogers 2003 [orig.pub 1964], p.171). Awareness of an innovation generally depends on personality or socioeconomic characteristics like age or social class. However, some consumer segments appear to be generally more receptive towards new ideas and often function as strategically important target groups for marketers and policy makers to stimulate the diffusion of innovations like microgeneration technologies. Persuasion is the next stage in which a consumer, once aware of the innovation, forms a favourable or unfavourable attitude towards the new product. Attitudes are mostly dependent on the beliefs about the perceived product characteristics. Having evaluated the product characteristics, at the decision stage consumers than make a choice to adopt or reject an innovation. Rogers (p. 177) defines adoption as the decision "to make full use of an innovation as the best course available." On the implementation stage, the consumer actually adopts (i.e. purchases) the innovation and evaluates its usefulness. Finally, on the confirmation stage, the consumer decides whether or not to continue using it.

It should be noted that consumers, regardless of at which stage of the adoption decision process, can be exposed to communication in the form of marketing or public policy campaigns. Yet, in order for any message to be effective it needs to be tailored to the respective target audience. Consumers at the very first stage of the adoption process (i.e. awareness) are likely to respond to different messages and information than consumers who are currently evaluating the innovation's characteristics (i.e. persuasion). Gaining an understanding of who is aware of what and what (socioeconomic) factors have an influence on the level of awareness can therefore be vital for marketers and public policy makers to more effectively promote the diffusion of microgeneration technologies.

Further, ignoring differing levels of awareness in research around adoption of microgeneration technologies can lead to nonresponse bias, which can result in distorted findings and policies (e.g. Armstrong and Overton 1977). Respondents who have not heard about the subject of the survey (i.e. microgeneration) might be less interested and hence less likely to participate. For example, studies aiming to understand willingness to pay for microgeneration technologies might overstate the population's true WTP as people who are unaware of the innovation might be less likely to participate in the survey. The respective literature provides various methods to assess non-response bias (e.g. Groves 2006). A common approach is to compare the distribution of sociodemographic variables from the survey results with the latest census data for the population. However, knowing differences in awareness among sociodemographic subgroups beforehand allows researcher to account for these differences prior to the survey and, for example, to stratify the sample. Conversely, those respondents who are unaware of a specific technology may well respond negatively on WTP, for lack of knowledge, rather than to express an opinion on a technology. In either case, lack of awareness by respondents, would threaten the validity of the findings relative to intention to purchase or WTP.

3 The awareness study

3.1 Research objective

The motivation of this study was to gain a better understanding of the overall and relative levels of awareness for microgeneration technologies in the Republic of Ireland. Further, the study aimed to understand sociodemographic factors which influence the likelihood of awareness and to highlight the implications for practitioners and researchers. As it is very little known about consumer awareness and microgeneration technologies, no hypotheses were formulated and the study is primarily exploratory in nature.

3.2 Survey design and question

In March 2009 a survey was developed to identify the level of awareness for microgeneration technologies in Ireland. The study was administered by a professional market research company alongside a larger fortnightly telephone omnibus survey of the Irish adult population. The survey accessed a fresh sample of n = 1010 adults aged > 15 years and ensured representativeness by setting strict quotas for age, gender, social class and region. Although some of the consumers included in the survey were too young to be home owners, we did to eliminate them in order to retain the national representativeness of the sample.

Further, sample leads were generated via Random Digital Dialling (RDD) which included 40% mobile phones. A small qualitative pilot-study revealed that many people were not familiar with the term microgeneration. Respondents in the survey were therefore provided with a short introduction referring to microgeneration as "renewable energy technologies people can install in their homes for heating and electricity production." This brief explanation was followed by the questions about the individual technologies. Each question started with "have you heard of, or seen anywhere" followed by a short explanation of the technology like "solar water heaters or solar thermal collectors which are placed on a roof to produce hot water from sunlight?”. The responses were collected in a dichotomous yes/no format and were followed by various questions about sociodemographic factors including age, gender, marital status, social class, household size, geographic location and Internet access.

3.3 Empirical model

In order to test the influence of sociodemographic factors on the level of awareness, the authors utilized a common microeconometric logit model. Total awareness for microgeneration technologies and awareness for each individual technology were tested in separate frameworks.

3.3.1 Measuring overall and technology-specific awareness

In a first step determinants of total awareness of microgeneration technologies were tested. In this model, the dependent variable was constructed as the sum of the binary responses for the individual technologies and used as a proxy for overall awareness of microgeneration, ranging from 0 to 6. The explanatory sociodemographic variables were than regressed on seven possible outcomes of awareness. A common approach in the respective literature is to employ a multiple logit model with simultaneous regressions on the individual outcomes (e.g. Greene 2008; Wooldridge 2009). This method assumes the outcomes to be ordered but independent from each other. However, as the employed variable (i.e. sum of answers) serves as a proxy for overall awareness, it can be argued that despite ordinal outcomes the distances between the seven outcomes are an indication for differences in awareness. In this case, an ordered logit model is more appropriate for the analysis.[26] The general form of the presented model can be formulated as follows:

[26] For a more general discussion see Greene (2008), pp. 831–862.

$$y^* = \beta_1' X_{1i} + \beta_2' X_{2i} + \varepsilon \text{ , where } y = \begin{cases} 1 & if \quad y^* \leq 0 \\ 2 & if \quad 0 < y^* \leq \mu_1 \\ 3 & if \quad \mu_1 < y^* \leq \mu_2 \\ 4 & if \quad \mu_2 < y^* \leq \mu_3 \\ 5 & if \quad \mu_3 < y^* \leq \mu_4 \\ 6 & if \quad \mu_4 < y^* \leq \mu_5 \\ 7 & if \quad \mu_5 < y^* \leq \mu_6 \end{cases} , \qquad (1)$$

In this model y* is the unobserved latent outcome (i.e. overall awareness) and X1 a set of explanatory variables representing individual characteristics including age, gender and employment status. X2 represents a set of household characteristics like social class, spatial location and a measure for Internet accessibility. All other unobserved influences are captured in the error term *e*.

In order to capture awareness for the individual technologies, the same explanatory variables were regressed on the binary outcomes in six separate logit models. The general functional form of the logit models is denoted as follows:

$$y_i^* = \beta_{1i}' X_1 + \beta_2' X_2 + \varepsilon_i \text{ , where } y_i = \begin{cases} 1 & if \qquad y_i^* > 0 \\ 0 & otherwise \end{cases} \qquad (2)$$

In these models, the dependent variable y* is binary coded and takes on the value 1 if the respondent states they are aware of the microgeneration technology in question and 0 if otherwise. The explanatory variables were scaled the same way as in the ordered model, with X_1 representing individual and X_2 household characteristics.

3.4 Antecedent of awareness

In both models, the variable Age reflects a person's individual age in years. Because an inverted u-shaped functional form was expected, a squared age (Age2) was also included in the estimation. Further, the model contains a dummy variable Gender which takes on the value 1 if the respondent is female and 0 if otherwise. Employed Fulltime, Employed Part-time, Unemployed and Other are binary coded dummy variables, indicating a person's employment status. Other includes individuals who are not actively participating in the labour market such as housewives, students and retired people. In the analysis Other was used as a reference group and coded as 0.

The set of household characteristics contains information about the individual's direct environment. The variable Householdsize reflects the number of people living in the respondent's home and is a linear measure. Social class of the respondent is also included and mainly reflects the vocation of the chief income earner. Households in which the chief income earner is working (or has worked until retirement) in senior management positions or as a top-level civil servant are categorised as upper to middle class whereas people in middle management positions or non-manual positions are labelled as middle class. Chief income earners in skilled or semi-skilled manual jobs are labelled working class and a fourth category included is farmers. However, the farmer-category made it difficult to methodologically justify modelling social class as an ordered categorical variable.[27] It was therefore decided to test the influence of social class as binary coded dummy variables. Working class was chosen as a reference variable and coded 0.

The third household characteristic is Internet Access. It provides information on the respondent's access to the Internet and is a binary coded dummy variable. The sample was further broken down geographically into the four main regions: Connacht/Ulster, Rest of Leinster,[28] Munster and Dublin. The last of these was used as a reference group and coded 0.

4 Analysis and results

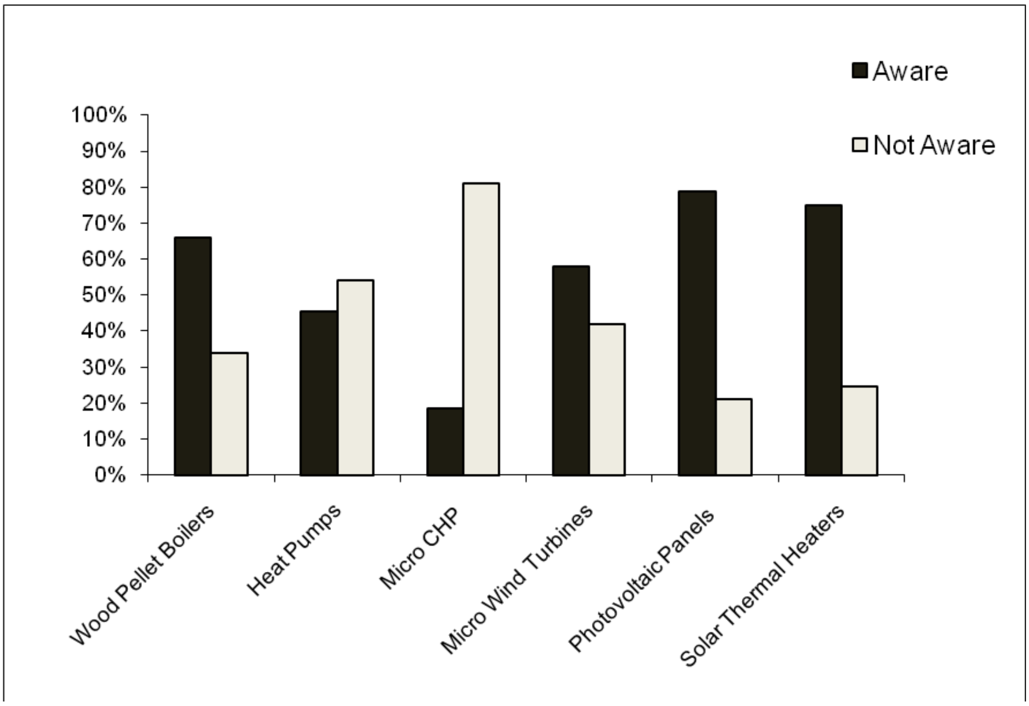
4.1 Descriptive results

A first glance at the data reveals that the level of awareness for the individual technologies differs significantly. As illustrated in Fig. 3.2, almost 80% of the Irish

[27] Note: the model was also run with social class as an ordered variable; however, a likelihood-ratio test (*p*-value < .05) revealed an overall inferior fit to the data.
[28] Dublin is a city within the region of Leinster, which is therefore referred to as Rest of Leinster.

population has heard of or seen photovoltaic panels, but only 18% are aware of Micro CHP. The other technologies fall between these two extremes with a 75% level of awareness for Solar Thermal Heaters, 66% for Wood Pellet Boilers, 58% for Micro Wind Turbines and 45% for Heat Pumps.

Figure 5.2: Overall level of awareness for microgeneration technologies among Irish consumers



Source: own calculation

However, the really interesting question was whether sociodemographic differences can explain the overall awareness for microgeneration and differences between technologies.

4.2 Logistic regression results

After accounting for missing values, the final sample consisted of n = 984 respondents. The estimations were performed with the standard procedures for logit and ordered logit models. In order to test for the overall significance for each model, a commonly presented likelihood-ratio test (LR) was applied (Greene 2008). Because goodness of fit measures, like McFadden-Pseudo-R^2 are only of limited use, the Hosmer–Lemeshow specification test is also presented for both models (Cameron and Trivendi 2009). The results of the ordered logit model (Eq. 1) give general evidence for socioeconomic influences on the overall awareness of microgeneration technologies. The likelihood-ratio test indicates that the exogenous variables are statistically significant at all levels of confidence (see Table 5.1).

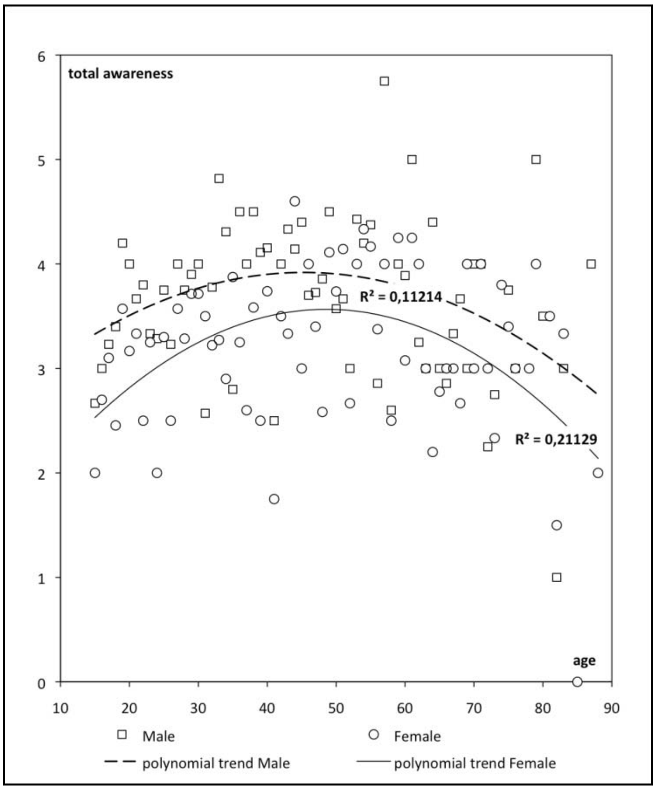
Table 5.1: Ordered logit model for total awareness of microgeneration technologies

	Total Awareness		
Variable	*Coefficient*		*Std. Err.*
Gender	–0.459	***	0.120
Internet Access	0.672	***	0.189
Age	0.056	***	0.005
Age^2	–0.00051	**	0.00023
Householdsize	–0.00881		0.139
Region (Rest of Leinster)	0.728	***	0.160
Region Munster	0.025		0.156
Region Connacht/Ulster	0.517	***	0.174
Region Dublin	/	/	/
Employed Fulltime	0.294	*	0.169
Employed Part-time	0.169		0.188
Unemployed	0.627	**	0.250
Other	/	/	/
Upper-Middle Class	0.416	**	0.199
Middle Class	0.096		0.150
Farmer	0.090		0.242
Working Class	/	/	/
κ_1	–0.811	**	0.450
κ_2	0.282		0.439
κ_3	1.157	**	0.439
κ_4	2.012	***	0.443
κ_5	3.094	***	0.448
κ_6	4.882	***	0.464
Number of Observations	984		
LL(0)	–1783		
LL	–1733		
LR Test χ^2(15)	99.98	***	
Pseudo R^2 McFadden	0.028		
*** p < 0.01, ** p < 0.05, * p < 0.1.			

(Source: own calculations)

For the overall level of awareness for microgeneration technologies the results show that women are less likely to be aware of the respective technologies (0.459, $p < 0.01$). Although gender and green consumption have been a long researched issue (e.g. Straughan and Roberts 1999) the relationship between gender and renewable energy is a relatively new field of study primarily researched in a development context (Farhar 1998; Farhar and Sayigh 2000). Research around green consumerism suggests that woman are often more aware or concerned about environmental issues (e.g. Laroche et al. 2001), yet the findings in this study indicate the opposite and thus provide scope for further investigation.

Figure 5.3: Inverted u-shape of age–awareness relationship



(Source: own calculation)

Further, there seems to be a positive relationship between age and awareness (0.056, $p < 0.01$), implying that older people are more likely to be aware of microgeneration technologies. However, applying the different functional form for the age variable

(Age2), the coefficient turns negative (0.00051, $p < 0.05$). This finding indicates that the relationship between age and awareness is of an inverted u-shape, with young and older people less likely to be aware of microgeneration (Figure 5.3). Whereas older people were expected to be less aware of microgeneration technologies, low levels of awareness for young people are somewhat surprising as "the general belief is that younger individuals are likely to be more sensitive of environmental issues" (Straughan and Roberts 1999, p.559). Yet, environmental concerns might not be as closely linked to microgeneration technologies as one would expect. In fact, microgeneration might be closer associated with energy-cost savings and is therefore more of a concern for home owners, which would explain higher levels of awareness among middle-aged people.

The results also show that people in employment are more likely than students, housewives or pensioners (Others) to have heard of microgeneration technologies (0.294, $p < 0.1$). Somewhat surprisingly, respondents out of employment were also significantly more likely to be aware of microgeneration (0.627, $p < 0.05$). This result might be somewhat distorted as due to the global recession, unemployment rates in Ireland doubled from 5.2% in March 2008 to 10.8% in March 2009.[29] During this period a lot of high-skilled and well-educated people were made redundant, possibly contributing to high levels of awareness among the unemployed group. Taking a closer look at the household characteristics, the findings show that Householdsize did not appear to have a significant impact. However, social class does seem to have a small but significant effect, with respondents from the uppermiddle class category showing higher levels of awareness than the other groups (0.416, $p < 0.05$). As social class is quite likely to be correlated with income and education, these results were expected as microgeneration technologies are still very high-cost and high-involvement products.

Finally, the data also confirm regional differences, with respondents living in Rest of Leinster (0.728, $p < 0.01$) and Connacht/Ulster (0.517, $p < 0.01$) being more likely to have come across microgeneration technologies than people living in Dublin and Munster. The city of Cork is located in Munster and is Ireland's second largest city

[29] Seasonally Adjusted Standardized Unemployment Rates (SUR). From: CSO (2009), "Life Register October 2009." Dublin: Central Statistics Office.

after Dublin. People living in both Munster and Dublin are less likely to be aware of microgeneration, indicating a split between rural and urban areas. One explanation could be that more people in urban areas live in apartments and therefore have less interest in microgeneration technologies. This phenomenon is also known as the landlord–tenant dilemma (e.g. Schleich and Gruber 2008). In a situation where a dwelling is rented, neither the landlord nor the tenant may have an incentive to invest in energy saving measures. Often unaware of the true energy costs, tenants, for example, might not feel the need to push for an investment that lowers their monthly energy-bill thus being less aware of any potential energy saving technologies available. Landlords on the other hand only have an incentive to buy a microgeneration technology if they can increase the rents and thus recoup the investment. Another consideration may be the difference in the type of housing stock between urban and rural. The urban stock is largely made up of speculatively built housing estates where the purchaser is offered little or no choice in the details of construction. In comparison, a large part of the rural housing stock is one-off dwellings where the owner will often have had a significant say in the nature and detail of construction leading to possible familiarity with microgeneration technologies.

Table 5.2: Logit models for the awareness of individual microgeneration technologies

	Solar water heaters			*PV panels*			*Micro wind*			*Micro CHP*			*Heat pumps*			*Wood pellet boilers*		
Variables	*Coefficients*		*Std. Err.*	*Coefficients*		*Std. Err.*	*Coefficients*		*Std. Err.*	*Coefficients*		*Std. Err.*	*Coefficients*		*Std. Err.*	*Coefficients*		*Std. Err.*
Gender	–0.269	*	0.163	–0.242		0.165	–0.290	**	0.140	–0.437	**	0.180	–0.554	***	0.140	–0.295	*	0.156
Age	0.027		0.026	0.011		0.027	0.0724	***	0.023	–0.025		0.032	0.0235		0.024	0.126	***	0.025
Age²	–0.0002		0.0003	–0.0001		0.0003	–0.0008	***	0.0003	9.68e–05		0.0004	–0.0001		0.0003	–0.001	***	0.0003
Internet Access	0.849	***	0.240	0.547	**	0.238	0.485	**	0.215	–0.011		0.291	0.726	***	0.224	0.432	*	0.243
Householdsize	0.0002		0.052	0.002		0.051	–0.041		0.044	0.049		0.053	0.026		0.044	0.013		0.050
Region Leinster	0.411	*	0.222	0.311		0.220	0.588	***	0.184	0.163		0.221	0.651	***	0.185	1.017	***	0.214
Region Munster	–0.181		0.204	–0.042		0.258	0.258		0.180	–0.497	**	0.247	0.046		0.184	0.334	*	0.194
Region Connacht/Ulster	0.394		0.247	0.360		0.249	0.472	**	0.207	–0.124		0.263	0.647	***	0.209	0.829	***	0.234
Region Dublin	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Employed Fulltime	0.303		0.229	–0.092		0.232	0.039		0.197	0.284		0.266	0.612	***	0.202	0.037		0.221
Employed Part-time	–0.077		0.244	0.128		0.262	–0.003		0.218	0.022		0.300	0.570	***	0.223	–0.036		0.242
Unemployed	0.102		0.318	–0.015		0.323	0.159		0.281	0.561		0.344	0.915	***	0.284	0.157		0.314
Other	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Upper-Middle Class	–0.150		0.267	0.357		0.278	0.118		0.231	0.190		0.284	0.607	***	0.234	0.453	*	0.262
Middle Class	–0.070		0.208	0.158		0.206	–0.005		0.177	–0.158		0.230	0.180		0.179	0.173		0.198
Farmer	–0.049		0.333	–0.281		0.311	0.283		0.289	–0.041		0.364	0.124		0.282	–0.183		0.316
Working Class	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Constant	–0.327		0.573	0.493		0.590	–1.563	***	0.505	–0.611		0.646	–2.166	***	0.519	–2.895	***	0.558
Number of Observations	984			984			984			984			984			984		
LL(0)	–530.3			–519.1			–665.5			–462.1			–681.5			–584.9		
LL	–511.7			–509.4			–643.4			–443.4			–635.8			–540.3		
LR Test χ^2(16)	37.06	**		19.48			44.63	***		37.02	***		91.52	***		89.12	***	
Hosmer-Lemeshow Stat.	0.3726			0.4023			0.2905			0.3239			0.3750			0.2242		
Pseudo R^2 (McFadden)	0.0350			0.0188			0.0328			0.0401			0.0671			0.0762		

(Source: own calculations)

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Although the levels of awareness for the technologies differ significantly, logistic regressions for the individual technologies (Table 5.2) reveal that the antecedents of awareness are quite similar between technologies. Like in the first model, gender had the most consistent impact, with male respondents being more aware of all technologies except PV panels, for which no significant differences could be found. With 79% awareness, PV panels had the highest level of awareness among the Irish population so that gender differences might have been washed out by the overall high level of awareness. A look at the other variables also reveals that, except for Internet access, none of the sociodemographic variables or household characteristics had a significant influence on PV awareness. Internet access is a statistically significant predictor of awareness across all technologies (except Micro CHP) and is the most consistent predictor of awareness of microgeneration technologies among the individual and household characteristics assessed in this study. It is not surprising that those who have adopted the Internet may be more aware of or interested in new technologies than those who have not yet adapted the Internet. The other main predictor of awareness was region. The biggest differences could be detected for Micro Wind Turbines, Heat Pumps and Wood Pellet Boilers, with people in Leinster and Connacht/Ulster having higher levels of awareness than the rest of the country. Whether this is due to greater marketing efforts in these areas or due to the earlier mentioned split between rural and urban areas also remains a question for further investigation.

5 Initial conclusions

The adoption of innovation process has shown that awareness and knowledge of microgeneration technologies precedes consumers' evaluation of product characteristics and thus their adoption decisions. Having a general understanding of the overall level of awareness and the differences between customer segments holds valuable information for marketers and public policy makers who aim to promote the diffusion of microgeneration technologies.

The analysis has shown that awareness among the Irish population for the individual technologies differs significantly. Whereas only 18% of respondents had heard about Micro CHP, about 80% were aware of PV panels. However, more importantly the results revealed great differences in awareness levels among consumer segments. The analysis of the sociodemographic variables indicates that men were significantly more likely to have heard of microgeneration technologies. However, as previous research shows, women are often more concerned about the environment and increasing levels of awareness among the female population might provide leverage to more effectively promote microgeneration in Ireland. Further, the analysis of age differences indicates that younger people in Ireland are less likely to be aware of microgeneration technologies. Educating children and young adults in schools and universities is not only vital to promote microgeneration among future home owners but also provides an important vehicle to raise awareness among their parents. The split between people with and without Internet also shows that nowadays the Internet provides an ever-increasing platform to raise awareness and provide appropriate information for people who are interested in applying these technologies at their homes. Further, the study indicates that there is scope to raise awareness in urban areas. Whereas this awareness study provides a comprehensive overview of awareness levels for different technologies and differences between consumer-segments it cannot offer any coherent explanations for these findings, thus providing scope for further research around people's attitudes towards and willingness to pay for microgeneration. However, awareness studies can serve as a first step and offer guidance on sampling issues and avoid selection bias like nonresponse and we discuss the full implications of our findings in Chapter 8.

Chapter 6

"… the vast majority of people who have no a priori desire to change may be more typical and even more rational than a small minority of individuals who seek change for its own sake … Therefore, it is about time we paid respect to individuals who resist change, understand their psychology of resistance and utilize this knowledge in the development and promotion of innovations…"

(Sheth 1981, p. 274)

Study II: Consumer resistance to green product innovation[30]

[30] This chapter is being prepared for submission as: Consumer Resistance to Green Product Innovation, to: Journal of Product Innovation Management.

1 Introduction

The *Harvard Business Review* recently referred to sustainability as an “emerging megatrend” (Lubin and Esty 2010) and “the motherlode of organisational and technological innovation” (Nidumolu et al. 2009). Market research data show that across industries environmental sustainability is now a key driving force of product innovation. For example, launches of green products in the US had doubled between 2007 and 2008 and were expected to triple in 2009 (Datamonitor 2009). Further, McKinsey and Company found in a global survey that about 50% of executives are taking climate change issues into consideration when developing new products. Green or sustainable innovations refer to products that “… strive to protect or enhance the natural environment by conserving energy and/or resources and reducing or eliminating use of toxic agents, pollution and waste” (Ottman et al. 2006, p. 24).

However, despite growing environmental concern and sentiment for environmental issues (e.g. Prothero et al. 2010), reported preferences for green products regularly fail to translate into purchase-behaviour, providing serious challenges for innovating companies (e.g. Peattie 2001). In this study, we argue that companies developing and marketing greener products often neglect factors that result in consumer resistance. For example, companies often fail to acknowledge that green product attributes directly compete with conventional product characteristics like price, performance or design or require consumers to accept new usage patterns or to break with deep-rooted traditions and norms (Ram and Sheth 1989). Failing to address these issues is likely to result in consumer resistance and slow diffusion (e.g. Garcia et al. 2007). Yet empirical evidence about consumers’ motives to resist innovation is scant. In this study we thus take a consumer resistance perspective to evaluate factors that prevent consumers from purchasing green product innovation.

However, a key problem is that the resistance literature has suffered from conflicting conceptualisations, inconsistent terminology and a lack of measurement instruments to measure of resistance behaviour. For example, research shows that consumers can engage in different resistance behaviours (i.e. postponement, rejection, opposition) that reflect different resistance intensities and which are driven by different motivations (e.g. Kleijnen et al. 2009). Yet the majority of empirical studies measure consumers' resistance indirectly as non-adoption, neglecting differences in resistance behaviour.

The objective of this study is therefore threefold. In our study we build on recent findings in the literature and (1) propose a consistent classification of resistant consumer categories, (2) develop a measure that allows us to classify consumers accordingly and (3) empirically investigate the motives behind different levels of resistance toward green product innovation.

We demonstrate across three green products and a total sample of 761 home owners that consumers engage in different resistance behaviours, which are motivated by different perceptions of functional and psychological barriers. Our findings thus address the paucity of empirical evidence around consumer resistance and provide valuable information for marketers and product managers aiming to enhance the impact of their marketing strategies in overcoming consumer resistance towards green product innovations.

The remainder of this study is structured as follows. Building on recent advances in the literature (Kleijnen et al. 2009) we first propose a classification of consumers based on their level of resistance and propose several hypotheses about the underlying motives. We then develop a measure of consumer resistance and establish its internal and external validity across four studies, allowing us to empirically test our hypotheses. Finally, we discuss the theoretical and managerial implications of this study and suggest avenues for further research.

2 Literature review

Evidence shows that many green innovations never become a commercial success or retain miniscule market shares. For example, Boini and Oppenheimer (2008, p. 56) report that organic foods account for approximately 3% of overall food sales, while green detergents and hybrid cars account for about 2% of sales in their respective markets. Other product innovations such as renewable energies have been languishing for years in the chasm between early adopters and mainstream markets and are often heavily dependent on policy support in the form of subsidies or tax incentives.

Sheth et al. (2010) for example argue that key reasons for the low uptake are "compromises in the performance quality for green products combined with their limited availability and higher prices." Others have argued that green products can conflict with consumers' belief structures and might require consumers to break with deep-rooted traditions or daily habits and routines (Ram and Sheth 1989). For example, many consumers believe that non-chemical detergents are less effective than their toxic counterparts (e.g. Coddington 1993). Thus, marketing strategies that simply focus on promoting the environmental superiority of green detergents are unlikely to change consumers' ingrained beliefs and deep-rooted traditions (e.g. Coddington 1993). Understanding consumers' resistance to green products, and more importantly their underlying motives, is thus of critical importance for managers aiming to enhance the effectiveness of marketing innovative green products.

2.1 Consumer resistance behaviour

The available evidence suggests that consumers can resist innovation differently, i.e. engage in less or more intense resistance behaviours, depending on the type and number of barriers consumers associate with a new product. Previous studies broadly distinguish between consumers who resist a technological innovation actively or passively (Bagozzi and Lee 1999; Kleijnen et al. 2009; Ram 1987; Ram and Sheth 1989).

These studies have suggested that active and passive forms of resistance behaviours occur at different stages in consumers' innovation-decision process i.e. knowledge, persuasion, decision, implementation, confirmation (Nabih and Bloem 1997; Rogers 2003 [orig. pub. 1964]). Passive resistance occurs when a consumer has no or little knowledge of the technological innovation and experiences little desire to change this state. Thus, consumers who are passively resistant towards an innovation are either not aware of the new technology at all or have very little knowledge about how it functions or what it does. Passive resistance can occur as a consequence of habit. Many consumers are likely to be satisfied with the status quo and have no intrinsic desire to change, thus paying little or no attention to innovative products (Sheth 1981). Arguably, passive resistance can be overcome by raising awareness among consumers and by communicating the benefits of a new technology.

Consumers who are actively resisting the innovation are psychologically more involved and have not only gained awareness but (partly) evaluated the technology's characteristics. This evaluation allows them to make a more informed decision whether to adopt or actively resist a new product. Active resistance resides with consumers who have gained awareness of a new technology, start evaluating advantages and disadvantages of a new green product and ultimately make a decision whether to adopt or actively resist the innovation. Based on an extensive meta-review of the literature and qualitative research, Kleijnen et al. (2009, p. 351) identify three active resistance behaviours: postponement, rejection, and opposition. The weakest form of active resistance is *postponement*, which is defined as "an active decision to not adopt an innovation at that moment in time". Their definition is similar to Nabih and Bloem's (1997, p.191) who argue that "the consumer may escape from the dilemma between adoption and rejection by postponing the decision". It also is in line with what Bagozzi and Lee (1999, p. 219) refer to as "consumers' indecision", meaning that consumers "will most often continue information processing until the perception of opportunity and/or threat are subjectively addressed to satisfaction".

The second active resistance behaviour is *rejection*, which is defined as "an active decision to not at all take up an innovation" (Kleijnen et al. 2009, p. 351). Rejection is the most commonly used term in the literature and has often been used interchangeably with resistance. For example, Rogers' (2003 [orig. pub. 1964], p. 177) definition of rejection "as the decision to not adopt an innovation" is similar to the one suggested by Kleijnen et al.

The third and strongest form of active resistance is *opposition*, which Kleijnen et al. define as an "active behaviour directed in some way towards opposing the introduction of an innovation." Opposition behaviour can range from (e.g.) verbal complaints to negative word of mouth or even protest action (e.g. Bagozzi and Lee 1999). Herrmann (1993) points out that "a variety of responses are available to consumers including exit (refusal to buy), voice (complaining actions) and loyalty (continued patronage in hope of change)". Opposing consumers are, from a marketing perspective, the target group most difficult to engage in buying behaviour.

To synthesize this past research, we delineate between resistance behaviours by expanding on the reasons for resistance by discriminating between active and passive resistance behaviours, depending on whether a consumer is unaware of a new technology or has started to evaluate the innovation's characteristics. Secondly, we demarcate consumers' level of active resistance by noting that consumers can actively resist a technology innovation by postponing, rejecting or even opposing the idea of adoption (Table 6.1).

Table 6.1: Consumer resistance behaviours

Type of resistance	Resistance behaviours	Selected literature
Passive	**Being unaware** Consumers have no or little knowledge of the technology and no desire to change this state	(Lapointe and Rivard 2005; Ram and Sheth 1989)
Active	**Postponement** Active decision to not adopt an innovation at that moment in time	(Gatignon and Robertson 1989; Nabih and Bloem 1997; Szmigin and Foxall 1998)
	Rejection Active decision to not at all take up an innovation	(Bagozzi and Lee 1999; Ram 1987; Ram and Sheth 1989; Rogers 2003 [orig. pub. 1964])
	Opposition Active behaviour directed in some way towards opposing the introduction of an innovation	(Fournier 1998; Garrett 1987; Herrmann 1993; Penaloza and Price 1993; Ritson and Dobscha 1999)

Having classified resistance behaviour, we need to further investigate the motives behind consumers' resistance of a new technology. Whereas extant research has concluded that passive resistance is simply caused by a lack of awareness, it has been suggested that motives behind active resistance can vary significantly, and determine whether consumers postpone, reject or oppose an innovation.

2.2 Motives for active consumer resistance

The reasons for consumers resisting new green products are manifold and often lie in complex interactions between the perception of product characteristics, socioeconomic factors and the social context (e.g. Kleijnen et al. 2009; Ram and Sheth 1989). Extant research distinguishes between functional, psychological and ideological barriers that consumers are likely to encounter when faced with an innovation.

2.2.1 Functional Barriers

Functional barriers refer to problems consumers associate with adopting an innovation, including usage, value and risk (e.g. Antioco and Kleijnen 2010). In this study we estimate consumers' perceptions of *value* via two measures, including (lack of) perceived relative advantage and perceived costs. *Relative advantage* is the degree to which consumers believe that a new product is better than the one it supersedes (Rogers 2003 [orig. pub. 1964]). Many new products offer superior performance, design or additional features like improved environmental sustainability. However, if the perceived value or relative advantage of an innovation is not sufficiently high, consumers are likely to resist it. More importantly, improved environmental performance might require consumers to accept tradeoffs in regard to more conventional product attributes like price or performance. For example, the environmental superiority or fuel efficiency of hybrid vehicles was for a long time not perceived as convincing enough by the majority of motorists to accept higher prices. Similarly, *costs* in general are a strong functional barrier that often prevents consumers from investing in new products (e.g. Tornatzky and Klein 1982). Consumers might see the advantage of an innovation over existing products, yet the initial costs might be perceived as too high, causing consumers to postpone adoption or reject the idea altogether.

Perceived usage barriers are measured as perceived *incompatibility*, which refers to the degree to which a consumer believes that a new technology is not compatible with his or her values, past experiences, and/ or existing practises (Rogers 2003 [orig. pub. 1964]). However, researchers have further distinguished between the different dimensions of compatibility. Tornatzky and Klein (1982, p. 33) for example broadly differentiate between a normative or cognitive compatibility (i.e. compatibility with how people feel about a technology) and a second dimension that relates to existing practises and suggests a more practical or operational compatibility (i.e. compatibility with what people do). Ram and Sheth (1989) argue that compatibility with existing practices, habits or routines (i.e. with what people do) is an important usage barrier, since any technological innovation that requires a change in well-established behavioural patterns is likely to be met with resistance. One example is ATM machines, which were initially met with resistance as consumers found them not providing all services (e.g. to issue drafts or open a bank account) that were traditionally performed at a bank counter (Ram and Sheth 1989). Further, researchers have argue that technological innovations also need to be compatible with existing infrastructure and thus introduced *physical compatibility* as an additional dimension (i.e. compatibility with existing infrastructure) (e.g. Moore and Benbasat 1991; Schwarz and Ernst 2008b). For example, one of the reasons why electric vehicles (EVs) have been met with resistance is the lack of charging stations. “Range anxiety” has been noted as a reason that drivers are shunning the EV. In this research we therefore measure usage barriers as perceive incompatibility with existing practices and infrastructure.

The third functional barrier causing innovation resistance is perceived uncertainty or *risk*. Like compatibility, risk is a multidimensional construct and researchers have identified different types of risk (e.g. Ram and Sheth 1989). In this study we specifically focus on performance, as it has been identified as “the most important dimension of risk in relation to new products” (Jacoby and Kaplan 1972, cited in Sääksjärvi and Morel 2010, p. 276). In the early stages of a technological innovation, consumers can draw on little experience from peers or experts, often leading to postponement of adoption until sufficient information is available to reduce uncertainty (Dholakia 2001). In relation to sustainable innovation, green attributes in particular might make consumers suspicious about the performance of a product, as shown to be the case with green detergents (e.g. Coddington 1993).

In addition, we argue that perceived *complexity* can be an important functional barrier. Complexity refers to consumers' perception of whether a product is difficult to use and understand. In fast-moving industries, rapid changes in technology are likely to limit consumers' willingness to understand and successfully use a new technology (Ellen et al. 1991). Mukherjee and Hoyer (2001) for example have shown that complexity can negatively affect consumers' evaluation of an innovation's novelty. In relation to green innovation, complexity can for example overshadow consumers' appreciation of a product's environmental superiority, thus positively influencing consumer resistance.

2.2.2 Psychological Barriers

Psychological conflicts are a second type of barrier that can lead to innovation resistance (Kleijnen et al. 2009; Ram and Sheth 1989). In this research we specifically focus on two psychological barriers: compatibility with values (i.e. traditions) and subjective norms.

Incompatibility with values refers to the above-described first dimension of compatibility as defined by Tornatzky and Klein (1982). It thus relates to a normative type of compatibility i.e. how people feel about a new product. For example, technological innovations that require consumers to deviate from existing values or traditions are likely to experience greater resistance. Screw caps on wine, for example, have traditionally been associated with cheap wine and were widely neglected by many consumers (Garcia et al. 2007). Only concerted marketing efforts on the part of the wine industry led to a change in consumers' perceptions and breaking with traditions and values.

Further, perceived social acceptance (i.e. subjective norms) provides cues for consumers to base their adoption decisions on. Venkatesh and Brown (2001), for example, showed that one motivation for personal computer adoption and usage at home was status i.e., the peer recognition of owning a personal computer. However, if perceived social acceptance is low, consumers are likely to postpone adoption or reject a new product. Kleijnen et al. (2009, p. 346) further point out that perceived low social acceptance can result from negative media coverage, which can result in negative image perceptions of innovations that lead to resistance.

2.2.3 Ideological Barriers

Lastly, we consider *ideological* barriers to innovation. Individuals sometimes reject innovations for ideological reasons as opposed to functional or psychological barriers. Kleijnen et al. (2009) for example show that some consumers sometimes disagree with an innovation 'out of principle'. A good example is genetically modified organisms (GMOs) in food products. Many consumers, particularly in Europe, strongly oppose GMOs, mainly because of concerns about potential health risks, overall preferences for 'natural' food or fears about adverse environmental effects. However, consumers' reservations appear irrational in light of the scientific consensus, which seems to suggest that GMOs are safe for humans and the environment. Yet the tension between consumer ideology and scientific recommendation has adversely impacted on the diffusion of GMOs in many European countries (e.g. Noussair et al. 2004).

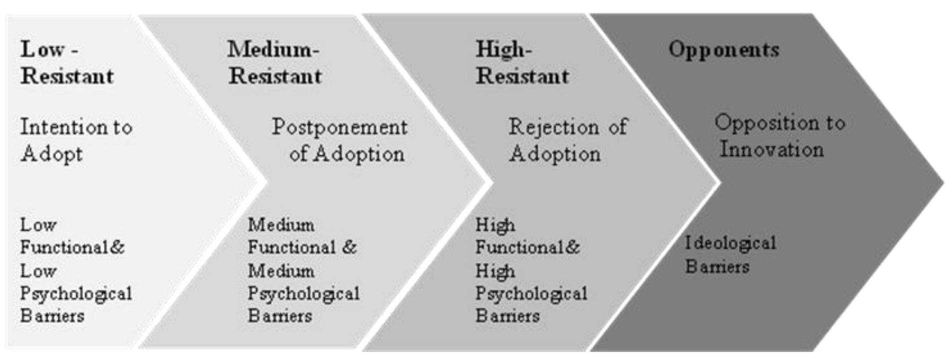
We next use these barriers (i.e. functional, psychological, ideological) along with our previous categories of active resistance (postponement, rejection, and opposition) to create a classification for adoption resistance by consumers.

3 Research objectives and hypotheses

The discussion above indicates that once aware[31] of a new technology, consumers evaluate its characteristics and ultimately make a decision whether to adopt or actively resist (i.e., postpone, reject, oppose) adoption. More importantly, consumers' active resistance behaviours broadly reflect different degrees of resistance, "moving from postponement, to rejection, to opposition, depending on both the amount and type of antecedents present" (Kleijnen et al. 2009, p. 351). Further, barriers that consumers associate with the adoption of new technology affect their level of resistance. However, the relative importance of these barriers is widely unknown, particularly for green product innovation. We thus hope to shed light on the factors that cause different intensities of resistance among consumers.

Building on these findings, we propose a classification of consumers that stretches from low to high levels of resistance, thus accounting for heterogeneity within this important segment (Figure 6.1).

Figure 6.1: Classification of resistant consumers



Source: Adapted from Kleijnen et al. (2009)

[31] Again, in this study no attention is paid to consumers who are passively resistant, i.e. unaware of the technological innovation. Unaware consumers have to gain a broad understanding of how the technology works before they can evaluate product characteristics and actively decide whether to adopt or resist a technological innovation. Thus, from a marketer's perspective passive-resistant consumers constitute a different segment altogether.

We first classify consumers who have not adopted a technological innovation as yet, but have formed an intention to do so, as *low-resistant customers*. Consumers falling into this segment are likely to have evaluated a product's characteristics and associate low functional and psychological barriers with it. Naturally, they can be expected to be the next consumers to adopt and need only moderate persuasion in the form of, for example, price or sales promotion.

Further, consumers who postpone adoption at a moment in time are broadly classified as *medium-resistant consumers*. These potential customers associate more barriers with the technological innovation than low-resistant consumers. Consumers falling into this category have not been fully convinced about the value and usage of the innovation. Kleijnen et al. (2009) for example show that consumers postponing adoption generally did so because of the price or perceived usage barriers. Further, consumers' who perceive a product is difficult to use and understand are also likely to postpone adoption until sufficient information is available to make an informed decision. However, medium-resistant consumers generally see the relative advantage of the product and do not experience conflicts with, for example, personal values. We thus argue,

> H1 = Medium-resistant consumers postpone adoption because of perceived cost barriers.
>
> H2 = Medium-resistant consumers postpone adoption because of perceived usage barriers.
>
> H3 = Medium-resistant consumers postpone adoption because of perceived complexity.

The third segment comprises *high-resistant consumers* who, at a moment in time, reject the idea of adopting an innovative green product completely. They associate high functional barriers with the new product and also experience psychological conflicts in relation to adopting it. Kleijnen et al. (2009) for example showed that resisting consumers associated poor image and higher functional risk with an innovation. Further, we can expect that consumers who completely reject the idea of adoption do not see the value (i.e. relative advantage) of an innovation over existing products. Naturally, these consumers are more difficult to persuade and will most likely reject an innovation until peer pressure grows too strong or adoption becomes an economic necessity. Thus, in addition to the price and usage barriers,

> H4 = High-resistant consumers reject adoption because of perceived poor image
>
> H5 = High-resistant consumers reject adoption because of perceived functional risk.
>
> H6 = High-resistant consumers reject adoption because of perceived low value

Further, research from the innovation literature suggests that innovators and early adopters often differ in their sociodemographic profile (Gatignon and Robertson 1991; Im et al. 2003; Rogers 2003 [orig. pub. 1964]). For example, younger consumers as well as people with higher levels of income and education are more likely to adopt innovative technology .We therefore argue that the opposite is true for the level of resistance, i.e., that older, less educated and low-income consumers have generally higher levels of resistance. Thus, we hypothesize that:

> H7 = Older consumers have a higher level of resistance towards green product innovation.
>
> H8 = Less educated consumers have a higher level of resistance towards green product innovation.
>
> H9 = Low-income consumers have a higher level of resistance towards green product innovation.

We should also remember that there may be opponents of an innovation, who may boycott the new product or even engage in protest action. These consumers are an idiosyncratic grouping that provides particular and different challenges for the marketer, as opponents not only associate functional or psychological barriers with a new product but resist it for ideological reasons or “out of principle” (Kleijnen et al. 2009). However, opposition is a phenomenon often unique to particular products or product categories. Because of the extreme nature of opposition, we deem the barriers to be unsurmountable, not just as high or low, and thus, leave the analysis of this idiosyncratic group for more elaborate future research in its specific context.

In the following we thus focus on consumers who experience low, medium and high levels of resistance. In particular, we develop and evaluate an approach that allows us to classify consumers according to their level of resistance to innovative green products and empirically investigate their underlying motives, i.e., test hypotheses H1–H9.

4 Methodology

To test the hypotheses proposed above, we first developed a measure that effectively segments potential customers according to their level of resistance (see Table 6.2). Our instrument should reflect consumers' strength of resistance towards green product innovation. Building on the conceptualization discussed above, the measure should discriminate between consumers with low, medium and high levels of resistance, thus allowing us to investigate the underlying motives.

The development and validation of the resistance measure were conducted with home owners[32] in Ireland in the context of renewable energies. Many renewable energy technologies such as solar panels have been languishing for years in the chasm between early adopter and mainstream markets and therefore provide a suitable object for this study (e.g. Egmond et al. 2006a, 2006b). In the next sections we first describe the development of the measurement instrument (i.e., resistance measure) and in a second step apply the measure to test the above discussed hypotheses.

4.1 Development of measurement instrument

This section aims to outline the scale development process, following recommendations by DeVellis (2003), Steenkamp and van Trijp (1991) and Richins and Dawson (1992).

[32] Ireland has a home ownership rate of over 80%, which makes home owners a particularly interesting market segment.

In a first step we defined the resistance behaviour we intended to measure. Next we generated a pool of items based on qualitative research and the existing resistance literature. Third, we assessed the initial items regarding their content validity and wording. Finally, we evaluated the resistance measure's internal and external validity and tested its nomological validity by applying it to investigate consumers' motives behind resistance.

Table 6.2: Development of measurement instrument

Stage	**Description**
Literature review	Examination of academic and industry literature relevant to consumer resistance
Semi-structured interviews	Interviews with consumers (*n* = 20) about their level of resistance and underlying motivations
Item generation	Resistance items written by authors; items for resistance motives adapted from previous studies
Evaluation	Assessment of content validity by five expert judges (four marketing professors, one PhD student)
Pre-test	Convenience sample (*n* = 83); refinement, dimensionality, internal consistency
Consumer study	National survey for three innovative technologies in the area of renewable energy, including micro wind turbines (*n* = 254), solar panels (*n* = 254) and wood pellet boilers (*n* = 253); testing convergent, discriminant and nomological validity

4.2 Definition of resistance behaviour

As outlined above, empirical studies predominantly measure resistance dichotomously as intentions/ no intentions to adopt, indirectly treating resistant consumers as a homogeneous group (e.g. Verhoef and Langerak 2001). In this study we aimed to take a closer look at the segment of non-intenders and particularly identify consumers who have formed a decision to not adopt an innovation at that moment in time (i.e. postponers) and to distinguish them from consumers who decided to not at all take up an innovation (i.e. rejecters). We thus expect our one-factor scale to measure non-intenders level of resistance i.e. discriminate between postponing and rejecting adoption of an innovation (Kleijnen et al. 2009).

4.3 Item generation and content validity

Prior to item generation, we conducted in-depth interviews with a diverse convenience sample of 20 adult consumers in Ireland (see section 1.6). During the interviews all respondents were asked about their intentions to adopt a renewable energy system in the near and distant future. Respondents who had no intention were further prompted to explain if they were postponing adoption or rejecting the idea completely. Participants were also asked about their motivations to resist adoption and the identified barriers were translated into items using existing scales from the relevant literature. Overall, respondents had no problem in articulating resistance and, like Richins and Dawson (1992), we converted the most frequently mentioned resistance behaviours into items. Based on the discussion in the respective literature, the researchers constructed additional items reflecting resistance and also adapted items from the innovation literature.

This led to an initial pool of 22 items, which was first screened to identify ambiguous wording, redundant items or double-barrelled questions (Churchill 1979). Following DeVellis (2003), the remaining 16 items, together with the definition of resistance behaviours, were presented to five expert judges (four marketing professors, one PhD student) for further screening. Only those items that four out of five judges agreed on were considered further, reducing the pool to nine items. For an initial evaluation of the resistance measure, the nine items were formatted on a five-point Likert scale that ranged from 1 (very unlikely) to 5 (very likely).

4.4 Pre-test

For an initial evaluation of the resistance measure, we collected surveys from a convenience sample of 83 Irish home owners. The main aim of the pre-test was to evaluate the internal consistency of the scale, reduce the number of items and confirm the above specified structure via factor analytical techniques (e.g. Floyd and Widaman 1995). In a first step we conducted a principal-axis factor analysis with non-orthogonal rotation to assess the general factorability of the data. Principal-axis factoring belongs to the family of exploratory factor analyses and aims to identify the underlying factor structure in data by analysing the common variance between individual items (Floyd and Widaman 1995). Since the underlying structure of the data can only be speculated about at this stage, principal-axis factoring provides a crucial first step in the psychometric evaluation of new scales. On the other hand, it provides an important tool to identify redundant items and items which show high cross loadings between different factors (Tabachnick and Fidell 2001). In our study, an initial principal-axis factor analysis revealed three items with very low item to total correlations (<0.35) which were thus dropped from further analysis (Ruekert and Churchill 1984). The analysis was then repeated with the remaining six items. The results are presented in Table 6.3 and support a one-factor resistance scale which explains about 47% of common variance and has an eigenvalue of 2.8. More importantly, all items loaded higher than 0.4 on the underlying construct resistance (Tabachnick and Fidell 2001). The inter-item reliability of the scale is also sufficient, with a Cronbach's alpha of 0.76 (Nunnally 1978). Further, the Kaiser-Meyer-Olkin (KMO) measure of 0.78 indicates that sample size was adequate for the analysis.

Table 6.3: Resistance behaviour items and factor loadings

Item	**Factor loadings**[a] **(*n* = 83)**
1. I intend to find out more about the benefits of installing … on my house in the near future	.723
2. I can see myself installing … on my house at some stage in the near future	.782
3. If the cost of … dropped significantly, I would install them on my house tomorrow	.446
4. For me personally, the benefits of installing … in the near future would outweigh the costs	.639
5. If my house or roof needed renovations, I would consider installing … on my house	.530
6. If the technology improves I will install … on my house	.443
Initial eigenvalue (variance explained)	2.793 (46.56%)
KMO	.776
Cronbach's alpha	.764

[a] We used principal-axis factoring as the extraction method and direct oblimin as the rotation method.
[b] The technology in this study was micro wind turbines. Two more studies were conducted in relation to other technological innovations: wood pellet boilers (*n* = 241) and solar panels (*n* = 227).

4.5 Consumer sample

The main study surveyed a sample of 761 home owners in Ireland. The sample was divided into three sub-samples with distinct, but related technological innovations: micro wind turbines (*n* = 254), solar panels (*n* = 254) and wood pellet boilers (*n* = 253). The data were collected by a professional market research company via computer-assisted telephone interviews. To ensure comparability of the studies we applied a quota sampling approach (i.e. age, gender, and region), illustrated in Appendix 1.

4.6 Adaptive survey design

We utilized an adaptive survey design to first identify the respective target population, which was home owners who are aware of the technology in question and are partly or fully responsible for making financial decisions regarding the house they currently live in. In line with the typology of consumer resistance presented earlier (Table 6.1), respondents who were unaware of the technological innovation were classified as passive-resistant and excluded from the survey. Likewise, consumers who had already adopted the technology in question were excluded from this study.

4.7 Resistant consumer segments

In a second step, suitable respondents were asked two sets of questions to identify their level of resistance. First, consumers were asked about their intention to purchase the respective technological innovation in the next 12 months. Respondents who stated an intention to adopt were classified as low-resistant consumers. Those who stated that they had no intention to buy were presented with a second set of questions (i.e. resistance measures developed for this study), in order to discriminate effectively between medium- and high-resistant consumers (i.e. postponing and rejecting consumers).

4.8 Measure validation

We first replicated earlier reliability and validity tests (see section 4.4). The item-total correlations for individual items exceeded 0.4 in each sub-sample. Further, factor analysis with non-orthogonal rotation revealed a one-factor resistance measure for each sub-sample. The factor loadings all exceeded 0.6 and the variance explained stretched from 57.74% to 63.33%. Cronbach's alpha ranged from 0.85 to 0.88. These preliminary analyses proved helpful indicating the unidimensionality of the resistance measure.

However, a "more rigorous evaluation of unidimensionality according to the constraints inspired by internal and external consistency" is needed (Gerbing and Anderson 1988, p. 189). In order to test the measure's discriminant and convergent validity we thus conducted a confirmatory factor analysis (CFA) in which we assessed the resistance measure against two intuitively related constructs, i.e., "intentions to adopt" and "attitudes towards adoption". For direct comparison, the data for these two constructs were collected together with the resistance data in the above described consumer survey. Both “intentions” and “attitudes” were measured using established scales (Ajzen 1991: Appendix 2), which are commonly used to predict adoption of innovation (e.g. Taylor and Todd 1995). The measures address resistance indirectly as “no intention to adopt” and “negative attitudes” towards adoption, respectively.

However, both measures have been criticized for their inaccuracy in predicting actual behaviour, particularly in relation to new products. Regarding adoption intentions, a meta-review assessing bias and variability in purchase intention scales concludes that “the most reported cases of substantial bias in the literature … are for new products” (Wright and MacRae 2007, p. 621). Studies have shown that in relation to new products the great majority of consumers express no intention to buy. Yet many non-intenders will end up purchasing the product in the future. Non-intenders therefore account for much of the bias in stated intention surveys (Day et al. 1992). Further, the relationship between attitudes and behaviour was also found to be weak in many studies, mainly because of compatibility issues in relation to the measures and because buying behaviour is not always under people’s volitional control (e.g. Ajzen 1991). Thus, in line with our earlier argument that the level of resistance (i.e. low, medium, high) is expressed in different behavioural responses (i.e. postponement, rejection, opposition), one explanation is that conventional measures do not account for enough heterogeneity among non-intenders. In other words, a consumer with no intention to adopt might postpone his or her decision or reject the idea of adoption completely, yet this is not measured with traditional approaches.

Table 6.4: Summary statistics for resistance, intention and attitude scales by subsample

	Mead/SD/Reliability (p^a)/ AVE		
	Wood pellet boilers	Solar panels	Micro wind turbines
Resistance	3.62	2.94	3.19
	1.44	1.52	1.44
	0.88	0.86	0.87
	0.56	0.50	0.53
Intentions to Adopt	1.38	1.62	1.54
	0.88	1.18	1.06
	0.74	0.70	0.71
	0.81	0.78	0.80
Attitudes towards Adoption	2.69	3.47	3.16
	1.46	1.39	1.38
	0.88	0.86	0.87
	0.66	0.64	0.65

[a]Composite reliability (Jöreskog, 1971)

In Table 6.4 we report the mean, standard deviation, composite reliability and average variance extracted for the three multiple item scales. The correlation matrix is presented in Table 6.5. The findings show that the scales exhibit good measurement properties, with composite reliabilities exceeding the critical value of 0.7 in all three sub-samples (Jöreskog 1971). The average variance extracted (AVE) meet the 0.5 threshold, thus indicating the measures' convergent validity (Bagozzi and Yi 1988). The overall results from the CFA show that all path loadings are significant (α = 0.01) and exceed the threshold of .6. Also, no cross-loadings between constructs could be detected. The fit statistics for the confirmatory model appear to be equally good for the wood pellet boiler (NFI = .98; CFI = .99; GFI = .95; RMSEA = .057), micro wind turbine (NFI = .97; CFI = .99; GFI = .96; RMSEA = .043) and solar panel (NFI = .97; CFI = .99; GFI = .95; RMSEA = .052) subsamples, providing additional evidence for the measures convergent validity (Bollen and Long 1993).

Table 6.5: Correlation among related measures in each subsample

	RSTC	INT	ATT
Resistance (RSTC)	1		
Intentions to adopt (INT)[a]	–.62	1	
	–.56		
	–.45		
Attitudes to adoption (ATT)[a]	–.67	.50	1
	–.59	.32	
	–.54	.24	

[a]Correlations from top to bottom: wood pellet boilers, solar panels, micro wind turbines

Further, we expect our measure to account for more variance in levels of resistance, i.e., provide additional explanatory power and discriminate effectively against the two intuitively related constructs (e.g. Shimp and Sharma 1987). To test the discriminant validity of the resistance measure we conducted three tests regularly used in the literature (e.g. Cannon et al. 2010). Each test was performed individually for the three subsamples. In the first test, we calculated the 95% confidence intervals around the estimated correlations between the latent constructs. The results were all significantly below 1.0 and thus demonstrate the constructs discriminant validity. Second, we conducted a number of nested model comparisons by constraining correlations between pairs of latent constructs to 1.0. χ^2 difference tests were significant for each model pair, providing further evidence for discriminant validity. Following a more rigorous test suggested by Fornell and Larcker (1981), in a last step we calculated the average variance extracted and found that it exceeds the squared correlation between all pairs of latent constructs. Overall, all pairs of constructs in each subsample passed these tests providing strong evidence of discriminant validity of the resistance measure (Gerbing and Anderson 1988). This is an important finding because it supports our supposition that resistance is different to lack of an "intention to adopt" or negative "attitudes to adoption". We now test our hypotheses with an understanding that resistance is a separate and distinct construct.

5 Hypotheses testing

5.1 Empirical model

Having successfully developed the resistance measure, we next employ logistic regression to test our hypotheses. The dependent variable, *Y*, was constructed based on consumers' level of resistance as measured by our six items as explained above. Consumers with an intention to adopt in the next 12 months were classified as low-resistant consumers (n = 59). Like Morwitz and Schmittlein (1992) we classified the remaining consumers according to their resistance score (i.e. lower and upper tercile), segmenting them into medium-resistant (n = 234) and a high-resistant-consumers (n = 234).[33] In other words, we effectively compare those who have decided to adopt (group 1) with people who are postponing adoption (group 2) and consumers who have decided to reject the innovations altogether (group 3). The descriptive statistics for differences in perceptions of barriers and sociodemographic variables between the three groups are presented in Appendix 4.

Formally, we have a dependent variable y_i with M outcome categories, where j = 1,2,…, M and M = 3. The probability that y_i is a particular j outcome category is generally expresses as:

$$\begin{aligned} &P(y_i = 1) = 1 - F(x_i^{'}\beta_1) \\ &P(y_i = j) = F(x_i^{'}\beta_{j-1}) - F(x_i^{*}\beta_j) \quad for \quad j = 2,...,M-1 \\ &P(y_i = M = F(x_i^{'}\beta_{M-1}) \end{aligned} \tag{1}$$

[33] It needs to be noted that there are other bases available for segmentation (e.g. sociodemographics, psychographics or product usage) and that segmentation techniques comprise of various methods (e.g. cluster-, conjoint-, or discriminant analysis). For an overview see for example Hair et al. (1998). However, in light of the research questions, the scale development efforts and the nature of the data, it was decided that a tertiary split along the intention and resistance scales was most appropriate.

The three-outcome variable y_i is the discrete expression of the underlying latent variable y_i^* (i.e., level of resistance), where y_i^* can be represented in the structural form of $y_i^* = x_i\beta + \varepsilon_i$. Given the ordered nature of the dependent variable (i.e., low, medium, high resistance) estimating a standard ordered logit would be appropriate. However, initial estimations showed that the parallel-lines assumption[34] was violated, indicating that one or more *β* values of the explanatory variables differ across values of *j*, implying that an ordered logit model is too restrictive.

More importantly, ignoring violations of the parallel-line assumptions can result in distorted findings (Williams 2011). Other solutions like multinomial logit models, however, often estimate too many parameters (Williams 2006). Instead we employ a partial proportional odds model which, like ordered logit models, accounts for the ordinal nature of the dependent variable but allows for potential violations of the parallel-lines assumption by the explanatory variables. The model is thus more flexible than ordered logit models and more parsimonious than multinomial regression as it allows some of the *β* coefficients to be the same for all values of *j*, while others can differ between categories.[35] For example, the cumulative probabilities of partial proportional odds model can be expressed as

$$P(Y \le j \mid \mathrm{x_j})F(a_j - x_1\beta_1 + x_2\beta_2 + x_3\beta_{3j}), \quad for \quad j = 1,2,\ldots,M \qquad (2)$$

where the *β* values for x_i and x_2 are equal for all values of *j* but the *β* coefficient for x_3 is free to differ.[36] Thus, "by fitting the partial proportional odds model the parallel-lines

---

[34] Ordered logit models can be seen as a set of *j* – 1 binary regressions, assuming that the slopes of the regression coefficients are equal across outcome categories (see for example DeMaris (1992) or Long and Freese (2006)). In our analysis a likelihood ratio test (Long and Freese 2006) and a Brant Test (Brant 1990) both revealed that the null hypotheses of parallel lines (i.e., coefficients are equal across level of outcome categories) was violated, implying that using a standard ordered logit model would be inappropriate.

[35] For a detailed discussion see Williams (2006).

[36] This compares to the ordered logit model $P(y_i \le j \mid x_i) = F(\tau_j - x_i\ \beta)$, for $j = 1,2,\ldots,M$, for which the *β* coefficients are equal across *j* and the (e.g.) generalized ordered model for $P(y_i \le \mathrm{j} \mid x_i) = F(\alpha_j - x_i\ \beta_\mathrm{j})$, for $j = 1,2,\ldots,$M, which uses a different set of *β* values for each outcome category *j*.

assumption is then relaxed only for coefficients of explanatory variables that actually violate the assumption" (Soon 2010, p. 96).

5.2 Antecedents of resistance

In our model we use three types of explanatory variables, including functional barriers, psychological barriers and sociodemographic variables. Measures reflecting barriers are all well-established constructs from the innovation and resistance literature and are defined in section 2.2.[37] All were measured on five-point Likert scales, stretching from strongly agree (1) to strongly disagree (5). The multi-item scales were assessed for reliability, and convergent and discriminant validity via CFA in Lisrel. The results indicate a satisfactory fit of the data (GFI = .0.96, CFI = 0.98, NFI = 0.97, RMSEA = 0.037). All items load significantly on the corresponding latent constructs ($\alpha = 0.01$) and show high composite reliability (CR > 0.7) and discriminant validity (AVE > 0.5). The results are presented in Table 6.6 and provide sufficient evidence for the reliability and external validity of the measures representing functional and psychological barriers (Gerbing and Anderson 1988).

[37] See Appendix 2 for a full list of items.

Table 6.6: Correlation matrix and confirmatory factor analysis of independent variables

Construct	RA__-	COST	COINF	COHAB	COMX	COVAL	SUBNOR	RISK
Relative advantage (RA)	1							
Cost (COST)[a]	0.08	1						
Compatibility infrastructure (COINF)[a]	–0.11	0.26	1					
Compatibility habits(COHAB)	0.48 *	0.06	–0.22 *	1				
Complexity (COMX)[a]	0.01	0.21*	0.46 *	–0.18 *	1			
Compatibility values (COVAL)	0.60 *	0.08	–0.14 [a]	0.70 *	0.16 *	1		
Subjective norms (SUBNOR)	0.52 *	0.02	–0.15 *	0.37 *	0.00	0.40 *	1	
Risk (RISK)[a]	–0.02	0.24 *	0.19 *	0.01	0.36 *	–0.02	–0.09 *	1
AVE	0.55	0.74	0.72	0.61	0.54	0.77	0.61	0.63
CR	0.78	0.90	0.83	0.83	0.78	0.91	0.82	0.84
Fit Statistics	X^2 = 440.1 (*df* = 224); GFI = .96; CFI = .98; NFI = .97; RMSEA = 0.037							

Note: [a] Items are negatively worded. * Significant at the 1% level.

However, compatibility with values (COVAL) shows high correlations with other explanatory variables and later tests confirmed multicollinearity problems. For this reason compatibility COVAL was excluded as a dependent variable from the analysis.

The sociodemographic variables contain information about consumers’ age, education and social class, which serves as proxy for income. Age reflects consumers’ personal age in years. Education and social class are both binary coded dummy variables. Education includes primary, secondary and third-level education, whereas primary education serves as the reference variable and is coded 0. Social class reflects the vocation of the chief income earner. Households in which the chief income earner is working (or has worked until retirement) in senior management positions or as a top level civilian servant are categorized as upper class whereas people in middle management positions or non-manual positions are labelled as middle class. Chief income earners in skilled or semi-skilled manual jobs are labelled working class and a fourth category included are farmers. In the model, working class was chosen as the reference variable and coded 0. Table 6.7 provides the descriptive statistics of the explanatory variables.

Table 6.7: Summary statistics of independent variables

Variable	Mean	Std. Dev.	Min	Max
Functional barriers				
RA	3.49	1.22	1	5
COST	3.46	1.38	1	5
COINF	2.77	1.27	1	5
COHAB	3.39	1.26	1	5
Psychological barriers				
SUBNOR	2.38	1.21	1	5
RISK	3.25	1.17	1	5
COMX	2.51	1.10	1	5
Sociodemographic variables				
Upperclass	0.13	0.34	0	1
Middleclass	0.48	0.50	0	1
Workingclass	0.28	0.45	0	1
Farmer	0.11	0.31	0	1
PrimaryEd	0.09	0.28	0	1
SecondaryEd	0.43	0.49	0	1
ThirdlevelEd	0.48	0.50	0	1
Age	50.9	16.71	16	99

Note: Sociodemographic variables (except age) are dummy variables.

5.3 Estimation results

The final sample consists of 527 consumers and the estimations were performed with the partial proportional odds model (Eq. (2)). Overall, model specification tests indicate a good fit. The Wald chi-square test rejects the null hypothesis that coefficients have no effect on resistance (p-value < .05). Further, a general model specification test (i.e., linktest) revealed that the model is adequately specified for each $j-1$ equation (hatsq1 p-value = 0.29; hatsq2 p-value = 0.44). We also tested a series of nested models in which we compared our model with a standard ordered logit model and in a second step with a multinomial model. In both cases likelihood-ratio tests show that the above specified model fits the data better than the two competing models (*p*-value < .05). Further, Akaike's Information Criterion (AIC) of the partial proportional odds model (AIC = 707.09) is smaller than that of the ordered logit (AIC = 733.13) and multinomial logit (AIC = 710.07), providing additional evidence for its superior fit.

The results of the partial proportional odds model provide evidence that functional and psychological barriers and sociodemographic factors influence consumers' level of resistance toward new technology. The model's coefficients, standard errors and odds ratios are presented in Table 6.8. In the table we first contrast low-resistant with medium and high-resistant consumers ($j = 1$). The coefficients indicate the probability to have low-resistance compared to the two remaining categories. Likewise, in a second step the model contrasts low and medium with high-resistant consumers ($j = 2$). Coefficients that appear twice are allowed to differ across outcome categories ($M – 1$) as they violate the parallel-lines assumption.

Overall, the model estimates 17 coefficients, i.e., 13 in the first category and four for the second category. In our case, the model allows four variables i.e., relative advantage, costs, compatibility with habits and age to vary across M-1 equations. In general, positive coefficients or odds ratios greater than 1 suggest that higher values of an independent variable increase the likelihood that a consumer is in a higher resistance category than the current one. Negative coefficients or odds ratios less than 1 mean that higher values of an independent variable increase the probability of being in the current or lower category (Williams 2006). Variables that violate the parallel-lines assumptions are somewhat more difficult to explain. Coefficients that appear twice indicate that the effect of an antecedent is different between categories. A perceived barrier might, for example, have a particular effect on consumers' decision to reject an innovation but might not explain differences between intentions to adopt and postponement.

Table 6.8: Coefficient estimates and odds ratios

Variables	Coef.	s.e.	Odds ratio	s.e.
Low-resistant consumers (versus medium- and high-resistant consumers)				
RA	-.256	.164	.774	.127
COST	.157	.123	1.170	.144
COINF	**.331*** **	**.0986**	**1.392*** **	**.137**
COHAB	-.040	.150	.961	.145
COMX	.108	.111	1.114	.123
RISK	.129	.102	1.14	.116
SUBNOR	**-.902*** **	**.105**	**.406*** **	**.042**
ThirdlevelEd	-.222	.423	.801	.338
SecondaryEd	.138	.404	1.148	.464
Upperclass	.140	.380	1.150	.431
Middleclass	.076	.271	1.079	.292
Farmer	-.328	.369	.721	.266
Age	.001	.011	1.001	.011
Medium- and low-resistant consumers (versus high-resistant consumers)				
RA	**-.779*** **	**.120**	**.459*** **	**.055**
COST	-.130	.093	.878	.081
COHAB	**-.364*** **	**.106**	**.695*** **	**.074**
Age	**.028*** **	**.008**	**1.028*** **	**.008**
Alpha1	**3.903*** **	1.177		
Alpha2	**3.18*** **	.959		
Number of observations	527			
LL(0)	-509.150			
LL	-334.547			
LR test $\chi 2$ (17)	**349.204*** **			
Pseudo-R2 McFadden	0.288			

Note: Significance * $p < .1$; ** $p < .05$ and ***$p < .0$. s.e. = standard errors.

In the discussion above we hypothesised that medium- and high-resistant consumers associate higher usage barriers with an innovation. The results clearly show that consumers who perceive a green innovation as incompatible with their existing infrastructure have a higher chance to be classified as medium or high-resistant consumers (.331, $p < .01$). Further, consumers who believe that a green innovation is incompatible with their daily habits and routines are *especially* likely to fall in the high-resistance category (.364, $p < .01$). However, the effect is non-significant when explaining differences between the other categories and we can thus only partly confirm H2.

The estimates further show that consumers who associate a positive image (i.e. subjective norms) with an innovation have a higher probability to experience low resistance (–.902, $p < .01$). However unlike hypothesised earlier the effect of perceived image is the same across resistance categories, again, partly confirming H4.

We have also argued that consumers postpone adoption mainly because of perceived price barriers and complexity. Both factors appear to be non-significant in explaining differences in the level of resistance among consumers, and we can thus reject H1 and H3.

However, we also suggested that high-resistant consumers, compared to medium and low resistant consumer, associate low value (i.e. relative advantage) with a new product. The estimates confirm H6, showing that consumers who do associate value with a green product innovation are especially unlikely to reject this product completely (–.779). The perception of functional risk, however, does not explain differences between medium and high-resistant consumers, and we can thus reject H5.

Surprisingly, sociodemographic factors appear to have no significant influence on resistance levels. The only exception is age, and the results show that high-resistant consumers in particular seem to be older. Thus our findings partly confirm H7 and reject H8 and H9.

Finally, alpha coefficients reflect the threshold parameters along the continuum of the latent variable resistance (y_i^*). In our 3-outcome model we test two threshold parameters, which are both statistically significant (p-value < .01). Relevant parameters indicate that outcome categories are indeed ordinal in nature and well placed on the continuum of the unobserved level of resistance. It also suggests that we should not collapse outcome categories into fewer categories. The findings thus imply that consumers' level of resistance should not be measured indirectly via dichotomous intent to adopt/not adopt approaches.

5.3.1 Outcome probabilities

Finally, we take a different view on the results by examining the changes in outcome probabilities (i.e. level of resistance) that result from changes in perceptions of barriers and sociodemographic variables. In Table 6.9 we compare a baseline scenario with five constructed scenarios, by evaluating the change in probability to fall into the above defined resistant categories that result from a constructed change in antecedents.

The baseline scenario reflects hypothetical consumers with mean perceptions of barriers and average sociodemographic characteristics, as shown in Table 6.7. The results show that the *average* consumer has the highest probability to experience medium resistance, i.e. is most likely to postpone the adoption of a green product innovation (PR|Y = 0.541). In scenarios 1 and 2 we then "model" perception of high and low barriers by taking the mean perceptions (Table 6.7) and adding or subtracting the respective standard deviation.

For example, in scenario 1 we depict consumers who perceive low functional and psychological barriers with innovative technology, while sociodemographic characteristics remain unchanged. As expected, the positive change in perceptions of barriers results in a dramatic increase in the probability to fall into the low-resistant category. In fact, consumers who perceive low barriers with innovative technology are about 10 times more likely to have low resistance (PR|Y=0.372) than average consumers who experience medium barriers (PR|Y=0.035).

In scenario 2, we model hypothetical consumers who experience high functional and psychological barriers with innovation. As expected, the results show that consumers who associate high barriers with new technologies have a 90% probability (PR|Y=0.904) to fall into the high-resistant category, which is twice as high compared to the baseline scenario. Overall, the three scenarios suggest that consumers' perception of barriers adversely influence consumer levels of resistance toward a new product and thus reduce the likelihood of adoption.

Table 6.9: Predicted outcome probabilities

	Scenarios					
Variable	**Baseline**	**1**	**2**	**3**	**4**	**5**
RA	3.49	4.71	2.27	–	–	–
COST	3.46	2.08	4.08	–	–	–
COINF	2.77	1.50	4.04	–	–	–
COHAB	3.39	4.65	2.13	–	–	–
SUBNOR	2.38	3.59	1.71	–	–	–
RISK	3.25	2.08	4.42	–	–	–
COMX	2.51	1.41	3.61	–	–	–
Upperclass	0.13	–	–	–	0	–
Middleclass	0.48	–	–	–	0	–
Workingclass	0.28	–	–	–	1	–
Farmer	0.11	–	–	–	0	–
PrimaryEd	0.09	–	–	–	–	1
SecondaryEd	0.43	–	–	–	–	0
ThirdlevelEd	0.48	–	–	–	–	0
Age	50.9	–	–	34.2	–	–
Predicted outcome probabilities						
Pr|Y=Low resistance	0.035	0.372	0.009	0.054	0.054	0.051
Pr|Y=Medium resistance	0.541	0.595	0.0086	0.645	0.544	0.532
Pr|Y=High resistance	0.406	0.033	0.904	0.301	0.402	0.418

As shown earlier, the influence of sociodemographic factors is somewhat less clear. In scenario 3 we evaluate the effect age has on the level of resistance. In order to do so we fix consumers' age one standard deviation below the average age, while leaving all other variables unchanged. Compared to the baseline scenario, the results show a decrease in the likelihood to fall into the high-resistance category (PR|Y=0.31) and an increase in the likelihood to experience medium resistance (PR|Y=0.645). However, the likelihood of low resistance remains largely unaffected. Further, in scenario 4 we restrict all consumers to fall into the working class category, while other variables remain unaltered. As social class is likely to correlate with income we would expect an increase in the probability to fall into higher resistance categories. Likewise, in scenario 5 we restrict all consumers to primary education levels and would also expect a shift in probabilities towards high resistance. However, both effects are minuscule and changes in probability levels are all below 2%.

6 Initial conclusions

Our research makes three main contributions by (1) creating a consistent classification of resistant consumers, (2) developing a measure to segment consumers according to their level of resistance, and (3) empirically investigating the motives behind different levels of consumer resistance toward green product innovation. Conflicting definitions and inconsistent terminology of consumer resistance have led to much confusion as to what constitutes consumer resistance and how it can be operationalised (e.g. Bagozzi and Lee 1999; Penaloza and Price 1993; Ram and Sheth 1989; Rogers 2003 [orig. pub. 1964]). Building on recent findings by Kleijnen et al. (2009), our classification addresses previous inconsistencies and provides a more coherent segmentation of resistant consumers, reflected in a continuum that stretches from low- to high-level resistance.

Further, empirical research has usually failed to address heterogeneity, i.e. different intensities in resistance behaviours (Cook et al. 2002; Paladino and Baggiere 2008; Venkatesh and Davis 2000). In our research, we accounted for differences in resistance behaviour and developed and validated a measure that was applied in an adaptive-survey segmentation approach. Our measure successfully discriminates between consumers with low, medium and high levels of resistance, accounting for more variance in consumer resistance than conventional measures such as “intentions to adopt” or “attitude towards adoption”. More importantly, the significant threshold parameters in our partial proportional odds model suggest that our resistance categories are well placed on the continuum of the unobserved level of resistance and collapsing resistance into fewer categories (e.g. adopt/not adopt) would yield an inferior measurement.

Further, when it is applied to empirically investigate differences in the perception of barriers between resistant consumer groups, the results show that the motivations underlying different resistance behaviours vary significantly (Table 6.7). The empirical findings show that consumers who intend to adopt, naturally associate no or low barriers with adopting a new product. Consumers who postpone their adoption decision on the other hand, associate higher barriers with the innovation and need additional persuasion especially in relation to compatibility with existing infrastructure. They also associated lower positive image with the respective green product than, for example, low-resistant consumers. However, postponing consumers have not ruled out adoption completely and associate high value with the product. Marketing strategies aiming to target this segment should therefore aim to overcome perceived usage barriers, particularly in relation to compatibility issues with existing infrastructure. Further, promotional efforts effectively boosting the image of the green innovation are likely to increase the likelihood of postponing consumers to convert to adopters.

High-resistant consumers, on the other hand, reject the idea of adoption and are therefore more difficult to persuade. The findings show that consumers who reject adopting a green innovation associate a poor image with the green innovation and perceive it as incompatible with their existing infrastructure. In addition, resistant consumers associate significantly less value with the new product and do not believe that it is compatible with their daily habits and routines. Further, the results show that high-resistant consumers are on average older. The findings suggest that marketing strategies aiming to convert this segment are likely to be ineffective until the innovation has taken over existing technology or has become an economic necessity.

Overall, the findings contribute to the body of theoretical knowledge around consumer resistance and partly fill the paucity of empirical evidence around the motives underlying resistance toward green product innovation. Our approach should also provide a useful tool for marketers who aim to identify potential target groups, understand the motives behind consumers' delays in adoption, and utilize this information to enhance the impact of their marketing strategy.

The technological innovations in the four studies were all renewable energies and future research should test and compare our approach across different product categories. Further, it would be interesting to see if the level of resistance corresponds to consumer predispositions such as innovativeness (e.g. Im et al. 2003, 2007) or resistance to change (e.g. Oreg 2003). Opposition, which is usually confined to specific product categories, was not investigated in this research and also provides an avenue for future research.

Chapter 7

"These days man knows the price of everything,
but the value of nothing."

(Oscar Wilde)

Study III: The diffusion of microgeneration technologies – assessing the influence of perceived product characteristics on home owners' willingness to pay[38]

[38] This chapter represents a slightly modified version of: Claudy, Marius C., Claus Michelsen, and Aidan O'Driscoll (2011a), "The diffusion of microgeneration technologies – assessing the influence of perceived product characteristics on home owners' willingness to pay," Energy Policy, 39 (3), 1459–69.

1 Introduction

Under the umbrella of the European Commission's Energy Policy Roadmap and the Kyoto Protocol, Ireland has committed itself to ambitious energy targets. As outlined in its National Climate Change Strategy (ENVIRON 2007), Ireland has agreed cut greenhouse gas emissions by 20% compared to 1990 levels by 2020. Further, Ireland set out the country's energy policy direction in its Energy White Paper (Department of Communications, Marine and Natural Resources, 2007), aiming to meet 33% of the country's total electricity consumption from renewable energy sources by 2020. The Irish government is also aiming for a 12% market penetration of renewables in the heat market by 2020.

In this context, the residential sector provides one of the greatest potentials to reduce overall energy demand and greenhouse gases. In 2008 this sector accounted for about 25% of the total primary energy requirements and 26% of energy-related CO_2 emissions in Ireland. It was thus the second largest source of CO_2 emissions after transport (O'Leary et al. 2008).

Whereas numerous regulations and energy standards have already led to significant improvements in energy efficiency of new buildings, the existing housing stock provides one of the greatest challenges for energy efficiency improvements and carbon emission reductions. For example, in 2005 Ireland's electricity usage per dwelling was 17% above EU-15 average and Irish houses emitted 92% more CO_2 than the average house in EU-15 countries (O'Leary et al. 2008).

Recent technological innovations have made it possible for home owners to retrofit their homes and generate their own electricity and heat by the use of microgeneration technologies such as photovoltaic (PV) panels, micro wind turbines, solar water heaters, wood pellet boilers, geothermal heat pumps or combined heat and power units (CHP), thus providing electricity and heat close to the source of consumption. Previous studies have shown that investment in microgeneration can be an economically viable[39] way to reduce energy costs and CO_2 emissions and can help to trigger positive changes in energy consumption patterns (e.g. Allen et al. 2008). Microgeneration has the potential to play an important part in reducing overall energy demand and CO_2 emission in the residential sector and help Ireland meet its renewable energy targets.

In order to encourage the uptake of renewable energy and microgeneration, the Irish government introduced several support policies and information campaigns. Since early 2006 the Renewable Energy Feed-in Tariff (REFIT) has become the main tool for promoting renewable energy. The tariffs are guaranteed for up to 15 years, and so far large-scale wind farms have been the main beneficiaries. While REFIT is likely to have a significant impact on the diffusion of renewable energies in electricity generation, it is questionable whether it will encourage Irish home owners, small businesses or communities to invest in microgeneration, as the reference prices for repayments to suppliers are relatively small. For example, the compensation for electricity from small-scale wind turbines is referenced at a price of €0.19 per kWh (SEAI 2006). The main policy instrument to encourage the uptake of microgeneration technologies in the residential sector is grant-aid, which for example is available to home owners via the Greener Home Scheme (SEAI 2010).

Despite these policy efforts, the application of microgeneration technologies in Ireland remains low. For example, estimates from 2008 show that on-grid cumulative capacity of PV panels in the comparable jurisdictions of Austria and Denmark were 26,977 MWp and 2,790 MWp respectively, compared to about 100 MWp in Ireland (Observ'ER 2009). Further, 2008 figures show that Austria had about 2,268,231 kW_{th} worth of solar thermal collectors installed and Denmark about 292,796 kW_{th}, compared to an estimated 50,080 kW_{th} in Ireland (ESTIF 2009).[40]

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[39] The economic potential of sustainable energy systems is largely theoretical, based on discount rates, life-cycle evaluations and current or expected energy prices.
[40] There are admittedly differences in the sociopolitical and cultural environment between the three countries. The early introduction of relatively high feed-in tariffs was a key driver of the diffusion of microgeneration technologies in Denmark and Austria.

The comparatively slow uptake of microgeneration technologies in Ireland suggests that home owners' willingness to pay (WTP) for microgeneration is significantly lower than actual market prices, posing a serious challenge for policy makers and marketers. More importantly, the figures imply that current grant schemes or feed-in tariffs are not able to bridge the gap between consumer WTP and actual market prices, providing scope for research around WTP of Irish home owners and their general perception of microgeneration technologies.

The objective of this study is therefore twofold. First, the study aims to address the lack of empirical evidence and to estimate home owners' willingness to pay for microgeneration technologies. The findings will highlight the gap between actual prices and home owners' WTP and emphasize differences in WTP between the technologies. Secondly, building on findings from the diffusion-of-innovation literature, the study aims to investigate home owners' perceptions of product characteristics and their influence on WTP, providing valuable information for policy makers and marketers aiming to promote the uptake of microgeneration effectively.

The rest of this study is structured as follows. In the next section we discuss previous studies around WTP for green energy and microgeneration technologies and highlight some of their shortcomings. We then discuss WTP in the diffusion-of-innovation framework to identify antecedents of WTP and to formulate testable hypotheses. Next the survey methodology, which was applied to estimate empirically Irish home owners' WTP and test the respective hypotheses, is explained. We discuss the measurement of WTP and its underlying antecedents. This is followed by the results section, showing overall WTP for four microgeneration technologies and evaluating the influence of perceptions of product characteristics, normative influence and sociodemographic factors. Finally we discuss how policy makers can use this knowledge to promote microgeneration, increase consumers' WTP and thus reduce the costs of public policy.

2 Literature

Numerous studies in the area of renewable energy and microgeneration have tried to estimate consumers' willingness to pay for green electricity or microgeneration technologies and to evaluate consumers' underlying motivations and perceived barriers via contingent valuation methods or choice experiments. In regard to green energy, Hansla et al. (2008) for example evaluated Swedish households' willingness to pay for green electricity. Their results show that WTP increases with positive attitudes towards green electricity. Ek (2005) arrives at similar findings, showing that Swedish house owners have a generally positive attitude to wind power which, however, decreases with age, income and information. Similarly to these findings, Zarnikau (2003) estimated willingness to pay for electric utility investments in renewable energy and energy efficiency resources, showing that sociodemographic factors such as age, education and salary had a significant impact on WTP. Evaluating WTP for green electricity in Korea, Yoo and Kwak (2009) demonstrate that households have a positive WTP for electricity coming from a renewable source. Nomura and Akai (2004) arrived at similar results, showing that Japanese consumers have a positive WTP for green electricity and that consumers who believe in the future success of renewable energy technologies have a higher WTP than others.

Broadly in line with these findings, a WTP study conducted by Batley et al. (2000) shows that willingness to pay more for green electricity in the UK depends on people's attitudes to and their experience with green energy sources. Borchers et al. (2007) estimated a positive WTP for electricity from green energy sources in the United States. However, the results from a choice experiment suggest that WTP differs by source and that consumers prefer electricity from solar power over wind and biomass. In another choice study, Wiser (2007) explored WTP for renewable energy under collective and voluntary payment vehicles, and under government and private provision of the good. The results clearly indicate that WTP is higher under a collective payment mechanism and under private provision.

The empirical evidence around microgeneration technologies is comparatively scarce. As far as the authors are aware, only one study has evaluated house owners' WTP for microgeneration and their underlying motivations. In a choice experiment, Scarpa and Willis (2010) investigated households' WTP for microgeneration technologies (i.e. solar PV, micro wind, solar thermal, heat pumps, and biomass boilers and pellet stoves) in the UK. The relative influence of six attributes, including capital cost of the technology, house owners' energy bill, maintenance cost and inconvenience of the system, on home owners' WTP was evaluated. They further assessed differences in WTP depending on whether the respective technology was recommended by someone (e.g. friend or plumber) and different contract lengths. The results show that although microgeneration adoption is valued by households, WTP is not high enough to cover the actual capital cost of these technologies.

Whereas choice experiments provide important evidence on the utility consumers derive from product characteristics by revealing the trade-offs they are willing to make, it can be argued that this rational choice perspective fails to "incorporate the fact that individuals also utilize their emotional perspective and may choose to either ally or distance themselves to goods or services they like or dislike" (Faiers et al. 2007, p. 4386). Several studies have shown that consumers not only evaluate costs against benefits when faced with a buying decision, but are also influenced by their psychological, social and institutional environments (Spash et al. 2009). For example, studies evaluating WTP for wildlife (e.g. Ojea and Loureiro 2007) or biodiversity (e.g. Spash et al. 2009) have challenged the rational choice assumption and shown that consumers' environmental and ethical beliefs have a positive influence on their WTP.

Kimenju and De Groote (2008) estimated consumers' WTP for genetically modified (GM) food in Kenya, incorporating the influence of consumers' subjective perceptions of GM food. The findings clearly show that perceived health risks or ethical concerns have a negative influence on people's WTP. In this context we argue that subjective perceptions of product attributes as well as social influences have a significant impact on consumers' willingness to pay for microgeneration technologies and should thus be included and empirically tested.

3 Willingness to pay for microgeneration technologies

The promotion of microgeneration technologies via public policy is likely to yield positive externalities. Microgeneration can play a vital role in reducing CO_2 emissions, ease fossil fuel dependency and to stabilize energy costs (EST 2006).

The discussion above, however, has indicated that consumers are often not willing to pay for microgeneration; this poses serious challenges for policy makers aiming to stimulate the uptake of these technologies. The predominant policy support mechanism is simply to reduce costs for consumers via grants, subsidies or tax incentives (Sorrell et al. 2004). Such policies, however, can be very costly and place a heavy burden on taxpayers, and might even adversely affect public support for renewable energy. The recent debate in Germany is a good example. Local energy providers have estimated that government support for PV will cost German taxpayers about €64 billion, which translates into yearly costs of €70 per household (Frondel et al. 2010). Thus, there is a need for government to provide support for microgeneration as (cost-)efficiently as possible.

Empirical research around weatherization measures has shown that the success of subsidies or grants often depends on the way programmes are marketed and managed (Stern 1986). What makes policies effective is the extent to which campaigns manage to capture the attention of the audience, gain their involvement and overcome possible scepticism (Stern 1999).

Promoting microgeneration technologies as (cost-)efficiently as possible thus requires a thorough understanding of the consumer and the factors influencing their decision to adopt such new technologies (e.g. Hastings 2007). In the following subsections we take a closer look at consumers' adoption decisions and, in light of the empirical evidence, form testable hypotheses as to how perceptions affect house owners' WTP for microgeneration technologies.

3.1 Diffusion of innovation perspective

The discussion above has shown that microgeneration technologies provide innovative solutions for home owners to produce electricity and heat close to the source of consumption. In this study we define innovation as “an idea, practice, or object perceived as new by the individual” (Rogers 2003 [orig. pub. 1964], p. 12). The definition clearly emphasizes potential adopters’ perceptions as a key criterion for defining the newness of a product. As long as a technology is perceived as new, it can be labelled an innovation. For example, PV cells have been commercially available since the 1950s, yet most consumers would regard them as an innovative technology to produce electricity. On the other hand, the definition indirectly suggests that a technological invention in itself cannot be considered an innovation. Only when consumers become aware of a new technology (i.e. through marketing efforts) can an invention be called an innovation. In other words, “a discovery that goes no further than the laboratory remains an invention” (Garcia and Calantone 2002, p.112).

From a consumer’s perspective, the innovation decision process thus begins when an “individual (or other decision-making unit) is exposed to an innovation’s existence and gains an understanding of how it functions” (Rogers 2003 [orig. pub. 1964], p. 171). According to Rogers’ model of the innovation decision process, this first stage is referred to as the *knowledge* stage and is followed by four stages: *persuasion*, *decision*, *implementation* and *confirmation*.

Gaining awareness of an innovation generally depends on personality variables and socioeconomic characteristics such as education or age. Some consumer segments appear to be generally more open to new ideas and “often function as strategically important target groups for marketers and policy makers to stimulate the diffusion of innovations like microgeneration technologies” (Claudy et al. 2010).

Persuasion is the next stage at which consumers, once aware of the innovation, evaluate characteristics such as relative advantages, complexity or initial price. On the basis of this assessment consumers form a favourable or unfavourable attitude to the new product, which ultimately results in a high or low intention to buy or WTP for the innovation (Rogers 2003 [orig. pub. 1964], p. 174). The perception of product characteristics is likely to vary, depending on the consumer and the type of product.

Next, this subjective evaluation of product characteristics leads to a decision whether to adopt or reject the innovation. If persuaded, consumers decide "to make full use of an innovation as the best course available" (Rogers 2003 [orig. pub. 1964], p. 177). On the implementation stage, consumers then actually purchase the innovation and assess its usefulness. This assessment leads into the confirmation stage, at which consumers decide whether or not to continue using the innovation.

It is important to note that throughout the adoption-decision process, consumers can be exposed to communication in the form of information or public policy campaigns. Understanding home owners' perceptions of microgeneration technologies and how they translate into WTP is therefore an important first step in the design of policies that aim to promote the uptake of microgeneration (cost-) efficiently in consumer markets.

3.2 Perceived product characteristics

As outlined above, home owners' evaluation of product characteristics is likely to yield low or high WTP for microgeneration technologies. The most commonly used product characteristics in innovation studies are *relative advantage*, *compatibility*, *trialability*, *complexity* and *observability*. According to Rogers (2003 [orig. pub. 1964], p. 221), these attributes are likely to explain 49–87% of variation in adoption rates.

An innovation's relative advantage reflects "the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers 2003 [orig. pub. 1964], p. 15). The usefulness of this attribute in innovation studies has, however, been questioned. Tornatzky and Klein (1982), for example, argue that relative advantage can convey almost anything, from economic profitability to social benefits or time saved. They point out that “typically, [relative advantage] is the garbage pail characteristic in innovation characteristic studies into which any of a number of innovation characteristics are dumped” and conclude that “relative advantage studies lack conceptual strength, reliability, and prescriptive power” (p. 34). More recent empirical studies around green innovations tend to confirm this, showing that consumers associate various advantages with microgeneration and energy efficiency measures, including *energy cost savings* (e.g. Nyrud et al., 2008), *environmental friendliness* (e.g. Schwarz and Ernst 2008) or *independence* from conventional sources of fuel (e.g. Hübner and Felser 2001). Since energy-cost savings were provided to consumers in the subsequent WTP experiment, the focus falls on the last two constructs, and we argue that:

> $H1_a$: Perceived environmental friendliness has a positive effect on home owners' willingness to pay for microgeneration technologies.

> $H1_b$: Perceived independence has a positive effect on home owners' willingness to pay for microgeneration technologies.

The second product characteristic is compatibility, which is defined as “the degree to which an innovation is perceived as being consistent with existing values, needs, and past experiences of the potential adopter” (Rogers 2003 [orig. pub. 1964], p. 15). Berkowitz and Haines (1980), for example, found in their study that adopters of solar water heating systems associated greater compatibility with the respective technology than non-adopters. Nevertheless, compatibility has been criticized as lacking a clear definition and operational clarity, as it refers to three different dimensions: values, needs and past experiences. Karahanna et al. (2006), for example, identified 15 different conceptualizations of compatibility in the information system adoption literature alone. In their meta-review, Karahanna et al. highlight an important dimension of compatibility that is particularly relevant for microgeneration technologies: compatibility with *existing practices* or *habits and routines*. According to Tornatzky and Klein (1982, p. 33), compatibility with existing practices “suggests a more practical or operational compatibility (compatibility with what people do)”. This dimension is relevant, as heating and electricity production is usually detached from people's daily practices, and potential adopters might worry that operating a microgeneration technology would require them to change daily habits and routines. Thus, we argue that:

> H2: Perceived compatibility with habits and routines has a positive effect on home owners' willingness to pay for microgeneration technologies.

Third, complexity refers to "the degree to which an innovation is perceived as being difficult to use or understand" (Rogers 2003 [orig. pub. 1964], p. 16). Most microgeneration technologies are high-involvement products, requiring significant cognitive efforts on the part of the consumers in order to understand fully the novelty and usability of these innovations. Research has shown that in case of high-complexity products, people often value novel attributes negatively because of the anticipated high learning costs involved (e.g. Mukherjee and Hoyer 2001). Thus, complexity associated with an innovation can ultimately result in lower WTP. Labay and Kinnear (1981) for example, compared consumers' perceptions of solar energy systems and found that non-adopters perceived such systems as significantly more complex. We therefore argue that:

> H3: Perceived complexity has a negative effect on home owners' willingness to pay for microgeneration technologies.

Trialability is the fourth attribute and stands for "the degree to which an innovation may be experimented with before adoption" (Rogers 2003 [orig. pub. 1964], p. 16). For example, in their study on water-saving devices, Schwarz and Ernst (2008) found that trialability had a positive impact on people's intention to adopt these innovations. Although most microgeneration technologies are impossible to try out before buying them, some home owners might be able to see these technologies working at a neighbour's or a friend's home, allowing them to make a more informed decision. Thus:

> H4*:* Perceived trialability has a positive effect on home owners' willingness to pay for microgeneration technologies.

Observability defines "the degree to which the results of an innovation are visible and communicable to others" (Rogers 2003 [orig. pub. 1964], p. 16). The definition indirectly refers to how the innovation is perceived by other people, and it can be argued that *social approval* or *subjective norms* might be a more suitable construct. The latter reflect the perceived social influence through significant others such as friends, family or neighbours (e.g. Ajzen 1991). Their opinion about the innovation can be considered a normative influence on a person's decision to adopt a microgeneration technology. Behavior that goes against the perceived subjective norm may result in feelings of "shame and self-reproach" (Pollard et al. 1999). Home owners who experience a strong support or favourable opinion for microgeneration among their friends and families are hence more likely to have a higher WTP. Thus:

> H5: Perceived subjective norms have a positive effect on home owners' willingness to pay for microgeneration technologies.

Rogers' product characteristics, however, have often been accused of excluding some important attributes. Darley and Beniger (1981) for example, extended Rogers' scheme and suggested including the perception of *capital cost* of the innovation. Yet, since capital costs were provided to consumers in the WTP experiment alongside energy cost savings, we did not include them as an independent variable.

However, microgeneration technologies often require home owners to modify the existing infrastructure (i.e. house) significantly to fit the new technology. These hidden costs also include the level of disruption caused by potential building works and are likely to vary depending on the *compatibility* of the house (e.g. Schwarz and Ernst 2008); we therefore argue that:

> H6*:* Perceived compatibility-related costs have a negative effect on home owners' willingness to pay for microgeneration technologies.

Another well-established concept in the innovation literature is perceived risk, which refers to consumers' evaluation of the likelihood of negative outcomes associated with an innovation (Kleijnen et al. 2009, p. 347). Various studies distinguish between three main types of risk – *economic*, *functional and social risk* – that consumers have associated with innovations (e.g. Dholakia 2001; Kleijnen et al. 2009; Peter and

Lawrence 1975; Stone and Grønhaug 1993). Economic risk reflects the fear of wasting financial resources whereas functional risk refers to performance uncertainties of a new product. Finally, social risk reflects uncertainty as to how adopting the innovation might be perceived by relevant others. In the case of microgeneration, performance and financial risk are two sides of the same coin, as the performance highly determines the financial viability of the technology. In this study, perceived risk thus refers to uncertainty related to the performance (i.e. reliability) and the perceived social approval associated with the technology.

> $H7_a$: Perceived performance risk has a negative effect on home owners' willingness to pay for microgeneration technologies.

> $H7_b$: Perceived social risk has a negative effect on home owners' willingness to pay for microgeneration technologies.

Whereas consumers' subjective perceptions of product characteristics are likely to have an influence on their WTP, sociodemographic variables should not be neglected and are discussed in the following subsection.

3.3 Sociodemographic factors

Various studies have shown that certain consumer segments are more likely to adopt microgeneration technologies, renewable energy or energy efficiency measures. For example, in a housing study in Ireland, O'Doherty et al. (2008) investigated determinants of domestic ownership of energy-saving devices. Their results clearly show that the adoption of energy-efficient devices is positively influenced by age and level of income. A study by Zarnikau (2003) arrives at similar results. The study shows that the willingness to pay for electric utility investments in renewable energy is highly influenced by the respondent's age and education. In this study we therefore decided also to control for differences in WTP between sociodemographic groups, segmenting home owners by *age*, *gender*, *education*, *social class*, *type of ownership*, *household size* and *region*. Another important factor often mentioned in innovation studies is knowledge (e.g. Arkesteijn and Oerlemans 2005; Nyrud et al. 2008), which was also included in this study.[41] Further, we were interested in whether people living in different types of houses have different WTP, and thus controlled for *age*, *type* and *energy efficiency* of the dwelling.

4 Research methodology

4.1 Survey design and sample

In order to test the above hypotheses empirically, data were collected through a field survey of home owners in the Republic of Ireland. The survey and sampling frame were developed in close cooperation with the Sustainable Energy Authority of Ireland (SEAI). Thanks to substantial external funding, a professional market research company was employed to carry out the data collection from November to December 2009. After discussions with academics and representatives from the market research company, computer-assisted telephone interviews (CATI) were chosen as the most appropriate mode of data collection. A preliminary study indicated low levels of awareness for heat pumps and micro CHP among the Irish population[42] (Claudy et al. 2010) and we thus decided to focus on four microgeneration technologies: solar panels, micro wind turbines, solar water heating systems, and wood pellet boilers. Each respondent was asked about only one of the four technologies.

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[41] As true or objective knowledge is difficult to assess, we asked home owners about their *subjective knowledge*, which can be defined as "a person's perception of the amount of information about a product class stored in his or her memory" (Klerck and Sweeney 2007, p. 174).

[42] Levels of awareness based on a nationally representative survey conducted in March 2009: micro CHP = 18%; ground source heat pumps = 45%; wood pellet boilers = 58%; micro wind turbines = 66%; solar thermal heaters 75%; and solar panels = 80%.

CATI allowed us to utilize an adaptive survey design to identify the respective target population, which was *home owners in the Republic of Ireland, who are aware of the technology in question and who are partly or fully responsible for making financial decisions regarding the house they currently live in.* As discussed above, awareness is a prerequisite of persuasion, and home owners who had not seen or heard of the technology in question were not interviewed. Using a quota sampling approach, the final sample of 1012 respondents was split equally across the four technologies. The quotas were based on region, gender and age to ensure an overall approximation of the overall population and, more importantly, comparability of subsamples for each technology. Table 7.1 shows that gender, age and regional splits are reasonably similar between subsamples and the overall population.

Table 7.1: Comparison of samples with population of Irish home owners (%)

Variable		**Wood pellet boilers (*n* = 241)**	**Micro wind turbines (*n* = 234)**	**Solar panels (*n* = 227)**	**Solar water heaters (*n* = 224)**	**Population of Irish home owners**
Gender	Male	55.2	51.2	46.7	51.3	50.0
	Female	44.8	48.8	53.3	48.7	50.0
Age group*	15–24	0.8	3.0	2.6	2.2	
	25–34	18.7	20.1	12.8	16.1	20.0
	35–44	20.3	19.7	23.3	20.5	45.0
	45–59	36.9	34.6	33.0	31.7	
	60+	23.2	22.6	28.2	29.5	35.0
Region	Dublin	19.9	21.4	20.7	20.5	24.0
	Rest of Leinster	32.0	29.1	30.0	30.4	28.0
	Munster	27.4	29.5	28.2	28.1	28.0
	Connacht/Ulster	20.7	20.1	21.1	21.0	20.0

The population data for home owners in Ireland stem from the market research company's own calculations and data from the Central Statistics Office (CSO) in Ireland. The age categories for the population data are 35–54 and 55+ cannot be compared directly.

The questionnaire was split into four parts and designed following the guidelines of Arrow et al. (1993), which were developed under the US National Oceanic and

Atmospheric Administration (NOAA). Whereas the first part of the questionnaire aimed to identify the target group defined above, in the second part suitable respondents were asked about their perceptions of characteristics of the respective microgeneration technology. In the third section, respondents were asked about their WTP for the technology, using a double-bounded contingent valuation approach (see section 4.3). In the final part, respondents were asked about their sociodemographic background.

4.2 Measurement of perceptions

The perceptions of microgeneration characteristics and subjective norms discussed above were elicited by asking home owners how strongly they agreed or disagreed with 27 statements, including 21 on product characteristics and three on subjective norms. Additionally, knowledge was measured using three statements. All statements were adapted from existing measures (see Appendix 2) and formatted on a five-point Likert scale stretching from “strongly disagree” (1) to “strongly agree” (5). Knowledge was also measured on a five-point Likert scale, stretching from “very unfamiliar” (1) to “very familiar” (5). For the analysis, the scores were averaged to form an index for the respective constructs. The questions used to form the respective indices were first tested for internal reliability and all Cronbach’s α values were significantly beyond the threshold of 0.7 (Nunnally 1978). The only exception was trialability (0.68), which was however close to the threshold and therefore included in the analysis.

For relative advantage, two benefit indices were formed: environmental friendliness (EFB_I) and independence (IB_I). Perceptions of hidden costs were measured in the compatibility-related cost index (CC_I). The perceptions of complexity (C_I), trialability (T_I) and compatibility with habits and routines (HRC_I) were captured in three individual indices. Home owners’ risk perceptions were divided into risk relating to performance (PR_I) and social risk (SR_I). The perception of normative influences was captured in a subjective norms index (SN_I). Finally, knowledge (K_I) was also measured as an index.

Table 7.2 clearly shows differences in the average perception of product characteristics associated with microgeneration technologies. For example, the mean scores suggest that on average more home owners seem to perceive microgeneration technologies as environmentally friendly (EFB_I) than make them independent from conventional forms of energy (IB_I). Further, the scores indicate that home owners perceive these technologies differently. For example, the mean scores imply that compared to the other technologies, fewer people belief that wood pellet boilers are compatible with their habits and routines (HRC_I). The more interesting question, however, is how these perceptions influence home owners' WTP for the respective technologies.

Table 7.2: Descriptive statistics of consumers' perceptions of product characteristics, subjective norms and knowledge

Perceptions indices		**Wood pellet boiler (n = 253)**		**Micro wind turbine (n = 254)**		**Solar panels (n = 254)**		**Solar water heaters (n = 251)**		**Influence on WTP (H_0)**
	C'α#	**Mean score***	**SD**	**Mean Score**	**SD**	**Mean Score**	**SD**	**Mean Score**	**SD**	
Relative advantage: Environmental friendliness (EFB_I)	0.88	3.74	1.35	1.96	1.27	4.07	1.24	4.04	1.30	+
Relative advantage: Independence (IB_I)	0.84	3.43	1.41	3.69	1.34	3.44	1.37	3.61	1.34	+
Compatibility: Habits and routines (HRC_I)	0.82	3.05	1.41	3.44	1.31	3.66	1.34	3.59	1.33	+
Trialability (T_I)	0.68	2.85	1.61	2.87	1.61	3.22	1.59	2.98	1.62	+
Complexity (C_I)	0.78	2.52	1.27	2.65	1.26	2.44	1.34	2.48	1.36	–
Compatibility-related cost (CC_I)	0.83	3.11	1.50	2.66	1.38	2.92	1.46	2.95	1.45	–
Risk: Performance (PR_I)	0.83	3.39	1.33	3.25	1.25	3.17	1.28	3.21	1.29	–
Risk: Social (SR_I)	0.76	2.03	1.36	2.38	1.46	1.93	1.33	1.97	1.34	–
Subjective norms (SN_I)	0.82	2.15	1.28	2.34	1.32	2.55	1.34	2.53	1.38	+
Knowledge (K_I)	0.86	2.24	1.29	1.92	1.23	2.26	1.25	2.23	1.29	+

* All indices were measured on five-point Likert scales, stretching from "strongly disagree" (1) to "strongly agree" (5). Source: own calculations. SD = standard deviation. # Cronbach's alpha.

4.3 Measurement of willingness to pay

In order to elicit Irish home owners' WTP for microgeneration technologies, we applied a contingent valuation (CV) approach. CV is a stated preference method that generally uses information from survey data and is commonly applied to investigate the WTP for non-market goods. Revealed preference methods such as the hedonic pricing approach, on the other hand, are based on actual choice decisions that are directly observable in the market place (e.g. Louviere et al. 2000; Verhoef and Franses 2002). In theory, either method could be used to estimate the WTP for the microgeneration technologies discussed above. However, due to the small number of Irish households that have installed microgeneration technologies, applying a revealed preference method would be very difficult and stated preference methods such as CV are more feasible to estimate home owners' WTP.

In particular, in this CV study we utilized a double-bounded dichotomous choice format, which has several advantages over open-ended questions or single-bounded formats. Open-ended questions, for example, allow people to state their WTP directly and are thus easy to analyse. However, respondents often find it difficult to state their WTP for goods they are not familiar with. This can lead to extremely high or low stated WTP or non-response, which can cause spurious results (e.g. Haab and McConnell, 2003). Further, strategic behavior such as "protest votes" (i.e. zero WTP) are statistically inseparable from real zero WTP and can also lead to skewed results (Mitchel and Carson 2003).

Close-ended questions, in which respondents are asked to accept or reject a given price offer, are therefore closer to everyday buying decisions and have become the more widely used method in CV studies (e.g. Schultz and Lindsay 1990). Close-ended questions can be single-bounded, double-bounded or multi-bounded. In single-bounded format respondents are offered a single bid (i.e. one price for a specific product) in a dichotomous yes/no answer format. From a utility-maximizing perspective, respondents are expected to accept the bid provided that the price is smaller than or equal to the person's reservation price. Yet researchers have shown that single-bounded formats are often statistically inefficient and require relatively large sample sizes. Hanemann et al. (1991) thus proposed to use double-bounded formats to investigate WTP for non-market goods. Depending on whether or not a respondent accepted the first bid, a second question offers a higher or lower bid to the respondents. Several studies have shown that this approach includes more information about WTP and improves efficiency of the WTP measures, including smaller confidence intervals of mean and median WTP (e.g. Carson et al. 1986; Hanemann et al. 1991). Double-bounded approaches have also been applied to measure WTP for renewable energies (e.g. Koundouri et al. 2009; Nomura and Akai 2004). In recent studies multiple-bounded or polychotomous approaches were tested, but efficiency gains from (e.g.) a third question appear to be minuscule (Cooper and Hanemann 1995). Further, Scarpa and Bateman (1998) point out that small efficiency gains come at costs (e.g. response effects) that are likely to offset the benefits of including a third question. We therefore decided to employ a double-bounded dichotomous choice format in order to investigate Irish home owners' WTP for solar panels, micro wind turbines, solar water heaters and wood pellet boilers.

4.4 Payment vehicle

In the valuation scenario we presented home owners with actual cost figures for the respective microgeneration technologies. In the scenario we told respondents that installing the microgeneration technology on/at their house would result in average annual energy cost savings of about €500 (€200 for solar thermal collectors). Further, we pointed out that the energy produced comes from a renewable source and would thus reduce the greenhouse gas emissions of their household. Respondents were then asked if, in consideration of their household's income and expenditure, they would be willing to pay one of €2,000, €5,000, €7,000, €10,000 or €15,000. Those who answered "yes" to the first question were then presented with a next higher amount and asked if they would pay €5,000, €7,000, €10,000, €15,000 or €20,000,[43] respectively. Home owners who answered “no” were asked if they were willing to pay €1,000, €2,000, €5,000, €7,000, €10,000, respectively. In order to minimise starting point bias, respondents were randomly assigned to one of the five starting bid levels.

4.5 Empirical model

As noted above, respondents are faced with two bids, where the response to the first bid (B_i) determines the level of the second bid (i.e., B_i^u if B_i accepted; and B_i^l **if** B_i rejected). Thus, there are four possible outcomes to the WTP questionnaire: π^{yy} for accepting both bids, π^{nn} for rejecting both bids, π^{yn} for accepting the first bid and rejecting the second and π^{ny} for rejecting the first bid and accepting the second. Following Hanemann et al. (1991), the probabilities for each outcome can be denoted as:

$$\pi^{yy}(B_i, B_i^u) = 1 - G(B_i^u; \theta), \quad (1)$$

$$\pi^{nn}(B_i, B_i^l) = 1 - G(B_i^l; \theta), \quad (2)$$

$$\pi^{yn}(B_i, B_i^u) = G(B_i^u; \theta) - G(B_i; \theta), \quad (3)$$

$$\pi^{ny}(B_i, B_i^l) = G(B_i; \theta) - G(B_i^l; \theta) \quad (4)$$

where $G(B_i; \theta)$ is the cumulative normal or logistic probability distribution of the bid with the parameter vector θ . Assuming *N* respondents to the CV-questionnaire, the log-likelihood function for the responses can be written as:

$$\ln L(\theta) = \sum_{i=1}^{N} \{ d_i^{yy} \ln[1 - G(B_i^u; \theta)] \; + \; d_i^{nn} \ln[1 - G(B_i^l; \theta)] \quad (5)$$

[43] A qualitative pilot study in the form of face-to-face interviews with 20 Irish home owners had revealed a maximum WTP of €20,000.

$$+ d_i^{yn} \ln\left[G\left(B_i^u;\theta\right) - G(B_i;\theta)\right] + d_i^{ny} \ln\left[G(B_i;\theta) - G\left(B_i^l;\theta\right)\right]\Big\},$$

where d_i^{yy}, d_i^{nn}, d_i^{yn}, and d_i^{ny} are binary coded variables (e.g. if the *i*th is "yes"/"yes", $d_i^{yy} = \mathbf{1}$ and zero otherwise). The *ML* estimator for the above defined model $\hat{\theta}$ is the solution for the first order condition:

$$\partial \ln [L(\square]\hat{\theta}) \Big/ \partial \theta = \mathbf{0} \,. \qquad (6)$$

There has been much discussion about the appropriate way to model double-bounded CV settings. Econometricians have argued that a prerequisite for using interval-data models, introduced for CV-analysis by Carson et al. (1986) and Hanemann et al. (1991), is the perfect correlation of the error term $\rho = \mathbf{1}$. However, the assumption that responses to both bids follow the same true underlying valuation was questioned by Cameron and Quiggin (1994, p. 219) and empirical tests show that this assumption is in fact regularly violated (e.g. Aprahamian et al., 2007; DeShazo 2002; Ready et al. 1996).

As an alternative, econometricians have suggested to use bivariate probit models, in which a bivariate normal distribution $\Phi(B_{i1}, B_{i2}, \theta_1, \theta_2, \rho)$ is assumed, while B_{i1} and B_{i2} are the first and second bid and ρ is the correlation between the error terms (e.g. Cameron and Quiggin 1994). Several studies have compared the statistical efficiency of the more general bivariate probit model with the more restricted interval-data model and concluded that ideally both variants should be tested and the interval-data model should be applied, when ρ is sufficiently large (e.g. Alberini 1995; Haab and McConnell 2003).[44,45]

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[44] Alberini (1995) found that the results for the interval-data model are robust for values of $\rho < \mathbf{1}$.

[45] When parameters in the bivariate model are restricted to be equal and the estimated correlation coefficient is statistically indistinguishable from zero, the model turns out to be an interval-data model. When the estimated correlation coefficient is statistically significant different from zero while the parameters equal, the model is a random effects probit model (Haab and McConnell, 2002).

Following this approach, we start our statistical analysis by applying a bivariate probit model, testing for equality of the parameters across equations and, when justifiable statistically, restrict them to be equal. In order to calculate the mean and median WTP and the respective confidence intervals, we employ the method introduced by Krinsky and Robb (1986) which was found to be robust, particularly for small to medium sample sizes (e.g. Cooper 1994).

5 Results

5.1 Willingness to pay

The estimations presented in Table 7.4 were used to determine the mean and median WTP for the individual technologies, presented separately in Table 7.3. The results suggest that WTP varies significantly between the four technologies. Comparing Irish home owners' median WTP,[46] the results clearly show that WTP for solar water heater is the lowest, at about €2,380. This is not surprising, as we presented respondents in the valuation scenario with a significantly lower annual energy-cost savings figure of €200 for solar water heaters compared to €500 for the other microgeneration technologies. The median WTP for micro wind turbines, solar panels and wood pellet boilers is €5,431, €4,231 and €3,476 respectively. The real costs for microgeneration technologies are significantly higher. According to the SEAI (2010), the average costs for installing a wood pellet boiler lie between €10,000 and €16,000. Further, a 5 kWh micro wind turbine or a 3 kWh solar panel system costs between €20,000 and €25,000. Solar water heating systems can be installed for approximately €2,400–€5,000.

[46] The median WTP was chosen since the mean is more affected by outliers (i.e. high bidding values), which can give excessive weight to a few respondents with exceptionally high WTP. Some scholars have therefore argued that the median "is arguably the better predictor of what the majority of people would actually be willing to pay" (Pearce et al. 2006, p. 118)

Table 7.3: Estimated willingness to pay for microgeneration technologies

Measure	WTP	LB	UB	ASL	CI/MEAN
			Wood pellet boilers		
Mean	5380.14	4556.02	7045.61	0.0000	0.46
Median	3476.31	2843.75	4097.03	0.0000	0.36
			Micro wind turbines		
Mean	8424.49	6801.94	12839.40	0.0000	0.72
Median	5431.42	4618.97	6384.63	0.0000	0.33
			Solar panels		
Mean	6207.80	5293.44	8003.34	0.0000	0.44
Median	4230.95	3495.58	4972.38	0.0000	0.35
			Solar water heaters		
Mean	3839.11	3256.23	4920.38	0.0000	0.43
Median	2379.65	1729.57	2964.57	0.0000	0.52

Source: own calculations. Krinsky and Robb (95%) confidence intervals for WTP measures (10.000 reps); ** Achieved significance level for testing H_0: WTP ≤ 0 vs H_1: WTP > 0.

The results have two important implications. First, the estimates clearly indicate that Irish home owners' WTP for microgeneration technologies is significantly lower than actual market prices, which confirms recent findings from the UK (Scarpa and Willis 2010). The only exceptions are solar water heaters, for which WTP appears to be close to market prices. These results also confirm sales figures in Ireland, which for example show that under the Greener Home Scheme, solar water heaters are by far the most installed microgeneration technology.[47]

Second, the results suggest that home owners' WTP is not solely based on rational financial reasoning. The payment vehicle in the CV study was the same across solar panels, micro wind turbines and wood pellet boilers. We would thus expect WTP to be fairly equal across technologies, yet the figures vary significantly. Further, the monthly

[47] www.seai.ie/Grants/GreenerHomes/Scheme_Statistics (last checked April 2011)

energy cost saving for solar water heaters was only €200 (compared to €500 for the other scenarios), but surprisingly home owners are willing to pay disproportionately more for this technology. This is reflected in the average accepted payback period, which is approximately 12 years for solar water heaters and only 11, 9 and 7 years for micro wind turbines, solar panels and wood pellet boilers respectively. Again, the findings indicate that home owners' WTP is not entirely based on rational cost–benefit evaluations but is likely to be influenced by subjective perceptions of the technologies' characteristics, people's personal background and social environment.

5.2 Influence of subjective perceptions, sociodemographic factors and subjective norms

The overall results from the bi-probit model[48] are presented in Table 7.4. The estimates show that home owners perceive the four technologies very differently, (partly) explaining differences in WTP.

Regarding the perceptions of advantages (H1), the results indicate that home owners who believe that investing in microgeneration technologies will make them independent from conventional fuels and energy suppliers have a higher WTP for wood pellet boilers and solar panels. Solar water heaters, on the other hand, appear to be more associated with environmental friendliness, which also translates into higher WTP.

Perceived compatibility with habits and routines (H2) translates into a higher WTP only for wood pellet boilers. This result is not surprising, since operating a wood pellet boiler (i.e. ordering, storing and providing the fuel) requires considerable effort on the part of

[48] Following Alberini (1995), we started our analysis by applying unrestricted bivariate probit models. Because Wald tests failed to reject the hypothesis of equality of coefficients (for all models), we restricted them to be equal across equations and re-estimated the models presented in Table 5.4. The Wald Test indicates high overall significance and ρ was found to be significantly different from zero. Thus, we employed random effects probit models that were first applied to CV studies by Alberini et al. (1997).

the home owner. Solar panels or wind turbines, on the other hand, once installed do not require additional work on the part of the home owner.

Table 7.4: Estimation results: Influence of independent variables on willingness to pay

		PV panels		Solar water heaters		Wood pellet boilers		Small wind turbines	
		Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Bid	Log Bid Value	**–1.142*** **	(0.143)	**–1.022*** **	(0.142)	**–1.070*** **	(0.131)	**–1.067*** **	(0.150)
Perceptions	Environment	0.0486	(0.0813)	**0.313*** **	(0.0848)	–0.0312	(0.0960)	0.105	(0.0892)
	Independence	**0.174** **	(0.0816)	–0.00211	(0.0955)	**0.164* **	(0.0884)	0.135	(0.0896)
	Compatibility (Routines & Habits)	–0.00127	(0.0711)	–0.00300	(0.0814)	**0.217*** **	(0.0815)	–0.0267	(0.0705)
	Complexity	–0.0124	(0.0290)	0.00275	(0.0333)	–0.0302	(0.0249)	0.0113	(0.0298)
	Trialability	0.0267	(0.0574)	**0.140** **	(0.0653)	–0.0303	(0.0621)	0.0543	(0.0585)
	Compatibility Cost	–0.0191	(0.0638)	–0.0740	(0.0719)	–0.00668	(0.0571)	–9.08e–05	(0.0687)
	Performance Risk	–0.0988	(0.0710)	**–0.258** **	(0.0878)	**–0.156** **	(0.0768)	0.0729	(0.0728)
	Social Risk	0.0466	(0.0769)	0.106	(0.0863)	0.0232	(0.0818)	**–0.171** **	(0.0721)
	Social Norms	0.0968	(0.0805)	**0.309*** **	(0.0794)	**0.155** **	(0.0738)	**0.187*** **	(0.0719)
	Subjective Knowledge	0.0799	(0.0751)	0.00243	(0.0746)	0.0214	(0.0793)	**0.192** **	(0.0763)
Sociodemographic Factors	Female	–0.206	(0.178)	0.236	(0.170)	0.149	(0.186)	0.105	(0.152)
	Age	–0.00302	(0.0279)	–0.0185	(0.0238)	**–0.0506** **	(0.0248)	–0.0284	(0.0197)
	Age^2	7.41e–05	(0.00023)	8.77e–05	(0.00018)	**0.00039* **	(0.00021)	0.000182	(0.00017)
Education & income	Household Size	0.0123	(0.0657)	–0.0930	(0.0631)	–0.0797	(0.0726)	**–0.140** **	(0.0596)
	High Education	**0.611*** **	(0.225)	0.189	(0.212)	–0.0759	(0.222)	**0.364* **	(0.211)
	Medium Education	**0.446* **	(0.233)	0.162	(0.245)	0.00223	(0.228)	0.0844	(0.237)
	Upper Class	0.284	(0.259)	–0.401	(0.285)	0.353	(0.307)	0.0120	(0.262)
	Middle Class	0.202	(0.189)	**–0.437** **	(0.216)	0.242	(0.173)	0.124	(0.182)
	Owner Outright	–0.0944	(0.193)	–0.279	(0.221)	**0.457** **	(0.195)	**0.316* **	(0.184)
Housing attributes	Detached Home	0.359	(0.280)	0.371	(0.348)	0.234	(0.250)	**0.501* **	(0.301)
	Semi Detached Home	0.213	(0.254)	0.378	(0.315)	–0.0138	(0.273)	0.0868	(0.287)
	Dwelling built after 1990	**–0.523*** **	(0.193)	–0.303	(0.232)	0.159	(0.196)	0.139	(0.175)
	Dwelling built before 1931	–0.190	(0.245)	0.0722	(0.270)	–0.344	(0.359)	0.156	(0.267)
	Energy Efficiency	–0.0757	(0.0599)	–0.0228	(0.0809)	0.0523	(0.0656)	0.0182	(0.067)
	Size of Dwelling	**–0.169* **	(0.0961)	0.0949	(0.117)	–0.129	(0.121)	0.0261	(0.983)
Region	Urban	0.352	(0.241)	**0.504** **	(0.243)	**0.435* **	(0.264)	0.367	(0.267)
	Rural	**0.363* **	(0.201)	–0.0708	(0.236)	0.0867	(0.231)	**–0.353* **	(0.189)
Statistics	Constant	**8.859*** **	(1.791)	**7.002*** **	(1.509)	**9.070*** **	(1.364)	**7.806*** **	(1.596)
	ρ	0.964**	(0.379)	0.984**	(0.447)	0.862***	(0.299)	0.802**	(0.314)
	Nobs.	251		246		252		250	
	Wald χ^2 (28)	112.0***		130.5***		115.2***		110.5***	
	Log pseudo-likelihood	–255.3		–211.71		–231.8		–267.21	
	AIC	570.5		483.4		523.6		594.4	

Source: own calculations, by individuals' clustered standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The perception of social risk ($H7_b$) associated with micro wind turbines has a negative impact on home owners' WTP. This result is not surprising, since wind turbines are arguably the most visually intrusive technology and home owners might fear to upset neighbours or local residents. On the other hand, home owners who experience strong support for microgeneration technologies from significant others such as friends and family (H5) have a higher WTP for wind turbines, and also for wood pellet boilers and solar water heaters. Further, home owners who stated that they know someone that operates a solar water heater (H4) had a higher WTP, which again highlights the importance of social influences for the diffusion of microgeneration technologies.

Uncertainty related to the performance of the technology ($H7_a$) has a negative influence on WTP for solar water heaters and wood pellet boilers, yet does not affect WTP for solar panels and wind turbines. Home owners' perceptions of (potential) compatibility-related costs (H6) as well as perceived complexity (H3) appear to not influence their WTP.

The influence of sociodemographic factors is somewhat less clear. The results indicate that home owners with high to medium levels of education seem to prefer solar panels. People in urban areas have a higher WTP for solar water heaters; rural respondents have a higher WTP for solar panels and lower WTP for micro wind turbines. The latter finding is somewhat surprising, as micro wind turbines are likely to work more effectively in a rural setting. The results also show that respondents living in detached houses have a higher WTP for micro wind turbines than people living in semidetached or terraced houses. Home owners in newer and bigger dwellings appear to have a lower WTP for solar panel systems. Apart from these findings, housing characteristics had almost no significant influence on WTP.

6 Initial conclusions

The diffusion of microgeneration technologies has great potential to help Ireland in meeting its energy and emission targets and to trigger positive shifts in energy consumption patterns. Yet, despite policy efforts, the rate of adoption among home owners remains low. The findings presented in this study clearly show that a major reason for the slow uptake is home owners' WTP, which is significantly below market prices. WTP for solar water heaters, which matches current sales figures in Ireland, is the only exception.

More importantly, the results suggest that home owners' purchase or investment decisions are not entirely "rational" but are influenced by factors other than cost–benefit evaluations. Using Rogers' (2003) "innovation decision process" as a theoretical framework, our findings show that home owners' perceptions of product characteristics, social norms and sociodemographic characteristics influence and (partly) account for differences in WTP for the respective technologies. The results, however, need to be interpreted with caution, since they are based on the assumption that people have assessed the potential cost savings against the upfront investment presented to them in the CV experiment. Yet, set-up and analysis of the CV experiment provide strong reason to believe that the direction and relative size of independent variables presented in Table 7.4 provide (on aggregate) an accurate reflection of the influences of "subjective" perceptions on WTP.

In relation to annual energy cost savings, home owners are willing to pay most for solar water heaters. They perceive this technology as environmentally friendly, which translates directly into higher WTP. Further, home owners who know someone who operates a solar water system have a higher WTP. This finding indicates that word of mouth is an important vehicle to communicate the benefits of microgeneration and that positive social pressure can translate into higher WTP.

Yet social influence can also have adverse effects. In regard to micro wind turbines, home owners are clearly concerned about the reaction of neighbours and local residents (i.e. social risk). Any effort to promote micro wind power thus needs to address, for example, issues around safety and noise. Also, policy makers and marketers need to further investigate consumer preferences for visually less intrusive and thus more acceptable turbine designs (e.g. vertical versus horizontal design).

Wood pellet boilers are perceived as being difficult to operate, adversely affecting home owners' daily routines and habits. In order to increase WTP for wood pellet boilers, operational requirements could be communicated to home owners more clearly. However, wood pellet boilers are perceived by home owners as a viable alternative to conventional fuels such as oil or gas, which can be communicated as a selling point.

The same is true for solar panels. However, as with wood pellet boilers and wind turbines, initial costs are a major barrier. Any policy aiming to promote microgeneration clearly needs to tackle the high upfront investment. The gap between WTP and actual market prices is large. In this context, public policy in the form of financial incentives such as grant aid or tax incentives can be very costly and might not provide a viable support mechanism for policy makers who aim to promote the diffusion of microgeneration.

Alternative and more market-based options such as consumer finance, leasing and fee-for-service models might thus prove more feasible solutions. "These instruments aim to increase affordability for users by spreading the repayment of the capital costs over longer periods and by reducing the initial payment, and to provide a framework for private initiatives to design and offer their services" (Sustainable Energy Regulation and Policymaking for Africa 2006)[49].

However, the success of (market-based) support mechanisms depends to a large extent on how programmes are marketed and managed (Stern et al. 1986). The findings presented in this study can thus be utilized by marketers and policy makers to capture the attention of home owners more effectively, overcome their scepticism and apply positive social pressure to ultimately increase people's WTP for microgeneration.

[49] See: http://africa-toolkit.reeep.org/modules/Module19.pdf (last checked April 2011)

Chapter 8

"Most executives know that how they respond to the challenges of sustainability will profoundly affect the competitiveness – and perhaps even the survival – of their organizations"

(Lubin and Esty 2010, p.2)

1 Introduction

The development and marketing of successful new products builds on a thorough understanding of consumer needs and wants (e.g. Hauser et al. 2006). In relation to green innovation, several studies claim to detect a rapidly growing environmental concern and consumer preferences for green products (e.g. Prothero et al. 2010). Responding to and encouraging changing consumer preferences by developing and marketing green products should thus prove a vital strategy for business to realise market objectives and attain a competitive advantage.

In reality, however, many companies developing and marketing environmentally superior products are facing grave challenges. Throughout this thesis we have shown that many green innovations experience slow take-up times, delaying returns on investment or resulting in loss of profits if products fail to penetrate mainstream markets. We have further argued that a key problem in this context is the discrepancy between consumers' stated preferences for green products and their actual unwillingness to purchase (e.g. Belz and Peattie 2009).

In order to empirically investigate this common but widely under-researched phenomenon, we applied a consumer resistance perspective as our theoretical lens (e.g. Ram and Sheth 1989). Our objective was to build on recent advances in the resistance literature and (i) to empirically investigate consumer resistance in the context of green product innovation, (ii) to better understand the underlying reasons and (iii) to provide strategic recommendations for marketers and policy makers on how to overcome consumer resistance to green product innovation. In particular, we identified three areas that provided scope for further investigations, including passive resistance, active resistance and willingness to pay.

In the forthcoming sections, we first discuss the theoretical contribution of each study before outlining the managerial implications and providing strategic recommendations on how to overcome consumer resistance to microgeneration technologies. Finally, we present some avenues for taking this research further.

2 Theoretical contributions

2.1 Study I

This study addressed passive resistance in order to answer two research questions (see Chapter 3). We aimed (1) to classify passive-resistant consumers according to their sociodemographic profile and (2) to use this information to address more effectively issues around bias in the design of the subsequent survey.

The results show that awareness for the individual technologies differed significantly. More importantly, the results reveal great differences in awareness levels among consumer segments. The analysis of the sociodemographic variables indicates that age, gender, geographic location as well as exposure to mass-media channels all had a significant influence on consumers' levels of awareness. However, researchers have pointed out that sociodemographic segmentation often yields inconclusive results and appears to be largely ineffective in identifying green consumers across specific consumption contexts (e.g. Belz and Peattie 2009; Peattie 2001; Straughan and Roberts 1999). Findings presented in Study I thus need to be interpreted in the context of the Irish housing market and cannot be applied to different technologies or countries. Further, the findings cannot offer any coherent explanations for differences in awareness levels between consumers and provide scope for further research around antecedents of passive resistance.

Despite these limitations, our findings contribute to the adoption of innovation literature by highlighting two problems that can result from ignoring respondents' level of awareness. First, ignoring levels of awareness can result in (non-)response bias and clearly undermine the interpretability and generalisability of statistical results. Second, disregarding differences in the level of cognitive involvement (i.e. awareness) is inconsistent with the conventional adoption decision process and raises important questions about the validity of many adoption studies.

In regard to the first problem, research shows that (non-)awareness of the subject of inquiry can result in (non-)response bias (e.g. Van Kenhove et al. 2002). In a number of experiments Groves et al. (2004), for example, show that "persons cooperated on higher rates to surveys on topics likely of interest to them". Their findings indicate that people with an interest in the subject matter were about 40% more likely to participate in the survey. The results confirm earlier speculation that people with prior knowledge of a survey topic are more likely to favour communication about it (Groves and Cialdini 1991). This seems particularly relevant in relation to surveys on new technologies and innovation. It is manifest that certain consumer segments have an innately higher level of innovativeness and are thus more likely to have an interest participating in surveys about new products (e.g. Im et al. 2003; Rogers 2003 [orig. pub. 1964]).

Researchers should thus pay attention to these factors and identify differences between non-respondents and respondents in order to address self-selection and response bias. However, Rogelberg et al. (2003) point out that in the absence of knowledge about non-respondents, adjustment for potential bias is limited. Scholars have thus argued that the best remedy against non-response bias is to minimise non-response rates and maximise response rates (e.g. Rogelberg and Stanton 2007). However, our study illustrates that a simple pre-test of the research population can be an important indicator of the magnitude of potential non-response bias. In our case, we illustrated that bias was likely to be higher for technologies such as geothermal heat pumps or micro CHP, while the chances to experience non-response bias in relation to solar panels (PV) or micro wind were found to be relatively low. More importantly, we illustrate that some consumer segments (e.g. middle-aged men) have higher levels of awareness and are therefore more prone to self-selection. Our findings had important implications for the research design of the subsequent survey. For example, knowing that certain consumer segments had a low awareness of microgeneration, we decided to make awareness a criterion for partaking in the survey. Further, we set strict quotas to guarantee sufficient representation of low-awareness groups and used CATI over mail-surveys to further increase response rates.

In regard to the second problem, research clearly shows that prior awareness or knowledge can have a significant influence on consumers' perception of product characteristics (e.g. Bang et al. 2000). This is consistent with the innovation adoption process, which suggests that consumers move through different cognitive states (i.e. awareness, evaluation, decision etc.) when faced with a new product (Rogers 2003 [orig. pub. 1964]). So depending on consumers' levels of awareness or prior knowledge we would expect consumers to evaluate products differently (e.g. Moreau et al. 2001). Ignoring these differences in adoption of innovation surveys can result in distorted findings and poorly designed marketing strategies. Yet very few studies actually report consumer awareness levels or consider it as a moderating variable. However, one study that addresses this important issue is by Labay and Kinnear (1981). In their research they exclude consumers who are unaware of the innovation in question (i.e. solar panels) from their analysis and thus form more homogeneous segments based on an "an awareness–attitude formation–behavioural response perspective" (p. 273). Following their example, we decided to make awareness a prerequisite for consumers to participate in the second survey.

Overall our findings show that awareness has important methodological and theoretical implications for the design of adoption of innovation studies. Our discussion shows that neglecting consumers' cognitive involvement and their awareness of innovation can clearly undermine the validity of adoption studies. Further, the study's results suggest that a simple pre-test can serve as a good indicator for the potential extends of non-response bias, allowing researchers to adjust the design of their surveys accordingly.

2.2 Study II

This study aimed to answer three research questions. In particular, we aimed to (1) empirically research active resistance behaviours, (2) identify motives behind different intensities of resistance and (3) provide recommendations on how to overcome consumer resistance to green product innovation.

The theoretical contribution of Study II is twofold. First, our literature review has shown that consumers can engage in less intense/active and more intense/active resistance behaviours (i.e. postponement, rejection, opposition) when faced with a new product (Kleijnen et al. 2009). However, consumer resistance is a widely under-explored phenomenon and no study to date has measured differing resistance behaviours empirically. In our study we contribute to the resistance to innovation literature by developing, testing and validating a new measure of resistance behaviours. The design of the measure was built on a recent conceptualisation of consumer resistance behaviours by Kleijnen et al. (2009) and our scale has been shown to be a robust measurement instrument that accounts for more variance in consumers' resistance behaviours than conventional measures such as intentions to adopt or attitudes to adoption scales.

Our scale thus addresses a methodological shortcoming in survey-based innovation research. A large body of empirical research in the innovation literature has aimed to identify factors that impact on consumers' adoption decision. In the absence of market data, the majority of studies use intentions to adopt as a proxy for actual behaviour. However, research shows that stated intentions often provide an inaccurate approximation of actual purchasing behaviour. In an extensive meta-review, Sheeran (2002) highlights a significant discrepancy between stated intention and actual behaviour, adversely affecting the predictive power of adoption studies. For example, stated intention studies often find that a majority of consumers express no intention to buy a new product, classifying this group as "non-intenders" (Bemmaor 1995). Follow-up research, however, shows that often a large percentage of buyers come from the segment of non-intenders and thus account for much of the bias in stated intention surveys (Day et al. 1992). In the context of green product innovation this effect seems to be reversed, with a large number of consumers *not* following up on their intention to purchase a green product (e.g. UN 2005b). However, regardless of the direction of the effect, the result remains the same: by grouping consumers into intenders/non-intenders categories, marketers neglect heterogeneity in consumers' behavioural responses to innovation. For example, by classifying both postponing and rejecting consumers as non-intenders, marketers risk failing to notice potential target groups. The scale developed in the scope of this thesis provides a more accurate reflection of resistance behaviours by distinguishing between adoption, postponement and rejection intentions.

Further, our findings show that consumers postponing their adoption decision have different motives from consumers rejecting the idea of adoption. In other words, our analysis suggests that consumers with differing levels of resistance perceive different barriers with the respective innovation. Intention-to-adopt studies classify resistant consumers as non-intenders and thus effectively ignore differences between behavioural responses to innovation. Like Kleijnen et al. (2009) our findings show a hierarchical pattern, indicating that the *number* of barriers consumers associate with a new green product affects their decision whether to adopt, postpone or reject an innovation. Our findings also expand on the work of Ram and Sheth (1989) and show that functional and psychological barriers influence consumers' resistance behaviours.

This leads to the second contribution of this particular study. Our work feeds into the adoption of innovation literature by addressing the "pro-change bias" in the context of green product innovation (e.g. Ram 1987). As pointed out by Sääksjärvi and Morel (2010, p. 287) "studies addressing innovation adoption have tended to focus on positive aspects of innovation adoption while ignoring reasons for consumer deference toward innovations". However, as argued throughout this thesis, innovations often require consumers to accept changes and "resistance to change is a normal consumer response that has to be overcome before adoption may begin" (Laukkanen et al. 2007, p. 420). For innovating companies it is thus of critical importance to understand the changes and compromises consumers have to accept when adopting new green products and to develop marketing strategies aiming to overcome consumers' resistance.

More importantly, the discussion suggests that in many cases companies may have launched their green product offerings prematurely, hoping that consumers will accept trade-offs between environmental improvements and, for example, higher prices or lower levels of performance. Yet slow takeoff times and failure rates of many green product innovations indicate that "green" is not a selling point *per se*. For innovating companies it is thus of critical importance to understand the changes and compromises consumers associate with new green products. By focusing on the motives for consumers resisting green products, marketers can develop strategies that accelerate the diffusion of green innovations into mainstream markets. The results of this thesis indicate three key areas that companies should focus on to overcome resistance and thus reduce failure rates of green product offerings: *cost–value perceptions*, *perceived compatibility* and *social image*. Yet, as the discussion below will highlight, improving these factors often requires companies to form strategic alliances with stakeholders or even engage in "coopetition" with competitors (see section 3).

In summary, Study II has contributed a new measurement scale of consumer resistance and usefully filled the void of empirical studies in the area. Further, we have addressed the pro-change bias in innovation studies and identified important barriers that are responsible for different intensities of consumer resistance to green product innovation.

2.3 Study III

A key challenge facing companies is selling green product innovations at a competitive price. Microgeneration technologies are a prime example and upfront cost were often identified as the most important barrier to adoption (e.g. Scarpa and Willis 2010). The aim of our third study was to answer two research questions, and (1) to estimate consumers' willingness to pay for microgeneration technologies and understand how consumers' subjective perceptions influence their WTP and (2) to provide recommendations for marketers and policy makers. The study's results reveal that consumers' WTP for three out of four tested microgeneration technologies is significantly below market prices and not entirely influenced by rational cost–benefit evaluations. These findings create challenges and opportunities for marketers and policy makers.

Study III contributes to the ongoing debate in energy policy in two ways. First, our study addresses the lack of empirical evidence around WTP for microgeneration technologies. Our findings identify a significant "gap" between consumers' WTP and actual market prices, which needs to be bridged in order for microgeneration to diffuse into mainstream markets. In many countries the predominant strategy to overcome the cost barrier is to provide policy support in the form of financial incentives such as grant aid or tax-breaks (Sorrell et al. 2004). Although subsidies and environmental taxation can be effective means to correct for the externalities (e.g. CO_2 emissions) of conventional energy sources, they are often perceived as unnecessary burdens on public spending and ultimately on taxpayers. In Germany, energy providers for example estimated that government support for photovoltaic is likely to cost German taxpayers about €64 billion, which translates into annual costs of €70 per household (Frondel et al. 2010). Thus an important contribution of this study is that it quantifies the "gap" between consumer WTP and the actual market prices of microgeneration technologies, allowing policy makers and marketers to adjust support schemes and pricing strategies, ultimately helping to improve the customer value proposition.

Our second contribution lies in the application of innovation adoption theory in the domain of energy policy. Support policies in the context of microgeneration and energy-saving technologies predominantly rely on decision-making models from economics, which traditionally believe that consumers make rational choices (e.g. Claudy and O'Driscoll 2008). Microeconomic theory assumes that the so called *Homo economicus* seeks to maximise utility[50] within given budget constraints. Individuals rationally weigh up alternatives based on the evaluation of cost and benefits in relation to available information, quality or value. A decision outcome with higher utility will be consistently preferred to an alternative outcome with lower utility (Faiers et al. 2007). The basic economic model of human decision making also assumes that consumers' preferences

[50] Utility is a construct in economics that measures an individual's expressed preference for different decision alternatives.

are complete, pre-existing, invariant and transitive.[51] In general, individuals' evaluation of outcomes is assumed to be purely self-interested and instrumental.

However, in the context of energy-efficient investments several studies have argued that the rational actor model does not provide an accurate account of consumer decision making. For example, economists commonly refer to the under-utilisation of energy-efficient investments that appear cost-effective on an estimated lifecycle basis as the so-called *energy efficiency gap* (Sorrell et al. 2004). In line with orthodox economics, the energy efficiency gap suggests that consumers act rationally but that (market) barriers prevent them from doing so, adversely impacting on decisions to invest in energy efficient technologies. The model suggests that consumers might be missing sufficient information, preventing them from making rational decisions. Other factors might include regulatory or legal barriers, which can include planning permissions or complicated permitting procedures (Janssen 2004). The energy efficiency gap provides the predominant rationale for most government interventions in the residential sector and its central implications is "to improve the instrumental outcome (i.e. net benefits) of the desirable alternative and to ensure sufficient information is available for reasoning-based decisions" (Wilson and Dowlatabadi 2007).

However, besides numerous information campaigns and the provision of government loans, subsidies or tax exemptions, the uptake of microgeneration technologies remains low in many markets, indicating that the underlying normative assumptions in utility theory might not hold in reality and that external conditions are not the only determinants of decision making. Disciplines such as social psychology or marketing that are less restricted by underlying normative assumptions have provided alternative models of human decision making, taking into consideration consumers' attitudes, values or social influences (Faiers et al. 2007).

[51] It needs to be noted that *behavioural economics* has questioned these assumptions and provided alternative explanations for behavioural responses inconsistent with the rational actor model. For example, contrary to the orthodox utility model, "behavioural economists argue that the biases in human decision making need to be taken seriously if a fully explanatory account of economic organization and behaviour is to be provided, and if the predictive capability of economic models is to be improved" (Sorrell et al. 2004, p. 48).

In Study III we applied Rogers' (2003 [orig. pub. 1964]) innovation adoption decision framework in the context of microgeneration. Our study thus contributes to a growing body of literature in the energy policy domain, which has deviated from the predominant economic perspective and gravitated towards alternative explanations of human decision making to explain and encourage behavioural change. For example, the results suggest that home owners' WTP is not solely based on rational financial reasoning. The payment vehicle in the CV study was the same across solar panels, micro wind turbines and wood pellet boilers and we expected WTP to be fairly equal across technologies. Yet the results show that WTP varies significantly between technologies. Further, the results reveal that consumers' perceptions of factors such as compatibility, risk or environmental benefits differ between technologies and partly explain the differences in consumers' WTP.

In the following section we discuss the managerial implications of this research and highlight consideration for the design of policy and marketing strategies aiming to minimise consumer resistance to microgeneration technologies.

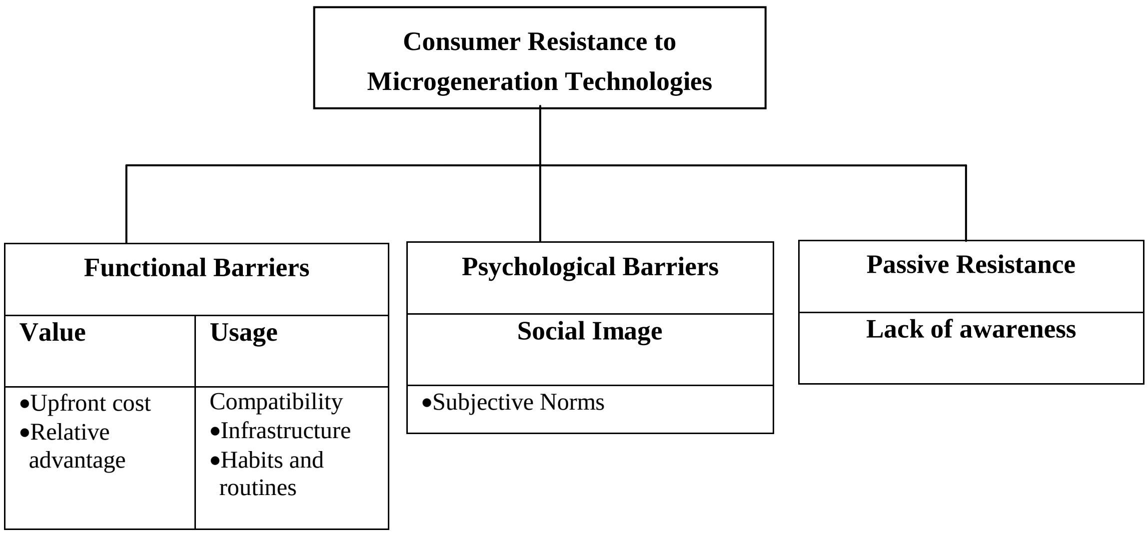
3 Managerial and policy implications

The housing sector offers one of the greatest potentials for reducing negative environmental impacts such as CO_2 emissions. Microgeneration technologies such as photovoltaic, wood pellet boilers or micro wind turbines have the potential to reduce negative externalities of energy consumption and to become an integral part of countries' national energy supply. However, these green innovations have experienced resistance from consumers, which resulted in slow diffusion in many consumer markets. Despite Ireland's plans to increase its share of renewable energies in final energy provision to 20% in 2020, a comprehensive strategy that aims to establish microgeneration as an attractive and economically viable alternative to conventional energy sources has yet to be developed. For microgeneration to diffuse into mainstream markets any such strategy needs to clearly address barriers that have led to consumer resistance and so far prevented large-scale adoption in the residential sector. In the following section we attempt to highlight some critical issues and identify potential building blocks of a comprehensive microgeneration strategy for Ireland.

Our findings suggest that four key barriers are responsible for consumer resistance to microgeneration in the research context defined above. The barriers include consumers' lack of *awareness* (i.e. passive resistance), perceived lack of *value* (i.e. price and advantage) as well as *usage* (i.e. incompatibility with infrastructure and habits and routines) and *image* (i.e. subjective norms) barriers (see Figure 8.1).

In Study I we showed that a significant number of consumers are passively resistant to green innovation, with levels of awareness reaching from 80% to as low as 18%. Further, the majority of consumers aware of the respective technologies associate significant barriers with them. The findings presented in Study II (Chapter 6) confirm that consumers' level/intensity of resistance is clearly influenced by their perceptions of functional and psychological barriers. The results show that perceived usage barriers are an important antecedent of resistance. For example, consumers who believe that an innovation is incompatible with their existing infrastructure are more likely to postpone adoption until compatibility issues have been clarified (e.g. information) or resolved (e.g. building standard). However, postponing consumers clearly saw the value of microgeneration technologies and believed that it would be compatible with their daily habits and routines. Rejecting consumers, on the other hand, could not see the advantage of microgeneration over conventional energy provision and also believed that the technologies would not fit into their daily routines. Regarding psychological barriers, we found that social image, i.e. the perceived judgement of peers, had an important influence on consumer resistance levels. Consumers who believed that their friends and family would interpret their decision to adopt a microgeneration technology favourably generally experienced lower levels of resistance. Surprisingly, we found that the perception of costs did not explain differences in the level of resistance. However, the descriptive results revealed that cost of microgeneration technologies is an equally important barrier for all consumers. In Study III (Chapter 7) we therefore focused on consumers' willingness to pay and, as expected, found that consumers' WTP for microgeneration technologies is significantly below market prices.

Figure 8.1: Motives for consumer resistance



3.1 Strategic approach

"Companies seeking competitive advantage from sustainability must match innovative green product offerings (…) with strategic execution" (Lubin and Esty 2010, p. 49). The literature suggests that managers and policy makers aiming to overcome consumers' resistance to innovative products often have to deviate from traditional marketing strategies. Kleijnen et al. (2009, p. 353), for example, argue that "scholars and practitioners should be careful about the simplistic conclusion that decreasing resistance calls for similar approaches to those used in increasing adoption". As outlined above, Garcia et al. (2007) investigated consumer resistance towards screw-cap wine closures in the US, Australia and New Zealand. Their results show that a critical success factor for the widespread acceptance of screw-caps in Australia and New Zealand was "coopetition" strategies of wineries in these regions. Coopetition meant that wineries cooperatively developed strategies aiming to change consumers' attitudes to screw-cap closures, while remaining competitors in all other areas. Further, wineries integrated important stakeholders in their strategic efforts and, for example, used wine connoisseurs as agents of change to communicate the high quality of screw-cap wines.

The respective literature suggests that coopetition and alliances with stakeholders are often strategic necessities, especially when green innovations are radical or really new products and mean significant change to consumers. Cooper (2000) for example argues that strategic planning for radically new products involves a careful analysis of environmental forces and, more importantly, requires companies to form relationships and strategic alliances with “dissimilar organisations whose fates are, basically, positively correlated” (orig. quote from: Emery and Trist (1965), p. 29). The idea of “co-evolution” or “networks and alliances” has widely diffused into management studies (e.g. Zajac 1998) and is adapted by many theories such as resource advantage theory (e.g. Hunt and Morgan 1995) or Porter’s (1985) added-value chain. Not surprisingly, stakeholder perspectives also found their way into the sustainability literature and have been referred to as “green alliances” (Crane 1998), “green stakeholders” (Fineman and Clarke 1996) or “responsible chain management” (de Bakker and Nijhof 2002). Belz and Peattie (2009, p. 141) for example argue that “a stakeholder approach encourages companies to consider the relevance of parties beyond satisfying just the wants of the consumer and the financial expectations of investors (…), and it can be important in identifying strategic opportunities and threats that arise from elsewhere”.

Table 8.1: Stakeholders in microgeneration technologies

Stakeholder Group	Parties	Interests
Consumers	Home owners	• Energy cost-savings • Minimum paybacks • Maximum benefit • Independence • Performance • Environmental issues • Social status
Political	Local, national and international governments Sustainable Energy Authority Ireland	• Job creation • Spending cuts • Getting re-elected Meeting emission targets • Meeting renewable energy targets
Utilities	ESB Airtricity Bord Gais	• Meeting emission targets • Potential new sources of revenue • Efficient use of available capacities • Technology gains
Financial Institutions	Banks, credit unions, mortgage lenders	• Potential new source of revenue • Possibility to lower households' financial burden and higher chance to recoup mortgage
Intermediaries	Architects Builders Installers	• Potential new source of revenue • Potential new contracts • Potential new jobs
Microgeneration Providers	National and international manufacturers New ventures	• Profitable production • Access to new markets • Increasing demand

In the next section we apply a stakeholder perspective to identify factors that are critical for overcoming consumer resistance toward microgeneration. We utilise Cooper's (2000) strategic planning approach for radically new products and, in light of the competitive environment (i.e. stakeholders and their interest)[52] and macro-environmental forces (i.e. political, social, behavioural, economic and technical), we draw out critical issues for overcoming consumer resistance. The discussion aims to identify factors necessary to mitigate resistance effectively and to create conditions under which microgeneration can become a viable and attractive source of energy in the Irish market.

3.2 Critical issues in overcoming consumer resistance

3.2.1 Value barrier

The empirical results clearly suggest that the majority of consumers perceive the relative advantage of microgeneration as insufficient to justify the high upfront investment. The current economic climate is likely to exacerbate the importance of the value barrier. Triggered by a (near-)collapse of the banking system and bursting of the property bubble, Ireland is facing its worst economic crisis in over 30 years. During 2009 the gross national product (GDP) declined by 7.6% and national unemployment levels rose to almost 15% (ESRI 2011). Further, household debt in Ireland is now one of the highest in Europe, most of it owed in form of personal loans (i.e. mortgages) to private financial institutions (Oireachtas 2009). Increasing oil-prices and interest rates have put additional financial pressure on many households. Given the current economic conditions, consumers are likely to be more price-conscious and unwilling to make substantial investments. However, the current economic conditions also provide opportunities, since consumers will be increasingly searching for new ways to save (energy) costs and offset rising energy prices. Thus, economic conditions and, in particular, prices for conventional energy indirectly determine the value proposition of microgeneration technologies. Yet moderate rises in energy prices alone are unlikely to result in large-scale adoption, and marketers and policy makers need to find alternative ways to reduce

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[52] In the context of the Irish microgeneration market we identified six key stakeholders: policy makers, utility companies, financial institutions, intermediaries (i.e. architects, builders, and installers) as well as providers of microgeneration technologies (Table 6.1).

cost barriers effectively and to create better customer value. This, however, requires strategic alliances between various stakeholders.

In this context, financial institutions have become an increasingly important stakeholder as they play a crucial role in the provision of credit and loans, enabling consumers to make investments. Ireland's financial crisis has led to more prudent lending policies, making it increasingly difficult for consumers and small businesses to obtain credit. At the same time, financial institutions are faced with an increasing number of households struggling to repay mortgages for properties that are often in negative equity. This situation provides both threats and opportunities. First, prudent lending policies are likely to further slow down diffusion of microgeneration and call for alternative approaches to stimulate uptake. On the other hand, it provides an opportunity for banks and mortgage lenders to offer low-interest loans for microgeneration technologies to customers struggling to repay their debt. Microgeneration could, for example, be used as a tool to help households to reduce their energy bills and thus increase the chances of repaying their mortgage. Further, microgeneration technologies can partly offset negative equity by increasing the value of the property. Irish financial institutions could adopt business models like that of ShoreBank, a US community development bank, which implemented environmental sustainability and conservation into its mission statement. ShoreBank follows the triple bottom line (Elkington 1998), giving economic, social and environmental objectives equal importance. For example, ShoreBank implemented a home owners' energy conservation loan programme, which offered consumers a free energy audit and financing for 100% of upfront costs of energy efficiency devices as well as subordinate mortgages of up to $20,000 for energy-efficient retrofits (Freehling 2009). However, a critical issue is accurate information for financial institutions to be able to predict energy savings and future cash-flows from investments into microgeneration. Without this information banks are unlikely to support households investing in microgeneration.

Arguably the most important stakeholders in relation to microgeneration technologies are national and local governments. Evidence clearly shows that political support has been a key factor for the diffusion of microgeneration technologies in countries such as

Germany, Denmark and Spain (e.g. Sijm 2002). The Irish government is committed to meet the European Commission's energy targets and to increase its share of renewable energies in final energy provision by 20% in 2020. Ireland's targets are outlined in the National Renewable Energy Action Plan, but a comprehensive strategy for the role of microgeneration in achieving these targets has yet to be developed.

A policy instrument that has proved most successful in overcoming the value barrier is the so-called renewable energy feed-in tariff (REFIT). REFITs provide consumers and businesses with access to electricity grids and guarantee a (fixed) price for the electricity produced over a specified period of time. The premium price for each kilowatt hour (kWh) of electricity produced is usually paid by regional or national utility companies, who are obliged to buy back the produced electricity. Guaranteed access to the grid and, more importantly, a guaranteed price for electricity produced allows consumers to estimate potential returns on investment, increasing the value of the technology significantly.

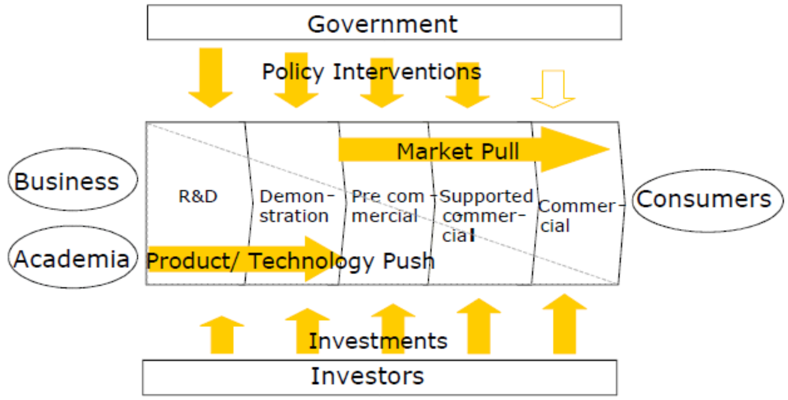
Worldwide REFITs have been introduced in more than 63 jurisdictions and were referred to by the European Commission and the International Energy Agency as the most efficient and effective instrument to promote the diffusion of renewable energy (EC 2008; IEA 2008). Evidence shows that the introduction of feed-in-tariffs also had positive economic impacts. For example, in Germany the renewable energy sector employed about 300,000 people in 2009, of which two-thirds can be attributed to the introduction of the feed-in tariff under the Renewable Energy Source Act (e.g. BMU 2010).

In 2009 the Irish Commission for Energy Regulation (CER) approved a proposal by the ESB – Ireland's main utility company – to introduce a microgeneration feed-in tariff of 9 cents per kWh for residential customers (CER 2010). This rate compares to about 45–50 cent per kWh in countries such as Spain and Germany, where REFITs have led to significant increases in the uptake of microgeneration technologies in residential markets. Raising the feed-in tariff is thus a critical issue that will be vital for overcoming the value barrier. Under the EU-wide Emissions Trading System (ETS) utilities such as the ESB are also incentivised to achieve emission reduction targets. Like in the UK, the Irish government could for example use some of its receipt from the EU emission trading scheme to subsidise the introduction of higher feed-in-tariffs. However, utilities have argued that REFITs are ineffective as they result in high costs to the consumer and are thus inefficient for reducing emissions (e.g. Radgen et al. 2011). An increase in REFITs is therefore unlikely to happen without political will (i.e. regulation and legislation), which in turn requires sufficient evidence that links REFITs to issues such as job creation and economic growth.

Other policy support mechanisms reducing the value barrier are direct financial incentives such as grants or tax incentives. The main body in Ireland directly concerned with providing grants for microgeneration technologies is the Sustainable Energy Authority Ireland (SEAI), whose mission is to transform Ireland into a society based on sustainable energy structures, technologies and practices. Its direct objective is to accelerate the development and adoption of technologies that exploit renewable energy sources, including microgeneration. The SEAI administers a number of such as the Greener Home Scheme that contribute to the initial investment costs of installing a microgeneration heating system, a worthwhile incentive in overcoming the value barrier (SEAI 2010). However, SEAI is funded by the Irish government and unless evidence clearly suggests that these schemes result in job creation and/or contribute to economic growth and recovery, financial incentives will be increasingly difficult to justify.

While the above issues all aim to reduce the upfront cost barrier, we also need to consider microgeneration’s value proposition. In this context a critical issue is technological learning curves and how quickly research and development (R&D) efforts result in “next stage” technologies (see Figure 8.2). One example is so-called “second generation photovoltaic (PV)”, which is PV technology produced on thin film, resulting in significantly lower material costs. Yet, despite reduced production costs, efficiency of these cells is, so far, below conventional PV systems. Thus, the industry is currently working on developing third-generation solar panels, which combine low material costs with high power-efficiency in order to improve the overall customer value proposition.

Figure 8.2: Stages of the innovation change



Source: Carbon Trust (2002)

How fast an innovation moves through stages of change depends on complex interactions of public (i.e. government, academia) and private (i.e. business, investors, consumers) forces in the promotion of R&D activities (Figure 8.2). Foxon et al. (2004, p. 99) for example point out that "conventional drivers of *technology push*, from R&D, and *market pull*, from customer demand, can be reinforced or inhibited by *feedbacks* between different stages and by the influence of *framework conditions*, such as government policy and availability of risk capital" [emphasis in original]. However, empirical evidence suggests that there is no single best instrument for promoting green innovation. In a comprehensive review of the effect of environmental policies on innovation, Foxon and Kemp (2008, p. 135) conclude that factors such as "longevity and consistency of policy measures and frameworks, and support for improving the innovation capabilities of industry sectors such as knowledge-sharing, may be more important to the promotion of environmental innovation than the type of instrument used". One way to achieve this is by incorporating comprehensive innovation and R&D objectives in, for example, the National Renewable Energy Action Plan.

3.2.2 Usage barrier

The study's results show that perceived usage barriers are an important antecedent of resistance. Usage as understood in this thesis refers to the perceived compatibility with existing infrastructure as well as daily habits and routines. In regard to integrating microgeneration into everyday practices, wood pellet boilers provide the greatest challenges to consumers. Ordering and storing wood pellets as well as re-fuelling the boiler require changes in daily habits and routines that many consumers might not be willing to accept. However, wood pellet boilers are not the only technology that experiences potential incompatibility issues. For example, the majority of people work during the day and might thus not utilise the full potential of technologies like solar panels or solar water heaters because of the current inability to store locally produced heat or electricity. Storage dramatically affects how microgeneration technologies can be used in domestic settings. Efficient storage facilities would allow microgeneration to advance from a supplementary source of energy towards a realistic substitute to conventional provision of energy. In this context, a critical issue for the industry is the advancement of storage technologies (i.e. batteries) that are powerful enough to store sufficient energy to overcome periods where energy from renewable sources is unavailable (for example at night time in regard to solar PV). However, in the absence of efficient storage technologies, feed-in-tariffs indirectly address this issue as produced electricity can be "stored" in the main grid. Nonetheless, as discussed above, REFITs depend on support they receive from political stakeholders. Heat on the other hand is relatively easy to store in domestic hot water tanks, partly explaining the higher popularity of technologies such as solar water heaters.

Another opportunity for microgeneration technologies to diffuse into mainstream markets is Ireland's plan to become a European leader in electrical transport. The government's aim is for 10% of vehicles to be electric by 2020 (DCENR 2010). The government further announced an offer of a €5,000 grant to consumers and, together with the ESB, plans to provide a comprehensive charging network for electric vehicles (EVs). Electric vehicles clearly offer new usage opportunities for microgeneration technologies to consumers. Providers should consider forming alliances with electric vehicles manufacturers and, for example, offer their products at discounted price together with EVs. Consumers who are willing to invest in electric vehicles are likely to be environmentally conscious and relatively affluent. More importantly, however, they will be concerned about the private costs of recharging their vehicle. Technologies such as PV or micro wind turbines are thus likely to provide an immediate use to owners of electric vehicles and indirectly address the storage issue.

Another issue in relation to compatibility with existing infrastructure is installation requirements. For example, the SEAI has launched a pilot scheme that investigates technical, market and regulatory issues in relation to installation and operation of microgeneration technologies connected to the grid (DCENR 2010). The SEAI already feeds information on installation requirements back to home owners, helping to eradicate potential misconceptions about usage barriers. However, the information is technical and complex and is primarily accessible through the SEAI website.

For this reason, key stakeholders such as architects, builders and installers (i.e. intermediaries) are critical agents of change as they have contact with home owners on a daily basis and are used to communicating technical issues to a non-technical "audience". For example, there is evidence that where housebuilders work with customers in designing energy efficient homes the consumers are more willing to embrace the technologies and change their behaviours (Heiskanen and Lovio 2010). Further, this group has a key interest in retrofitting houses with microgeneration as it provides a potential new source of revenue in times where most people are reluctant to buy or build new houses. The building sector is arguably the industry worst hit by the recession. Figures from the Central Statistics Office show that between 2009 and 2010 the value of construction output fell by more than 22% (CSO 2011). More importantly, experts indicate that due to poor demand for new homes and lack of incentives, the sector is unlikely to recover in the forthcoming years.

However, expertise of these stakeholders is of critical importance as poor advice or faulty installations can lead to negative word-of-mouth, resulting in even higher levels of resistance to microgeneration. For example, in 2009 wood-pellet boilers received some negative press coverage in relation to delayed fuel supply (i.e. wood pellets), general lack of efficiency and faulty installations (e.g. *The Irish Times*, October 12, 2009). As a result, we found that in comparison to other microgeneration technologies, significantly more consumers stated a negative attitude to wood-pellet boilers (Claudy et al. 2011b).

Industry and government should thus engage in upgrading the skill base of people in the sector by, for example, developing and providing government certified training schemes. One example is *Construction Training Services* (2011), which has specialised in providing certified training programmes on microgeneration technologies such as domestic wind, solar thermal or solar PV to people in the UK. The courses provide participants with information about the market and regulations as well as technical information about the equipment and installation and servicing requirements. Further, government should have a particular interest in offering such training courses to people out of employment, thus helping to upgrade their skills and increasing the likelihood of these people returning into the workforce.

3.2.3 Image barrier

The study's results also imply that consumers are highly receptive to social influences. Scholars have long argued that social acceptance of renewable energies is an important factor for these innovations to diffuse into mainstream markets (e.g. Sauter and Watson 2007; Wüstenhagen et al. 2007). However, it is important to distinguish between a general *socio-political acceptance* of microgeneration (Wüstenhagen et al. 2007) and a more narrow definition of *social influence*, referring to the social pressure individuals experience from members of a reference group (e.g. Kulviwat et al. 2009). A similar distinction is made in the social marketing literature, which often differentiates between consumers' immediate environment (e.g. peers, family or local community) and the wider social context (e.g. societal norms or cultural symbolism), both influencing consumers' (purchase) behaviour (e.g. Hastings 2007).

In the context of green innovation, studies have found that social acceptance of renewable energy is high in many countries, yet research also shows that this broader acceptance seldom results in purchase behaviour (e.g. UN 2005b). Social influence (or social image) as measured in this thesis refers to a person's perception of what relevant others might think about this person adopting a microgeneration technology. The evidence suggests that social pressure experienced from reference groups is likely to influence adoption decisions positively (Nyrud et al. 2008; Paladino and Baggiere 2008). Further, the research clearly showed geographic differences in people's levels of awareness. This could indicate that awareness for microgeneration develops locally through, for example, visibility of wind turbines or solar panels. Awareness precedes acceptance and marketing campaigns and public policy should thus focus on raising awareness and instigating social pressure via consumers' immediate environments. Companies could for example focus on building showcase installations in densely populated areas.

SEAI plays an important part in increasing peer pressure and contributing to a more positive social image of microgeneration. SEAI is currently involved in several initiatives such as the *Power of One Campaign* (SEAI 2011) and the *One Good Idea* schools initiative (Green Schools 2011), which both aim to raise awareness for sustainability issues. However, a campaign that is more likely to boost the social image of green technologies is the *Sustainable Energy Community* programme (SEAI 2011b), which demonstrates sustainable energy practice via exemplar communities in different parts of Ireland. These programmes clearly provide opportunities for businesses to form strategic alliances with government bodies such as SEAI and, for example, offer to install and promote their technologies in local communities. Further, business should consider installing showcase installations in strategic locations such as schools or universities and in highly populated areas, and thus boost the social image of microgeneration.

3.2.4 Awareness barrier

Finally, the study's results have clearly shown that consumer awareness of certain technologies is relatively low. Dangelico and Pujari (2010) pointed out that companies perceive the lack of consumer awareness as a key challenge, which has important implications for marketing strategy. Further, findings from the resistance literature suggest that consumers are not actively engaging in information search or are simply not paying attention to innovation because of habits and a thrive for consistency. Other research suggests that passive resistance can result from information overload (e.g. Herbig and Kramer 1994; Hirschman 1987).

Awareness campaigns thus need to balance carefully educational requirements and grabbing consumers' attention. A good example of such a campaign is the television series *My family Aren't Wasters* (RTE 2011) in which two families under the supervision of energy experts competed against each other to minimise the amount of energy they used. The format was both educational and entertaining and received very positive responses from the general public. Extending such formats to the application of green technologies such as microgeneration is likely to provide an effective way to raise awareness among wider audiences.

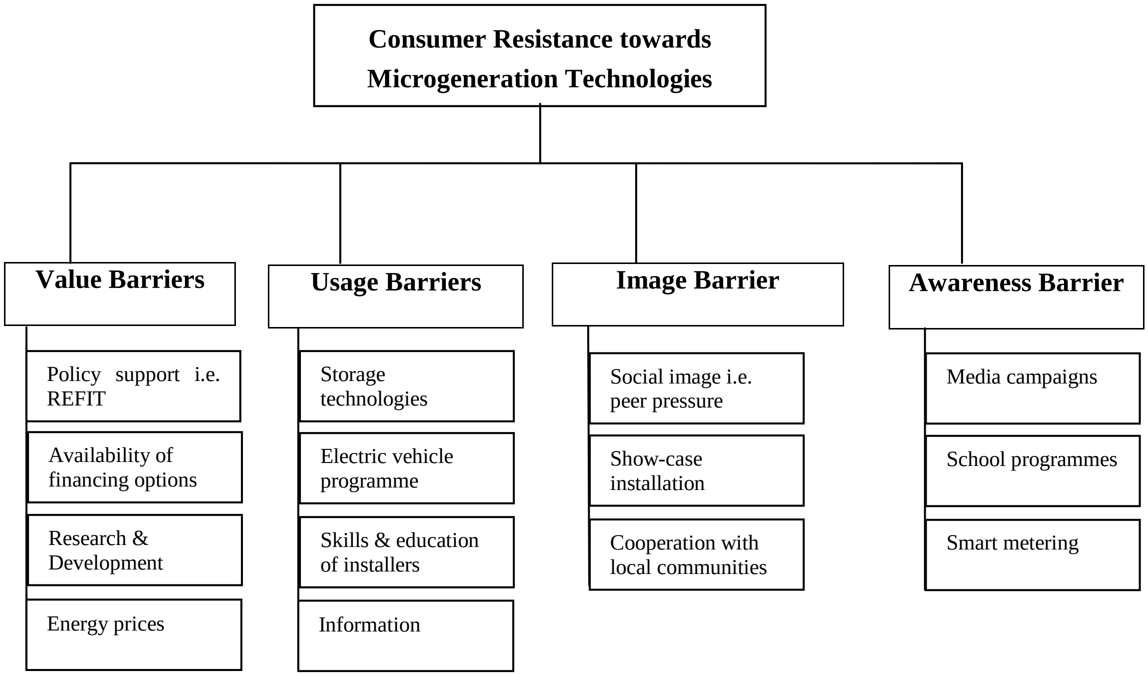
Further, our analysis indicates differences in the level of awareness between sociodemographic groups. For example, we found that men were significantly more likely to be aware of microgeneration technologies. However, as previous research shows, women are often more concerned about the environment, and increasing levels of awareness among the female population might provide leverage to promote microgeneration more effectively (Farhar 1998; Farhar and Sayigh 2000). Further, the analysis of age differences indicates that younger people in Ireland are less likely to be aware of microgeneration technologies. The *One Good Idea* school initiative (SEAI 2011) and the *Green Flag School Program* (2011) are two campaigns that raise awareness for environmental sustainability and encourage positive behavioural change among children. Again, manufacturers of microgeneration could proactively engage in these initiatives and provide technologies at discounted prices to schools in order to raise awareness and educate children about the merits of renewable energies.

Another means of raising awareness is the provision of complementary technical infrastructure such as *smart metering*. Evidence suggests that the visualisation of energy usage via smart meters resulted in a higher probability of home owners investing in energy-saving equipment (OECD 2011, p. 69). In this context, the ESB will have an important role to play in retrofitting homes with smart meters, which allow real-time recording of energy consumption and production, raising awareness for energy-saving measures and microgeneration.

3.3 Summary

In the preceding section we identified some high-level managerial implications and critical issues that marketers and policy makers need to address in order to overcome consumer resistance and accelerate the diffusion of microgeneration technologies into mainstream markets, summarised in Figure 8.3. Our findings show that the current value proposition of microgeneration technologies is not attractive to consumers. While technological advances in terms of efficiency or production costs are unlikely to be realised in the short term, providers need to form strategic alliances with important stakeholders. Critical issues are the availability of and demand for credit as well as policy support in the form of realistically priced feed-in tariffs.

Figure 8.3: Critical issues for overcoming consumer resistance



In order to overcome usage barriers, the microgeneration industry needs to advance storage solutions further, which would allow consumers to integrate microgeneration fully into their daily habits and routines. In the absence of efficient battery technologies for domestic usage, one of the most promising opportunities is the roll-out of the government's electric vehicle programme in 2012. Electric vehicles clearly offer a new and more efficient usage of microgeneration technologies and providers should consider forming strategic alliances with car manufacturers. Further, many consumers perceive microgeneration technologies as incompatible with their existing infrastructure. Information is technical and complex and installers, builders and architects serve as important agents of change for communicating the benefits and requirements of microgeneration to home owners. A critical issue is to provide certified training schemes to people in the industry. Further, evidence shows that perceived social image is an important factor in people's adoption decision. Increasing the image of microgeneration via, for example, showcase installation requires close cooperation with stakeholders such as local communities, schools or universities. In order to overcome the awareness barrier, marketers and policy makers need to develop campaigns that are both educational and entertaining. It is also important to consider the sociodemographic profile of the least aware groups and design campaigns accordingly. Again, strategic alliances with schools and universities are likely to raise awareness among the younger population who often function as important change-agents.

4 Limitations and further research

While the research presented in this thesis has advanced our understanding of consumer resistance to green product innovation, it is also subject to several limitations, providing avenues for further research.

In relation to Study I, we have highlighted differences in levels of awareness between technologies and sociodemographic groups. However, one limitation is clearly the reliance on consumers' self-reported awareness rather than objectively observed knowledge or understanding of microgeneration. Future studies could measure the level of cognitive involvement more accurately and, more importantly, investigate antecedents of passive resistance. For example, our study did not provide a coherent explanation for differences in awareness. However, research on passive resistance has argued that consumers do not engage in information-search because of habit or other factors such as information overload (Ram and Sheth 1989). Future research should thus investigate the reasons behind passive resistance. In this context, it would also be interesting to investigate how reasons for passive resistance differ between types of innovation (e.g. radical versus incremental) and different consumer segments. Findings would have important implications for innovation marketers aiming to raise awareness and stimulate interest in new products. A particularly interesting avenue for further research in the context of green innovation is so called *eco-labels*, which aim to communicate sustainability claims and thus create value for consumers. To date, most research has tried to explain which labels are recognised by consumers and/or have their confidence.

Banerjee and Solomon (2003), for example, found that the most successful labels were clear about their sustainability aspects (e.g. fair trade, carbon savings), were linked to other incentives and had government support. Other scholars investigated the factors that make consumers pay attention to eco-labels (Thogersen 2000; Verplanken and Weenig 1993).

Although research seems to suggest that eco-labels add value to a product (D'Souza et al. 2006), recent studies find that most consumers cannot easily identify greener products and do not find the current marketing for these types of products particularly relevant or engaging (Pickett-Baker and Ozaki 2008). Further, beyond a small core of green consumers, most people do not know to look for these labels, or where to look, and generally do not know what the labels mean when they do see them. The literature suggests that thorough understanding of eco-labels and their effect on raising awareness, stimulating trust and creating value is lacking in the marketing literature. Thus, further research could focus on how eco-labels might affect consumer behaviour and what types of labels will be most successful when it comes to introducing high-cost, high-involvement products like microgeneration or electric vehicles to the market.

In Study II, we showed that consumers engage in different behavioural responses to green innovation, which represent differing degrees of resistance. We thus developed and validated a scale to account for greater heterogeneity in resistance behaviours. However, one limitation of our research is that it is restricted by the chosen type of innovation. Microgeneration technologies are high-cost/high-involvement products and it would be useful to test our scale in relation to non-technical innovation such as green detergents. Thus, in order to confirm fully the external validity of our scale, we need to conduct further research with different innovations and different contexts. This would also be interesting from a managerial perspective, as one could test whether consumers' level of resistance differs between radical and incremental innovation and what explains these differences (Kleijnen et al. 2009).

Further, in our study we argued that opposition is an idiosyncratic behaviour that requires special attention elsewhere. However, future research could extend the resistance scale in order to identify and better understand motives behind consumer opposition to green innovation (e.g. Garrett 1987).

This research can also be taken forward theoretically by, for example, investigating the link between resistance behaviour (i.e. postponement, rejection, opposition) and innate consumer traits such as innovativeness (e.g. Roehrich 2004), variety seeking (e.g. McAlister and Pessemier 1982) or general resistance to change (e.g. Oreg 2003). Exploring how these personality traits influence the relationship between perceived product characteristics and behavioural responses to innovation could be a fruitful avenue for further research. In the context of green product innovation, it would also be of interest to investigate further the relationship between resistance intensities and lifestyles (e.g. Schwarz and Ernst 2008), (environmental) beliefs (e.g. Bang et al. 2000) or political orientation (e.g. Paladino and Baggiere 2008). Further, this study failed to inquire about how long consumers' planned to stay in their current house. Information about consumers' intention to stay as well as envisaged length of stay would have provided an opportunity to investigate consumers' adoption decision in the context of their personal life-stages, thus providing scope for future research.

Another area that was not sufficiently addressed in this research is the role of contextual or societal factors, like public policy, culture, institutions or the economy. For example, factors like planning permission provide a major (institutional) barrier for consumers' intending to adopt microgeneration technologies. Contextual factors differ significantly between countries, and thus provide scope for cross-national research around green innovation adoption.

Further, this study has focused primarily on functional and psychological barriers that prevent consumers from adopting microgeneration technologies. Although the chosen barriers were theoretically justified and empirically grounded in the consumption context, the symbolism of renewable energies requires a more in-depths (qualitative) analysis. For example, innovation researchers sometimes distinguish between an innovation as a material object and the idea it encapsulates (e.g. Klonglan and Coward 1970). This links into a much broader debate in consumer research and the widely held view that consumer goods are more than just material objects but play important symbolic roles in people's life (e.g. Jackson 2005). Consumers' relationships with material objects often suggest that people own more than material artifacts that purely fulfil certain functional benefits. In fact, many scholars have argued that "material commodities are important to us, not just for what they do, but for what they signify" (Jackson 2005, p.15). Thus, future research could investigate the symbolic or emotional meaning of green product innovations like microgeneration and, for example, explore their potential role as status symbols.

However, any research in this field would most likely require a more qualitative methodology. The research presented in this thesis was clearly limited by the chosen quantitative research design and in particular by the reliance on structured questionnaires. The use of closed questions made it impossible to explore certain issues in greater depths and investigate, for example, more complex aspects like the symbolic meaning of green innovations or explore adoption-decisions in the context of consumers' life-plans. The limitations of this research thus provide several avenues for more qualitative follow-up research.

5 Consumer resistance and the sustainability imperative

Moving our path of economic and social development towards a more sustainable trajectory is imperative. We argue that innovation plays an important role in reducing the negative externalities of our production and consumption activities. Green innovation can help to conserve energy and resources and to reduce or eliminate toxic agents, pollution and waste (Ottman et al. 2006). Market research also shows that an increasing number of companies have begun to improve the environmental performance of existing products and to develop and market really new or radical green innovation. According to the *Harvard Business Review*, sustainability is the new megatrend (Lubin and Esty 2010) and a key driver of technological innovation (Nidumolu et al. 2009, p. 2), providing companies with many benefits including "increased efficiency in the use of resources, return on investment, increased sales, development of new markets, improved corporate image, [and] product differentiation" (Dangelico and Pujari 2010, p. 480).

But despite growing environmental concern and consumer preferences for green products, many sustainable innovations encounter slow rates of diffusion. Market research confirms this, showing that a significant majority of consumers do not follow up on their intentions to purchase green products (e.g. UN 2005b). This has contributed to the impression that green marketing is significantly underachieving (Peattie and Crane 2005).

In seeking to explain this underperformance we contend that much innovation research has suffered from pro-change bias and focused too much on positive aspects of adoption. Our research shows that, to the majority of consumers, green is clearly not a selling point *per se* as environmental improvements often require consumers to accept trade-offs with conventional product characteristics such as price or performance. Our analysis clearly reveals that the higher the perceived barriers or trade-offs, the higher consumers' level of resistance to green innovation.

Businesses developing and marketing innovative green products need to consider consumers' mindsets and their perceptions of barriers, as failure to address both is likely to result in slow takeoff times (Garcia et al. 2007, p. 83). Thus, in circumstances where environmental improvements result in, for example, higher prices or require consumers to adopt new usage patterns, companies need to consider the implications for marketing strategy. Often, this requires forming strategic alliances with stakeholders or engaging in "coopetition" strategies with rival businesses. Both can be effective means for businesses to adapt to turbulent environments and to overcome consumers' resistance to change (Cooper 2000; Garcia et al. 2007). The sustainability imperative thus not only challenges our production and consumption activities but also the way businesses, consumers and other stakeholders interact in the marketplace.

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Appendix 1a

Information sheet for participants of exploratory study

DIT Research Project

Understanding House-Owners' Perceptions of Microgeneration Technologies

Marius Claudy, MSc, B.A – PhD Research

Research Team

Dr. Aidan O'Driscoll, Senior Lecturer, School of Marketing, DIT

Dr. Ela Krawczyk, Head of Futures Academy, DIT

Dr. Aidan Duffy, Lecturer, School of Planning, DIT

Dublin Institute of Technology and Dublin Energy Lab

The Dublin Energy Lab (DEL) is part of the Dublin Institute of Technology (DIT) and is a leader in science and engineering energy research in Ireland with an associated staff of fourteen academics, four full time researchers, fifteen full and part time PhD researchers and three MPhil researchers. DEL conducts research across a range of disciplines with key efforts organised into themes of electrical power, energy policy, low carbon buildings and solar energy. DEL's mission is to maintain its position as a foremost resource for energy related research and development in Ireland, serving the island's institutional, industrial and academic needs. This is achieved through basic and applied research collaborations closely linked with national and international targets for carbon reduction and growth of a knowledge economy.

Research Objective

DEL is conducting a survey of house owners' perceptions towards Small Scale Renewables. The aim is to gain a general understanding of Irish house owners' beliefs and level of awareness of these new technologies. Based on this first explorative study, DEL will conduct a nation wide survey of Irish house owners' views about small scale renewables. The findings will be translated into policy-recommendations that will ultimately make it easier for house-owners to invest into energy-saving devises and small scale renewables.

Small Scale Renewable Energies are new technologies that people can install in their homes for heating and electricity production. The technologies that fall under this category are:

- *Photovoltaic panels* or PV panels which are panels placed on a roof to produce electricity from sunlight
- *Solar water heaters* or solar thermal collectors which are placed on a roof to produce hot water from sunlight
- *Wood pellet boilers* which are like gas or oil boilers but burn small wood pellets
- *Heat pumps* or ground source heat pumps which heat a house using pipes buried in a garden
- *Micro CHP* which is like a gas or oil boiler but produces electricity as well as heat for a house
- *Micro wind turbines* which are small wind turbines placed on a house or in a garden to produce electricity

The Interview

This semi-structured interview aims to elicit the respondent's personal views about small scale renewables and will approximately take between 20 and 40 minutes. The interview contains about 15 open and 10 closed questions. We would like to record your answers, however, participation is completely voluntary and the interviewee can refuse to answer any question at any time.

Provisions for Confidentiality, Anonymity and Informed Consent

All times this research will follow the guidelines of the DIT Research Ethics Committee (http://www.dit.ie/research/researchethicscommittee/principles/) the official DIT body that promotes good ethical research and scholarly practice. To ensure that confidentiality, anonymity and privacy are maintained, all respondents will never be referred to by their name or any other details that makes them

identifiable. The information will purely be used in the ‘aggregate’ and names and details of respondents are only accessible by the researcher.
Interview respondents will be given the opportunity to review interview transcripts and will have the opportunity to review draft material before it is submitted for publication in any journals. Further, participants will be advised that participation is completely voluntary and they are at liberty to withdraw at any time without prejudice or negative consequences. The contact details of the researcher, his supervisor and the DIT Research Ethics Committee are included below in case further information is required.

PhD Researcher

Marius Claudy, BA (University of Erfurt), MSc (University of St Andrews), is currently pursuing his doctoral studies at the Dublin Energy Lab’s ‘Energy Policy in Domestic Building Group’. His research concerns energy efficiency behaviour of Irish house owners. His research aims to identify key barriers and motives to investments into small scale renewables. The findings will ultimately be translated into policy tools that increase the adoption of small scale renewables in domestic buildings in Ireland.
Marius has a background in Economics and Social Science with a strong focus on environmental issues. In his Master Thesis for example he evaluated health costs associated with levels of pollution stemming from urban road transport in the city of Dortmund (Germany). Before Marius joined the DIT he worked for two years as a Government Economist for the Department for Work and Pensions in London, UK.

Supervisor

Aidan O’Driscoll is founder and editor of *Irish Marketing Review*, an international refereed journal of research and practice, currently in its 18th volume. He has written numerous case studies in management and marketing as well as many journal articles and learned papers. He is co-author, with Professor J.A. Murray of Trinity College Dublin, of two books, *Strategy and Process in Marketing* (Prentice Hall, 1996) and *Managing Marketing: Concepts and Irish Cases* (2nd edition, Gill and Macmillan, 1999).
He teaches courses in strategic management and strategic marketing at undergraduate and postgraduate level and is responsible for instruction in strategic management on the faculty’s Executive MBA program. He received the A.C. Cunningham Outstanding Achievement award for service to marketing education in 1999. He is a Fellow and former council member of the Marketing Institute of Ireland.
Prior to joining DIT in 1980, he worked with a number of leading European companies and has wide experience in both consultancy and directorship roles. He is managing director of Mercury Publications Ltd., Dublin, which publishes *Irish Marketing Review* and an expanding portfolio of academic texts and monographs.

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Appendix 1b

Consent form for participants of exploratory study

DIT Research Project

Understanding House-Owners’ Perceptions of Microgeneration Technologies

Consent Form

I hereby consent that,

- I have been informed of and understand the purposes of the study.
- I have been given an opportunity to ask question.
- I understand I can withdraw at any time without prejudice.
- Any information which might potentially identify me will not be used in published material unless I agree.
- I agree to participate in the study as outline to me.

Name of Participant ______________________________

Signature and Date ______________________________

Appendix 1c

Ethical approval

Institiúid Teicneolaíochta Átha Cliath, 143-149 Bóthar Ráth Maonais, Baile Átha Cliath 6, Éire
Dublin Institute of Technology, 143-149 Rathmines Road, Dublin 6, Ireland
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OIFIG AN CEANN / HEAD OFFICE

27 April 2011

Marius Claudy
47 Joyce House East
Viking Harbour
Ushers Island
Dublin 8

Re: Your application for ethical clearance Ref. 15/09

Dear Marius,

Thank you for submitting an application for ethical clearance for your PhD research "*Towards Sustainable Housing – A Consumer's Perspective*" (Ref. 15/09) on 25th March 2009. Your application was assessed in the first instance by the DIT Research Ethics Committee at a meeting on 1st May 2009. A series of recommendations were made and were followed up over the summer of 2009. Your application was reviewed again by Chair's action in July 2009 and then again at a meeting on 10th November 2009.

Further to you providing additional information and a risk assessment form for the off-site field work involved (including a personal safety statement), the Committee granted ethical approval to your research at the meeting of 10th November 2009.

Kind regards,

Raffaella Salvante
Graduate Research School Office

Coláistí: Ealaíon & Turasóireacht | Gnó | Innealtóireachta & Timpeallacht Tógtha | Eolaíochtaí & Sláinte
Colleges: Arts & Tourism | Business | Engineering & Built Environment | Sciences & Health

Appendix 2a

List of multi-item constructs

A – List of constructs and items from study II (Chapter 6)

Construct	Items	Adapted from
Resistance measure	You intend to find out more about the benefits of installing **<*Small Wind Turbine*>** on your house in the near future	Self-developed based on Kleijnen et al. (2009)
	You can see yourself installing **<*Small Wind Turbine*>** on your house at some stage in the near future	
	If the cost of **<*Small Wind Turbine*>** dropped significantly, you would install it on your house tomorrow	
	For you personally, the benefits of installing **<*Small Wind Turbine*>** in the near future would outweigh the costs	
	If your house or roof needed renovations, you would consider installing **<*Small Wind Turbine*>** on your house	
	If the technology improves you will install **<*Small Wind Turbine*>** on your house	
Perceived relative advantage (global)	Installing **<*Small Wind Turbine*>** on your house would reduce your monthly energy bill significantly	Moore and Benbasat (1991), Schwarz and Ernst (2008)
	By installing **<*Small Wind Turbine*>** on your house you would help to improve your local environment	
	Installing **<*Small Wind Turbine*>** on your house would make you self-sufficient	
Perceived initial costs	You do not have the money to install **<*Small Wind Turbine*>** on your house	Tornatzky and Klein (1982)
	You would find it a financial strain to install **<*Small Wind Turbine*>** on your house	
	The initial cost of installing **<*Small Wind Turbine*>** on your house would be too high for you	
Perceived compatibility with infrastructure	<***Small Wind Turbine***> would not fit with the existing infrastructure of your house	Moore and Benbasat (1991), Schwarz and Ernst (2008)
	<*Small Wind Turbine*> could only be installed on your house with major additional work	
	In order to install **<*Small Wind Turbine*>** on your house, you'd have to undertake some serious renovation	
Perceived compatibility with habits & routines	To use **<*Small Wind Turbine*>** would not require significant changes in your existing daily routines	Karahanna et al. (2006)
	Using **<*Small Wind Turbine*>** would be compatible with most aspects of your domestic life	
	To use **<*Small Wind Turbine*>** you don't have to change anything you currently do at home	
Perceived complexity	**<*Small Wind Turbine*>** are very complex products	Moore and Benbasat (1991)
	<*Small Wind Turbine*> would be difficult to use	
	<*Small Wind Turbine*> require a lot of knowledge	
Perceived compatibility with values	Using **<*Small Wind Turbine*>** would be in line with your own personal values	Karahanna et al. (2006)
	Using **<*Small Wind Turbine*>** fits the way you view the world	
	Using **<*Small Wind Turbine*>** would be consistent with the way you think you should live your life	
Subjective norms	Most people who are important to you think that you should install **<*Small Wind Turbine*>** on your house	Ajzen (1991)
	Many people like you will install **<*Small Wind Turbine*>** on their houses	

	The people in your life whose opinion you value most would encourage you to install **<*Small Wind Turbine*>** on your house	
Perceived performance risk	When thinking about installing **<*Small Wind Turbine*>** on your house you would worry about how dependable and reliable they would be	Stone and Grønhaug (1993); Peter and Lawrence (1975)
	When thinking about installing **<*Small Wind Turbine*>** on your house, you would worry about how much ongoing maintenance they would require	
	When thinking about installing **<*Small Wind Turbine*>** on your house, you would be concerned that they would not provide the level of benefits you would be expecting	
Attitudes	Installing **<*Small Wind Turbine*>** on your house in the next 12 months would be very good	Ajzen (1991)
	Installing **<*Small Wind Turbine*>** on your house in the next 12 months would offer a lot of advantages	
	Installing **<*Small Wind Turbine*>** on your house in the next 12 months would add a lot of value	
Intentions	You will install **<*Small Wind Turbine*>** on your house in the next 12 months	Ajzen (1991)
	You intend to install **<*Small Wind Turbine*>** on your house in the next 12 months	

B – List of constructs and items from Study III (Chapter 7)

Construct		Question	Adapted From
Perceived relative advantages (individual)	Energy saving benefits	Installing < ***Small Wind Turbine*** > on your house would reduce your monthly energy bill significantly	Adapted from Schwarz and Ernst (2008)
		Installing <***Small Wind Turbine*** > on your house would allow you to spend more money on other things in life other than your energy bill	
		By installing <***Small Wind Turbine*** > on your house, they would eventually pay off and make a profit	
	Environmental benefits	By installing a <***Small Wind Turbine*** > on your house you would help to significantly reduce greenhouse gases	
		By installing **< *Small Wind Turbine*** > on your house you would help to improve your local environment	
	Indepdence benefits	Installing < ***Small Wind Turbine*** > on your house would make you independent from national energy providers	
		Installing < ***Small Wind Turbine*** > on your house would make you self-sufficient	
		Installing < ***Small Wind Turbine*** > on your house would reduce your dependence on oil or gas	
Perceived compatibility with habits and routines		To use **<*Small Wind Turbine*>** would not require significant changes in your existing daily routines	Karahanna et al (2006)
		Using **<*Small Wind Turbine*>** would be compatible with most aspects of your domestic life	
		To use **<*Small Wind Turbine*>** you don't have to change anything you currently do at home	
Perceived trialability		You know where you could go to satisfactorily see various types of **<*Small Wind Turbine*>** working	Moore and Benbasat (1991)
		You could draw on someone's experience who has installed **<*Small Wind Turbine*>** already	
Perceived complexity		**<*Small Wind Turbine*>** are very complex products	Moore and Benbasat (1991)
		<*Small Wind Turbine*> would be difficult to use	
		<*Small Wind Turbine*> require a lot of knowledge	
Perceived initial costs		You do not have the money to install **<*Small Wind Turbine*>** on your house	Tornatzky and Klein (1982)
		You would find it a financial strain to install **<*Small Wind Turbine*>** on your house	
		The initial cost of installing **<*Small Wind Turbine*>** on your house would be too high for you	
Perceived compatibility with		**<*Small Wind Turbine*>** could only be installed	Schwarz and Ernst

infrastructure	on your house with major additional work	(2008)
	In order to install **<*Small Wind Turbine*>** on your house, you'd have to undertake some serious renovation	
Perceived performance risk	When thinking about installing **<*Small Wind Turbine*>** on your house you would worry about how dependable and reliable they would be.....	Dholakia (2001) Stone and Grønhaug (1993); Peter and Lawrence (1975)
	When thinking about installing **<*Small Wind Turbine*>** on your house, you would worry about how much ongoing maintenance they would require	
	When thinking about installing **<*Small Wind Turbine*>** on your house, you would be concerned that they would not provide the level of benefits you would be expecting	
Perceived social risk	When thinking about installing **<*Small Wind Turbine*>** on your house, you would be concerned that your friends would think you were just being showy	Dholakia (2001) Stone and Grønhaug (1993); Peter and Lawrence (1975)
	When thinking about installing **<*Small Wind Turbine*>** on your house, you would be concerned that some people whose opinion you value would think that you were wasting money	
	When thinking about installing **<*Small Wind Turbine*>** on your house you would be worried that the local residents might not be happy	
Subjective norms	Most people who are important to you think that you should install **<*Small Wind Turbine*>** on your house	Ajzen (1991)
	Many people like you will install **<*Small Wind Turbine*>** on their houses	
	The people in your life whose opinion you value most would encourage you to install **<*Small Wind Turbine*>** on your house	
Subjective knowledge	How knowledgeable are you regarding:	Bang et al. (2000)
	The cost of **<*Small Wind Turbine*>** systems?	
	The installation requirements for **<*Small Wind Turbine*>** on your house?	
	Maintenance and servicing needs of **<*Small Wind Turbine*>** ?	

Appendix 2b

Descriptive statistics of measuring instrument

1. Perceived functional barriers

Perceived relative advantage – energy saving benefits	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
Installing a PV Panel on your house would reduce your monthly energy bill significantly.	1	5	3.91	1.116	–.718	.254	–.277	.503
Installing a PV Panel on your house would help you to keep your energy costs low.	1	5	4.12	.992	–1.026	.254	.661	.503
Installing a PV Panel on your house would cut your electricitybill.	1	5	4.20	.974	–1.236	.254	1.268	.503
Perceived relative advantage – environmental benefits								
Installing a PV Panel on your house would have a positive impact on the environment.	1	5	4.48	.974	–2.360	.254	5.539	.503
Installing a PV Panel on your house would help to significantly reduce greenhouse gases.	1	5	4.23	1.082	–1.681	.254	2.443	.503
Installing a PV Panel on your house would be a good thing for the local environment.	1	5	4.28	1.092	–1.690	.254	2.381	.503
Perceived relative advantage – independence benefits								
Installing a PV Panel on your house would make you independentfrom main energy providers.	1	5	3.33	1.366	–.250	.254	–1.217	.503
Installing a PV Panel on your house would make you self-sufficient.	1	5	3.24	1.327	–.257	.254	–1.052	.503
Installing a PV Panel on your house would reduce your dependence on foreign oil and gas.	1	5	3.93	1.216	–1.097	.254	.254	.503
Perceived compatibility with infrastructure								
PV Panels would fit with the existing infrastructure of your house.	1	5	3.39	1.347	–.379	.254	–1.014	.503
Your house is well suited for installing PV Panels.	1	5	3.50	1.392	–.549	.254	–.888	.503
PV Panels could be installed at your house without major additional work.	1	5	3.18	1.268	–.072	.254	–.949	.503
Perceived compatibility with habits & routines								
Using PV Panels would not require a change in the way you currently live in your house.	1	5	3.59	1.297	–.579	.254	–.772	.503
Using PV Panels would be compatible with most aspects of your domestic life.	1	5	3.66	1.201	–.615	.254	–.452	.503

To use PV panels you would not have to change anything you currently do at home.	1	5	3.57	1.255	–.486	.254	–.741	.503
Perceived initial costs								
You do not have the money to install PV Panels on your house.	1	6	3.79	1.402	–.764	.254	–.638	.503
You would find it a financial strain to install PV Panels on your house.	1	5	3.62	1.268	–.501	.254	–.738	.503
The initial cost of installing PV Panels on your house would be too high for you.	1	5	3.69	1.233	–.521	.254	–.634	.503

2. Perceived psychological barriers

Psychological Barriers								
Perceived functional risk	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
When installing PV Panels on your house, you would worry how reliable they would be.	1	5	3.10	1.152	–.290	.254	–.433	.503
You would be concerned that installing PV Panels on your house would not provide the benefits you expect them to.	1	5	2.86	1.223	.169	.254	–.644	.503
If you installed PV Panels on your house you would be worried that they not perform efficiently under your local weather conditions.	1	5	3.22	1.130	–.069	.254	–.654	.503
Perceived social risk								
Installing PV Panels on your house would cause you concern that your friends would think you was just being showy.	1	5	1.62	1.241	1.927	.254	2.323	.503
If you installed PV Panels on your house, you would be concerned that some people whose opinion you value would think that you was wasting money.	1	5	1.52	1.008	2.091	.254	3.770	.503
If you installed PV Panels on your house you would be worried that the local residents might disagree.	1	5	1.86	1.232	1.424	.254	1.036	.503
Perceived compatibility with values								
Using PV Panels would be in line with your personal values.	1	5	3.83	1.134	–.703	.254	–.211	.503
Using PV Panels would suit your lifestyle.	1	5	3.70	1.194	–.731	.254	–.149	.503
Using PV Panels would be consistent with the way you think you should live your life.	1	5	3.81	1.131	–.810	.254	.099	.503

Perceived subjective norms								
Most people who are important to you think that you should install PV Panels on your house.	1	5	2.08	1.192	.702	.254	–.495	.503
Many people like you will install PV Panels on their houses.	1	5	2.72	1.254	.126	.254	–.844	.503
The people in your life whose opinion you value most would encourage you to install PV Panels on your house.	1	5	2.48	1.325	.412	.254	–1.004	.503
Perceived complexity								
PV Panels are very complex products.	1	5	2.77	1.181	.091	.254	–.629	.503
PV Panels would be difficult to use.	1	5	2.29	1.173	.652	.254	–.375	.503
PV Panels require a lot of knowledge.	1	5	2.71	1.274	.297	.254	–.820	.503
Subjective knowledge								
How knowledgeable are you regarding...The cost of PV Panel Systems?	1	5	2.00	1.209	.937	.254	–.208	.503
How knowledgeable are you regarding installation requirements for PV Panels on your house?	1	5	1.87	1.062	1.135	.254	.508	.503
How knowledgeable are you regarding maintenance and servicing needs of PV Panels?	1	5	1.68	.922	1.307	.254	1.218	.503
How knowledgeable are you regarding the cost--savings that PV Panels can make over the course of a year?	1	5	2.17	1.211	.721	.254	–.415	.503

Appendix 3

Questionnaires

A – Final questionnaire Study I

Q.1 We are interested in some renewable energy technologies people can install in their homes for heating and electricity production. Have you heard of, or seen anywhere any of the following technologies? **READ OUT – ROTATE**

	Yes	**No**
'Wood pellet boilers' which are like gas or oil boilers but burn small wood pellets	1	2
'Heat pumps' or 'ground source heat pumps' which heat a house using pipes buried in a garden	1	2
'Micro CHP' which is like a gas or oil boiler but produces electricity as well as heat for a house..	1	2
'Micro wind turbines' which are small wind turbines placed on a house or in a garden to produce electricity	1	2
'Photovoltaic panels' or 'pv panels' which are panels placed on a roof to produce electricity from sunlight...........................	1	2
'Solar water heaters' or 'Solar thermal collectors' which are placed on a roof to produce hot water from sunlight	1	2

B – Final questionnaire Study II & III

I.D. No. Interviewer No.
(1–4) (5–8)

Ass. No. ______________________ **Qst. No.** ______________________

Good morning/afternoon/evening my name is ………….. and I'm calling from Ipsos mrbi. We are conducting a survey on various types of energy sources. Would you like to take part and is now a good time? It will take about 20–25 minutes and all your answers are, of course, totally confidential.

Yes 1
CONTINUE
No... 2 **CLOSE**
Refused .... 3 **CLOSE**

Q.R1 RECORD GENDER. **SINGLE CODE.**

Male.............................. 1 Female............................. 2

Q.R2 To start off with, just some questions about yourself. How old are you?

(Max 98)

Refused 99

IF 14 OR YOUNGER, ASK TO SPEAK TO ADULT AGED 15 YEARS OR OLDER IN HOUSEHOLD

ASK Q.R3 IF REFUSED IN Q.R2:

Q.R3 Can I ask you which of the following age categories do you fall into? **READ OUT. SINGLE CODE**

Under 15 .... 1 **ASK TO SPEAK TO ADULT AGED 15+**
15–24 2
25–34 3
35–44 4
45–59 5
60+ 6
Refused (DNRO) .... 7 **CLOSE**

Q.R4 Are you involved in making the financial decisions in regard to home improvements in the house that you currently live in?

Yes .... **1.CONT.**
No .... **2. ASK TO SPEAK TO PERSON WHO IS IN CHARGE OF**

Q.R5 What type of house are you currently living in? Is it a …? **READ OUT. SINGLE CODE**

Detached House / Bungalow.. 1
Semi-detached House / Bungalow 2
Terraced House (including end of terrace).. 3
Purpose-built Flat / Apartment.. 4 **CLOSE**
Flat / Apartment in a converted house (including bed sit) 5
Caravan / Mobile Home.. 6
Others.. 7

(Codes 4–7: **CLOSE**)

Q.R6 Is this house your own outright and you have finished paying mortgage, or have you purchased it and are currently paying mortgage, or are you renting it? **SINGLE CODE.**

Own outright – finished paying mortgage 1
Purchased it, and currently paying mortgage 2
Renting it .... .3 **CLOSE**
Others... .4
DK.. .5

(Codes 3–5: **CLOSE**)

Q.R7 We are interested in some renewable energy technologies people can install in their homes for heating and electricity production. Have you heard of……… **READ OUT – RANDOMISE**

		Yes	No
1.	'Wood pellet boilers' which are like gas or oil boilers but burn small wood pellets..	1	2
2.	'Small wind turbines' which are small wind turbines placed on a house or in a garden to produce electricity...	1	2
3.	'PV Panels' or 'Solar panels ', which are panels placed on a roof to produce electricity from sunlight	1	2
4.	'Solar water heaters' or 'Solar thermal collectors' which are placed on a roof to produce hot water from sunlight	1	2

IF ALL NO CLOSE SURVEY

RANDOMLY CHOOSE ONE TECHNOLOGY FROM AMONST ALL TECHOLOGIES AWARE OF – CHECK QUOTA. IF QUOTA FULL CHOOSE NEXT TECHNOLOGY AWARE OF.

Q.R8 Have you bought and installed a_________<**SHOW RANDOMLY CHOSEN TECHNOLOGY>** (WOOD PELLET BOILERS/SMALL WIND TURBINES/SOLAR PANELS /SOLAR WATER HEATERS) in the house that you currently live in?

Yes 1
REPEAT R8 FOR NEXT RANDOMLY CHOSEN TECHNOLOGY AWARE OF & CHECK QUOTA

No 2
GO TO Q.1

DK**..**3
RE**PEAT R8 FOR NEXTRANDOMLY CHOSEN TECHNOLOGY AWARE OF & CHECK QUOTA**

<u>INTERVIEWER READ OUT: THIS SURVEY IS CONDUCTED TO MEASURE PEOPLE'S OPINIONS, ATTITUDES AND BELIEFS – THERE ARE NO RIGHT OR WRONG ANSWERS.</u>

Q.1 In the first part, we are interested in people's intentions to install **<Solar panels>** on their houses. For each one please tell me if you think that this statement is likely or unlikely, using a scale from 1 to 5 where 1 means 'very unlikely and 5 means you 'very likely', or any number in between. I'll repeat that scale – 1 means 'very unlikely and 5 means you 'very likely', or any number in between.
<u>READ OUT. RANDOMISE</u>.

		Very Unlikely 1	**2**	**3**	**4**	**Very Likely 5**	**Don't Know 6**
I1	You will install **<Solar panels>** on your house in the next 12 months..	1	2	3	4	5	6
I2	You intend to install **<Solar panels>** on your house in the next 12 months..	1	2	3	4	5	6

<u>BELLVIEW SCRIPTING INSTRUCTION: IF THE AVERAGE OF THE SCORES IN Q1 (I1–I2) IS LESS THAN OR EQUAL TO 3, ASK Q.2, ELSE SKIP TO Q.3</u>

Q.2 <u>This is a very important part of the survey</u>. I am going to read out some statements people made about installing **<Solar panels>** at some stage in the future. For each one please tell me if you think that in your case this statement is likely or unlikely, using a scale from 1 to 5 where 1 means 'very unlikely and 5 means you 'very likely', or any number in between. **<u>READ OUT. RANDOMISE</u>.**

		Very Unlikely 1	**2**	**3**	**4**	**Very Likely 5**	**Don't Know 6**
R1	You intend to find out more about the benefits of installing **<Solar panels>** on your house in the near future	1	2	3	4	5	6
R 2	You can see yourself installing **<Solar panels>** on your house at some stage in the near future	1	2	3	4	5	6
R 3	If the cost of **<Solar panels>** dropped significantly, you would install them on your house tomorrow	1	2	3	4	5	6
R 4	For you personally, the benefits of installing **<Solar panels>** in the near future would outweigh the costs	1	2	3	4	5	6
R 5	If your house or roof needed renovations, you would consider installing **<Solar panels>** on your house	1	2	3	4	5	6
R 6	Installing **<Solar panels>** on your house would be a great waste of money	1	2	3	4	5	6
R 7	If the technology improves you will install **<Solar panels>** on your house.....................	1	2	3	4	5	6

ASK ALL

Q.3 Now I would like to find out about your general views about installing <Solar panels> on your house.
For the next part the scale is slightly different from what we have been using so far. As I read out each statement, please tell me if you you agree or disagree, using a scale from 1 to 5 where 1 means you 'strongly disagree' and 5 means you 'strongly agree', or any number in between. **READ OUT. ASK SECTION 'A' FOLLOWED BY SECTION 'SN' FOLLOWED BY SECTION 'PBC' – RANDOMISE ATTRIBUTES WITHIN EACH SECTION.**

		Strongly disagree 1	**2**	**3**	**4**	**Strongly agree 5**	**Don't Know 6**
A1	Installing **<Solar panels>** on your house in the next 12 months would be very good	1	2	3	4	5	6
A2	Installing **<Solar panels>** on your house in the next 12 months would offer a lot of advantages	1	2	3	4	5	6
A3	Installing **<Solar panels>** on your house in the next 12 months would add a lot of value..	1	2	3	4	5	6
SN1	Most people who are important to you think that you should install **<Solar panels>** on your house in the next 12 months...	1	2	3	4	5	6
SN3	Many people like you will install **<Solar panels>** on their houses in the next 12 months	1	2	3	4	5	6
SN4	The people in your life whose opinion you value most would encourage you to install **<Solar panels>** on your house in the next 12 months..................................	1	2	3	4	5	6
PBC1	You do not see any problems with installing **<Solar panels>** on your house in the next 12 months	1	2	3	4	5	6
PBC2	For you, installing **<Solar panels>** on your house in the next 12 months would be very easy.	1	2	3	4	5	6

Q.4 Now I would like to ask you more specific questions about some specific advantages people have associated with installing **<Solar panels>** . As I read out each statement, please tell me if you agree or disagree that this advantage will occur in your situation. So please tell me if you agree or disagree, using a scale from 1 to 5 where 1 means you 'strongly disagree' and 5 means you 'strongly agree', or any number in between. **READ OUT. RANDOMISE ATTRIBUTES**

		Strongly disagree 1	**2**	**3**	**4**	**Strongly agree 5**	**Don't Know 6**
PRA1a	Installing **<Solar panels>** on your house would reduce your monthly energy bill significantly	1	2	3	4	5	6

PRA1b	Installing <**Solar panels**> on your house would allow you to spend more money on other things in life other than your energy bill	1	2	3	4	5	6
PRA1c	By installing <**Solar panels**> on your house, they would eventually pay off and make a profit	1	2	3	4	5	6
PRA2b	By installing a <**Solar panels**> on your house you would help to significantly reduce greenhouse gases	1	2	3	4	5	6
PRA2c	By installing <**Solar panels**> on your house you would help to improve your local environment.........	1	2	3	4	5	6
PRA3a	Installing <**Solar panels**> on your house would make you independent from national energy providers............	1	2	3	4	5	6
PRA3b	Installing <**Solar panels**> on your house would make you self-sufficient .	1	2	3	4	5	6
PRA3c	Installing <**Solar panels**> on your house would reduce your dependence on oil or gas	1	2	3	4	5	6

Q.5 People have also expressed some <u>concerns</u> about installing **<Solar panels>** on their house. So in this section I would like to ask you a few questions regarding specific <u>risk</u> associated with installing **<Solar panels>** . Once again, as I read out each statement, please tell me if you agree or disagree, using a scale from 1 to 5 where 1 means you 'strongly disagree' and 5 means you 'strongly agree', or any number in between..**<u>READ OUT. RANDOMISE ATTRIBUTES</u>.**

		Strongly disagree 1	**2**	**3**	**4**	**Strongly agree 5**	**Don't Know 6**
PR1a	When thinking about installing **<Solar panels>** on your house, you would be concerned that the financial investment would <u>not</u> pay off	1	2	3	4	5	6
PR1b	When thinking about installing **<Solar panels>** on your house, the upfront investment would mean a great financial risk for you..	1	2	3	4	5	6
PR1c	When thinking about installing **<Solar panels>** on your house, you would be concerned about <u>not</u> getting your money's worth from this product............................	1	2	3	4	5	6
PR2a	When thinking about installing **<Solar panels>** on your house you would worry about how dependable and reliable they would be..	1	2	3	4	5	6
PR2b	When thinking about installing **<Solar panels>** on your house, you would worry about how much ongoing maintenance they would require	1	2	3	4	5	6
PR2c	When thinking about installing **<Solar**	1	2	3	4	5	6

	panels> on your house, you would be concerned that they would not provide the level of benefits you would be expecting...						
PR3a	When thinking about installing **<Solar panels>** on your house, you would be concerned that your friends would think you were just being showy.........................	1	2	3	4	5	6
PR3c	When thinking about installing **<Solar panels>** on your house, you would be concerned that some people whose opinion you value would think that you were wasting money	1	2	3	4	5	6
PR3b	When thinking about installing **<Solar panels>** on your house you would be worried that the local residents might not be happy	1	2	3	4	5	6
PRI1	Insulating your house would provide more benefits than installing **<Solar panels>**	1	2	3	4	5	6
PRI2	Insulating your house would make more sense financially than installing **<Solar panels>**	1	2	3	4	5	6

Q.6 We would also like to ask you a few questions about the image of **<Solar panels>** . As I read out each statement, please tell me if you agree or disagree, using a scale from 1 to 5 where 1 means you 'strongly disagree' and 5 means you 'strongly agree', or any number in between. **READ OUT. RANDOMISE ATTRIBUTES.**

		Strongly disagree 1	**2**	**3**	**4**	**Strongly agree 5**	**Don't Know 6**
IM1	Having **<Solar panels>** would be a status symbol in your local area.	1	2	3	4	5	6
IM2	Installing **<Solar panels>** on your house would improve your standing in the local area	1	2	3	4	5	6
IM3	People in your local area who've installed **<Solar panels>** on their homes have more prestige than those who don't	1	2	3	4	5	6

Q.7 We now seek your opinion regarding the installation of **<Solar panels>** and how compatible you think they are with your day-to-day life and personal values. **READ OUT. RANDOMISE ATTRIBUTES.**

		Strongly disagree 1	**2**	**3**	**4**	**Strongly agree 5**	**Don't Know 6**
COM2a	To use **<Solar panels>** would not require significant changes in your existing daily routines	1	2	3	4	5	6
COM2b	Using <**Solar panels>** would be compatible with most aspects of your domestic life............	1	2	3	4	5	6
COM2c	To use **<Solar panels>** you don't have to change anything you currently do at home	1	2	3	4	5	6

COM3a	Using **<Solar panels>** would be in line with your own personal values	1	2	3	4	5	6
COM3b	Using **<Solar panels**> fits the way you view the world..	1	2	3	4	5	6
COM3c	Using **<Solar panels>** would be consistent with the way you think you should live your life...	1	2	3	4	5	6

Q.8 In the next section, we would like to ask you about some difficulties people have stated in regard to installing **<Solar panels>** . As I read out each statement, please tell me if you agree or disagree, using a scale from 1 to 5 where 1 means you 'strongly disagree' and 5 means you 'strongly agree', or any number in between. **RANDOMISE ATTRIBUTES.**

		Strongly disagree 1	**2**	**3**	**4**	**Strongly agree 5**	**Don't Know 6**
IC1	You do not have the money to install **<Solar panels>** on your house..................................	1	2	3	4	5	6
IC2	You would find it a financial strain to install **<Solar panels>** on your house......................	1	2	3	4	5	6
IC3	The initial cost of installing **<Solar panels>** on your house would be too high for you.......	1	2	3	4	5	6
LCa	Getting sufficient information about **<Solar panels>** would take up a lot of time..............	1	2	3	4	5	6
LCb	Getting necessary information about **<Solar panels>** would take up a lot of effort............	1	2	3	4	5	6
LCc	Getting proper information about **<Solar panels>** would take up a lot of energy...........	1	2	3	4	5	6
PC1	**<Solar panels>** are very complex products ..	1	2	3	4	5	6
PC2	**<Solar panels**> would be difficult to use	1	2	3	4	5	6
PC3	**<Solar panels>** require a lot of knowledge ...	1	2	3	4	5	6
TR1	You know where you could go to satisfactorily see various types of **<Solar panels>** working	1	2	3	4	5	6
TR2	Before deciding whether to install **<Solar panels>** , you would be able to properly try them out	1	2	3	4	5	6
TR3	You could draw on someone's experience who has installed **<Solar panels>** already.....	1	2	3	4	5	6
COM1c	**<Solar panels>** would not fit with the existing infrastructure of your house..............	1	2	3	4	5	6
COM1b	**<Solar panels>** could only be installed on your house with major additional work..........	1	2	3	4	5	6
COM1d	In order to install **<Solar panels>** on your house, you'd have to undertake some serious renovation	1	2	3	4	5	6

Q.9 As we near the end of the interview, we have a few general questions in regard to the environment and the economy. As I read out each statement, please tell me if you agree or disagree, using a scale from 1 to 5 where 1 means you 'strongly disagree' and 5 means you 'strongly agree', or any number in between. **READ OUT. RANDOMISE ATTRIBUTES.**

		Strongly disagree 1	**2**	**3**	**4**	**Strongly agree 5**	**Don't Know 6**
NEP1	In the modern world natural resources are being depleted too rapidly..................	1	2	3	4	5	6
NEP2	The natural environment is fragile and needs great care	1	2	3	4	5	6
NEP3	It is very important to maintain the variety of living species in the world.......	1	2	3	4	5	6
NEP4	Modifying nature for human use seldom causes serious problems...........................	1	2	3	4	5	6
NEP5	We worry too much about the future of the environment and not enough about prices and jobs today	1	2	3	4	5	6
NEP6	People worry too much about human progress harming the environment	1	2	3	4	5	6
NEP7	In order to protect the environment Ireland needs economic growth...............	1	2	3	4	5	6

Q.10 Now I would like to know how knowledgeable you consider yourself regarding some elements of **<Solar panels>** . Here the scale is slightly different from what we have been using so far. As I read out each statement, please tell me if you are unfamiliar or familiar, using a scale from 1 to 5 where 1 means you are 'extremely unfamiliar' and 5 means you are 'extremely familiar', or any number in between.

How knowledgeable are you regarding … [**READ OUT**]? **RANDOMISE ATTRIBUTES.**

		Extremely unfamiliar 1	**2**	**3**	**4**	**Extremely familiar 5**	**Don't know 6**
K1	The cost of <**solar panel** > systems?.......	1	2	3	4	5	6
K2	The installation requirements for **<Solar panels>** on your house?...........................	1	2	3	4	5	6
K3	Maintenance and servicing needs of **<Solar panels>** ?	1	2	3	4	5	6
K4	The cost-savings that **<Solar panels>** can make over the course of a year?	1	2	3	4	5	6

Q.11 And finally, when thinking about installing **<Solar panels>** on your house, how important would be the following factors for your decision. When I read out each statement, please tell me if it is important or not important to you, using a scale from 1 to 5 where 1 means it is 'not at all important to you' and 5 means it is 'very important to you', or any number in between.

How important is … [**READ OUT**]? **<u>RANDOMISE ATTRIBUTES</u>.**

		Not at all important to me 1	**2**	**3**	**4**	**Very Important to me 5**	**Don't know 6**
IPRA1	Doing something positive for the environment..	1	2	3	4	5	6
IPRA2	Saving energy cost....................................	1	2	3	4	5	6
IPRA3	Having an independent and self-sufficient source of energy..	1	2	3	4	5	6
IPR1	The financial cost of installing **<Solar panels>** on your house	1	2	3	4	5	6
IPR2	The reliability/performance of **<Solar panels>**	1	2	3	4	5	6
IPR3c	The opinion of your neighbours................	1	2	3	4	5	6
IPR3b	What your friends think of you.................	1	2	3	4	5	6
ICOM1	The suitability of your house when installing **<Solar panels>**	1	2	3	4	5	6
ICOM2	Easy usage of **<Solar panels>**	1	2	3	4	5	6
ICOM3	A fit with your personal values and lifestyle	1	2	3	4	5	6

Q.12b **WTP 1** In this final part, I am going to present you with actual cost figure for **<Solar panels>** and we would like you to simply state if you would be willing to pay this amount for **<Solar panels>** , by answering 'yes' or 'no'.

I would like you to assume that the total cost for installing **<Solar panels>** on your house would be €**___<INITIAL CAPITAL COST>.** The annual/yearly savings in energy cost resulting from this investment would be **€500 (€200 for solar water heaters)** per year. Because the energy produced is from a renewable source, **<Solar panels>** also reduce the greenhouse gas emission of your home. In consideration of your household's income and expenditure, would you be willing to pay €**___ <INITIAL CAPITAL COST>** for **<Solar panels>**?

ENSURE THAT INITIAL CAPITAL COST IS SPLIT EQUALLY BETWEEN ALL RESPONDENTS

Number of Respondents	**Initial capital cost**	**Next Lower Cost**	**Next Higher Cost**
20%	€2,000	€1,000	€5,000
20%	€5,000	€2,000	€7,000
20%	€7,000	€5,000	€10,000
20%	€10,000	€7,000	€15,000
20%	€15,000	€10,000	€20,000

Willingness to pay at initial cost: **SINGLE CODE**

Yes ……………………………1 **ASK Q12b NEXT HIGHER COST**

No ……………..………………2 **ASK Q12b NEXT LOWER COST**

DK ……………………………3 **GO TO Q13**

IF ANSWER IS 'NO', ASK QUESTION 12b WITH NEXT LOWER VALUE. IF ANSWER IS 'YES', ASK QUESTION 12b WITH NEXT HIGHER VALUE.

Q.12b **WTP 2** Now I want you to assume that the cost for installing **<Solar panels>** on your house would be €___**<mention next higher/lower costs>**. Again, they would save you about €500 **(€200 for solar water heaters)** per year in energy costs**.** Under these circumstances, would you be willing to pay €_____ **<mention next higher/lower costs>**. for **<Solar panels>** ? **SINGLE CODE**

Yes 1
No 2
DK.. 3

Q.13 I will read out a few policies and support schemes that have been used to promote **<Solar panels>**. Please name the two policies you would find most helpful. **MAX 2 ANSWERS**

[**READ OUT AND TICK THE RELEVANT BOX**]? **RANDOMISE ATTRIBUTES.**

		Most helpful policy
PP1	Information in form of leaflets or brochures or websites	1
PP2	Grants	2
PP3	Low Cost Loans	3
PP4	Show Case Houses	4
PP5	Tax Incentives/ Subsidies	5
PP7	Payment for electricity produced..............................	6

Q.13b In 2010, in your opinion, will the Irish economy improve, or weaken, or remain the same as 2009?
SINGLE CODE

Improve 1
Weaken.. 2
Remain the same 3
Don't know (DNRO) 4

Q.14 Could I just check in which county you live? **SINGLE CODE**

Dublin	1	Kilkenny..................	10	Offaly.....................	19
Carlow....................	2	Laois........................	11	Roscommon	20
Cavan	3	Leitrim	12	Sligo.......................	21
Clare.......................	4	Limerick..................	13	Tipperary	22
Cork	5	Longford	14	Waterford..............	23
Donegal..................	6	Louth........................	15	Westmeath	24
Galway...................	7	Mayo	16	Wexford................	25
Kerry	8	Meath	17	Wicklow................	26
Kildare	9	Monaghan	18		

Q.15 Would you say you live in a...? **SINGLE CODE**

Rural area or village (<1500) 1
Town (>1500 < 10000) 2
City (>10000)... 3

Q.16 And can you tell me the occupation of the chief income earner in your household?

____

CODE SOCIAL CLASS

AB	1	C1............................	2	C2	3
DE...........................	4	F	5	Refused	6

Q.17 And can tell me your highest level of education completed? **SINGLE CODE**

No formal education 1
Primary Certificate... 2
Junior cert /Intercert /Group Cert (Lower secondary)................................. 3
Leaving Certificate (Upper secondary)... 4
Certificate/Diploma.. 5
Degree or equivalent 6

Q.18 And can you tell me the number of person in the household **SINGLE CODE**

1 1
2 2
3 3
4 4
5 5
6+ 6
Refused 7

AND JUST A COUPLE OF LAST QUESTIONS REGARDING THE HOUSE YOU CURRENTLY LIVE IN:

Q.19 Can you tell me in which decade was your house built**? INSTRUCTIONS: IF RESPONDENT IS NOT SURE, ASK FOR BEST ESTIMATE – SINGLE CODE**

Years of construction

before 1919	1
1919–1920	2
1921–1930	3
1931–1940	4
1941–1950	5
1951–1960	6
1961–1970	7
1971–1980	8
1991–2000	9
2000 and later	10
Don't know	11

Q.20 And can you tell me the number of bedrooms in the house? **SINGLE CODE**

1	1
2	2
3	3
4	4
5	5
6+	6
Refused	7

Q.21 Does your house have a central heating system? **SINGLE CODE**

Yes	1
No	2
DK	3

Q.22 Which of the following energy efficiency improvements (if any) have been implemented in your house.
READ OUT – MULTICODE

	YES	**NO**	**DK**
Attic Insulation	1	2	3
Cavity Wall Insulation	1	2	3
Other Wall Insulation	1	2	3
Cylinder Jacket	1	2	3
Double Glazing	1	2	3
Closed in Porch	1	2	3
Energy Saving Light Bulbs	1	2	3

THANK AND CLOSE INTERVIEW.

INTERVIEWER: Thank you very much for your help. As I said I am calling from Ipsos MRBI . If you would like to check on any aspect of the survey you have just completed, you can call Silke Heinzel on 01 438 9000 during office hours. Thank you.

Appendix 4

Summary statistics for resistant consumer categories

Descriptive statistics for resistant consumer categories

Perceived Barriers		Low Resistant (n=59)	Medium Resistant (n=234)	High Resistant (n=234)	F-Statistic
		Mean Values (SD)			
Functional	Relative Advantage	4.14^{a} (0.92)	4.07^{a} (0.88)	2.75^{b} (1.17)	109.15**
	Cost	3.12^{a} (1.30)	3.64^{b} (1.21)	3.36^{a} (1.52)	4.45*
	Compatibility Infrastructure#	2.14^{a} (1.15)	2.55^{b} (1.13)	3.14^{c} (1.32)	22.49**
	Compatibility Habits	3.97^{a} (1.08)	3.84^{a} (1.04)	2.79^{b} (1.26)	57.72**
	Complexity#	2.25^{a} (1.12)	2.39^{a} (1.00)	2.69^{b} (1.16)	6.41**
Psychological	Compatibility Values	4.07^{a} (1.20)	4.06^{a} (0.96)	2.77^{b} (1.35)	79.24**
	Subjective Norms	3.37^{a} (1.03)	2.91^{b} (1.02)	1.60^{c} (0.92)	137.88**
	Risk#	2.79^{a} (1.13)	3.23^{b} (1.02)	3.38^{b} (1.30)	6.053**
Age		50^{a} (16)	46^{a} (14)	56^{b} (18)	19.66**
Education		4.56 (1.15)	4.37 (1.28)	4.44 (1.31)	0.59
Social Class		3.03 (1.39)	2.97 (1.24)	3.00 (1.30)	0.07

#Items were formulated negatively

a, b, c Means with a different superscript indicate a significant difference ($p < .05$) (means are compared two at a time)

Variables were measured on a 5-point scale strongly agree (1) to strongly disagree (5).

* $p < .05$; ** $p < .01$.

In order to test for statistically significant mean differences between low, medium and high resistant consumers, a Bonferroni test was conducted to compare two groups at a time. The findings are presented in the table above and the superscripted characters indicate significant differences in the perception of barriers and personal characteristics.