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Home Owners' Attitudes, Perceptions and Willingness to Pay for Microgeneration Technologies

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Main Report

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The Survey

- Based on a large-scale survey (n = 1012), this report evaluates Irish home owners' awareness of, attitudes to and perceptions of microgeneration technologies. It also presents home owners' willingness to pay (WTP) for microgeneration technologies, including solar panels (PV),[1] solar water heaters, micro wind turbines and wood pellet boilers.

Awareness

- Awareness of microgeneration technologies varies significantly. Only 18% of the Irish population are aware of micro CHP (combined heat and power), whereas 45% have heard of ground source heat pumps, 58% of wood pellet boilers, 66% of wind turbines, 75% of solar thermal heaters and about 80% of solar panels.

- Awareness differs between socio-demographic groups. Men are generally more aware of microgeneration technologies than women. Younger and older people have a lower awareness. People with internet access are more likely to have heard about microgeneration technologies. Further, people from Leinster (excluding Dublin) and Connacht/Ulster are more aware of these technologies, indicating differences between urban and rural areas.

Willingness to Pay

- Irish home owners' WTP for solar panels, micro wind turbines and wood pellet boilers is significantly lower than actual market prices. The only exception is solar water heaters, for which WTP matches market prices. The average WTP for micro wind turbines, solar panels and wood pellet boilers is €5,169, €4,254 and €3,500 respectively. In comparison a wood boiler system would require an investment of between €10,000 and €16,000. Likewise, a 5 kWh micro wind turbine or a 3kWh solar panel system costs between €20,000 and €25,000. The WTP for a solar water heater is about €2,591; market prices are approximately €2,400–€5,000.

- The results indicate that, in light of the respective savings in energy costs, the average accepted payback period is about 13 years for solar water heaters, 10 years for micro wind turbines, 8.5 years for solar panels and 7 years for wood pellet boilers.

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- The gap between WTP and market prices is largest for solar panels (PV) and micro wind turbines. Without grant aid or a signifant drop in prices the uptake rates for these technologies are likely to remain low. Grant aid for solar water heaters, however, should be reconsidered since home owners' WTP is close to market prices for this technology.

[1] Because of the low level of familiarity with the term 'photovoltaic panels', they are referred to in this report as 'solar panels'.

- Although WTP is likely to increase with income, in this study no differences in WTP were detected between socio-demographic groups.

Attitudes and Social Pressure

- General attitudes towards solar panels, micro wind turbines and solar water heaters are very positive. Wood pellet boilers are the only exception, with more home owners claiming to have a negative attitude.

- Home owners claim to experience some social pressure to buy solar panels and solar water heaters. The study indicates that awareness as well as the (visible) diffusion of these technologies is likely to influence people's decision to invest. Showcase installations in highly populated areas can thus be a viable option to increase awareness, foster word of mouth and increase positive social pressure.

Perceptions of Product Characteristics

- The perception of benefits associated with these technologies varies significantly. Overall the level of benefits associated with wood pellet boilers is lower than with the other technologies. However, compared to the other technologies more people believe that wood pellet boilers would provide a realistic alternative to oil and gas.

- Energy cost savings appear to be the main selling point. However, the majority of home owners are sceptical about the financial viability of microgeneration technologies.

- The results indicate that home owners worry about the reliability of microgeneration technologies. In regard to micro wind turbines, home owners would also be concerned about the reaction of neighbours and local residents.

- Another barrier is the level of disruption caused by fitting the technology to the existing infrastructure (i.e. dwelling). In particular, the installation of wood pellet boilers is believed to be very disruptive.

- Whereas the majority of home owners believe that solar panels, solar thermal heaters and wind turbines would not interfere with their daily lives, significantly more people are concerned about the daily usage of wood pellet boilers.

Market Potential

- About 8% of home owners stated that they intend to install a microgeneration technology at their house in the next 12 months. Past research, however, has shown that this figure needs to be deflated and that the true proportion of home owners that will install a microgeneration technology might be closer to 2% or 3%.

- About 42% of home owners claim to be generally open to the idea of investing in microgeneration at some stage in the future.

- About 50% of homeowners state they would never buy microgeneration technology. Those people are on average older, live in households with fewer people and are less knowledgeable about microgeneration. Further, they hold negative attitudes towards microgeneration and state no experience of postive social pressure. They also seem to reject microgeneration technologies for reasons other than cost, indicating that they would find them more difficult to use and understand and to retrofit to their house.

- On average, more home owners can see themselves adopting solar panels and solar water heaters. The technology that most Irish home state they would not adopt is wood pellet boilers.

Policy Implications

- A promotional campaign aimed at increasing the uptake of microgeneration should be tailored towards the individual technology, taking account of home owners' needs and reservations. Suppliers and installers will have a key role to play in overcoming some of the negative perceptions and provide people with the right information about potential costs savings as well as installation and usage requirements.

- Because of the good visibility and relatively high levels of uptake, a relatively large number of home owners experience positive social pressure relating to solar water heaters. Social pressure is a strong driver in the diffusion of new products. Showcase installations in identified (e.g. high-income/high-density) geographic clusters can be one way to increase awareness, foster word of mouth and ultimately speed up adoption.

- Any policy needs to address the significant gap between home owners' WTP and actual market prices of microgeneration technologies. The only exceptions are solar water heaters, for which WTP matches market prices. The majority of home owners would prefer financial support such as grant aid or tax incentives. Given the large gap between WTP and real capital costs, such policies are expected to be very costly. Other policies, such as micro-loans/micro-credits that

reduce the initial capital cost for home owners and are repaid via energy-costs savings might provide (financially) more viable alternatives.

- Micro-loans lower or eliminate the high upfront investment for home owners, and repayments would be financed via monthly or annual energy savings. Further, providers of micro-loans can buy technologies in bulk, generate economies of scale and ultimately lower the prices for microgeneration.

- Renewable energy feed-in tariff (REFIT) is another policy tool that has been a suceesful driver of the diffusion of microgeneration technology in Europe. Ireland introduced REFIT for electricity produced by microgeneration technologies in 2006, yet the current price of 19 cent/kWh is not sufficient to encourage significant market development.

Introduction

This report evaluates Irish home owners' perceptions, attitudes and willingness to pay (WTP) for microgeneration technologies, including photovoltaic (solar panels),[2] solar water heaters, micro wind turbines and wood pellet boilers.

The data presented in the report stem from two large-scale surveys, both designed by Dublin Institute of Technology (DIT) and commissioned on behalf of Sustainable Energy Authority Ireland (SEAI) and DIT. The first study gathered data on Irish people's general awareness of microgeneration technologies and was conducted in March 2009. The second and main survey targeted Irish home owners in order to understand their perceptions of and attitudes to microgeneration. The survey was designed based on the findings from a series of exploratory face-to-face interviews with home owners and an extensive review of the available evidence around microgeneration. Both studies were administered by TNS MRBI via computer-assisted telephone interviews.

The report is structured as follows. Part I presents the research methodology and findings from an awareness study, discussing differences in the level of awareness between the respective microgeneration technologies and consumer segments.

Part II presents the findings from the large-scale field survey, breaking the analysis into four parts. It discusses Irish home owners' WTP for the respective microgeneration technologies and analyses differences in WTP between socioeconomic groups. The findings show significant differences in WTP between the technologies.

Part III compares home owners' attitudes and perceptions of product characteristics between the four microgeneration technologies. Part IV takes a different perspective, evaluating differences in attitudes and perceptions between three distinct groups of home owners, i.e. potential adopters, undecided and rejecters. Part V evaluates Irish home owners' intention to buy these technologies and tests the influence of some of the perceptions, attitudes and social norms that have been discussed.

[2] Because of the low level of familiarity with the term 'photovoltaic panels', they are referred to in this report as 'solar panels'.

Part I
Research Methodology

1. Study I: Awareness of Microgeneration Technologies in Ireland

This section provides an overview of the general level of awareness of microgeneration technologies in the Republic of Ireland. The study served as a starting point for designing a large-scale field survey on home owners' attitudes to and perceptions of microgeneration technologies. The following describes some of the research and key findings.

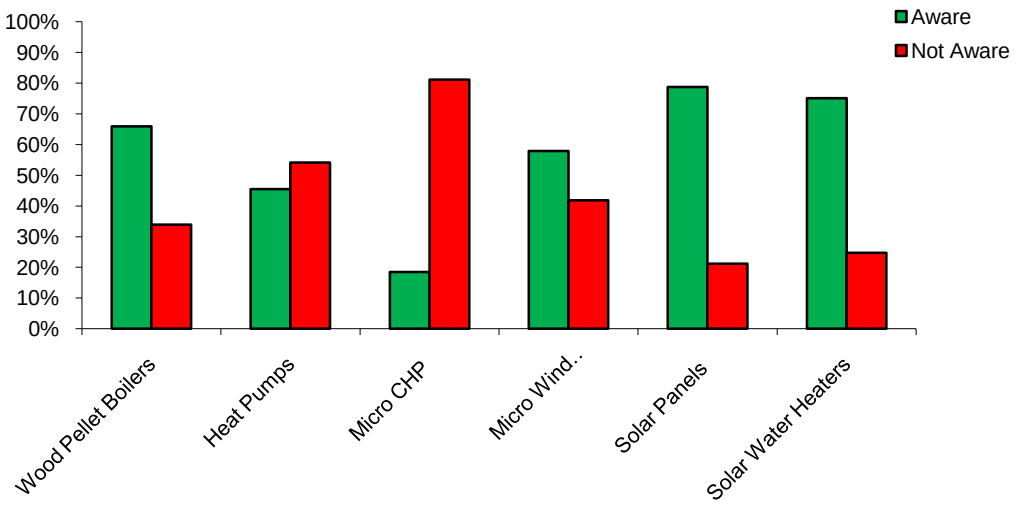
The study was commissioned by DIT and SEAI and administered by a professional market research company alongside a larger fortnightly telephone omnibus survey of the Irish adult population in March 2009. The survey accessed a fresh sample of 1012 Irish adults aged >15 years and ensured representativeness by setting strict quotas for age, gender, social class and region. Further, sample leads were generated via random digital dialling (RDD), which included 40% mobile phones.

Previously conducted face-to-face interviews 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 such as *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 socio-demographic factors including age, gender, marital status, social class, household size, geographic location and internet access.

The overall findings show that the level of awareness varies significantly between the six microgeneration technologies. Figure 1.1 shows that about 18% of the Irish population are aware of micro CHP, 45% of ground source heat pumps, 58% of wood pellet boilers, 66% of micro wind turbines, 75% of solar thermal heaters and about 80% of solar panels.

Figure 1.1: Irish Population's (%) Overall Level of Awareness for Microgeneration Technologies



Source: Own calculations

In a second step, socio-demographic variables were used to explain differences in the level of awareness among different consumer segments. Results from a logistic regression (Claudy et al., 2010) reveal the following findings:

- Men are generally more aware of microgeneration technologies than women.
- Younger and older people have a lower awareness of microgeneration technologies.
- People with internet access have higher level of awareness of microgeneration technologies.
- People living in Leinster (excluding Dublin) and Connacht/Ulster are more aware of microgeneration technologies, indicating differences between urban and rural areas.
- No significant differences were found between social classes or household sizes.[3]

Whereas the initial awareness study provides an overview of how awareness levels differ between socio-demographic subgroups, it could not offer any coherent explanations for these findings, thus providing scope for further research around people's attitudes to and willingness to pay for microgeneration.

However, awareness was a prerequisite for respondents to take part in the large-scale field study discussed below, and geothermal heat pumps and micro CHP were therefore excluded from any further analysis. The levels of awareness of these technologies were simply too low and would have increased the costs and scale of the field study disproportionately.[4] It was therefore decided to focus on the four

[3] Results for employment status are somewhat inconclusive as the findings show higher levels of awareness among the unemployed, which could be explained by the recessionary times in which the survey was conducted.
[4] Consideration should be given to raising the level of awareness of heat pumps since this is a well-established and cost-efficient microgeneration technology, which has the potential to reduce GHG emissions significantly as electricity production is

microgeneration technologies with the highest levels of awareness: solar panels, micro wind turbines, solar water heating systems and wood pellet boilers.

2. Study II: Attitudes, Perceptions and Willingness to Pay for Microgeneration

2.1. Introduction

In order to better understand Irish home owners' attitudes to and perception of microgeneration technologies as well as willingness to pay, SEAI and DIT commissioned a large-scale survey. The data were collected by TNS MRBI via computer-assisted telephone interviews between November and December 2009.

2.2. Survey Instrument

Based on an extensive screening of the available literature around microgeneration as well as findings from the exploratory study, DIT developed an extensive questionnaire to empirically evaluate Irish home owners' perceptions of and attitudes to microgeneration technologies. The questionnaire was designed so that each respondent was only asked detailed questions about one of the mentioned microgeneration technologies (i.e. solar panels or micro wind turbines or solar water heaters or wood pellet boilers).

The questionnaire was divided into four parts. The first part utilized an adaptive survey design to identify the 'right' respondents (see Section 3.3). The second part aimed to evaluate people's attitudes to microgeneration and also asked them about their perceptions of product characteristics such as costs, benefits, risks, complexity and image. In the third part, people were presented with an actual cost and savings scenario and were asked about their willingness to pay for the respective microgeneration technology. The fourth part then asked questions about the socio-demographic background of the respondent such as location, social class or number of people living in the household.

Previous face-to-face interviews had revealed that home owners were often not familiar with the technical terminology for the respective microgeneration technologies, and the following terms and explanations were used instead:

- 'wood pellet boilers', which are like gas or oil boilers but burn small wood pellets
- 'small wind turbines', which are placed on a house or in a garden to produce electricity

decarbonised. Further, it is not surprising that micro CHP has a low level of awareness since the technology is not yet fully commercialised at an individual-dwelling level and will be available only in urban areas with a natural gas supply.

- ‘PV panels’ or ‘solar 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.

2.3. Data Collection and Target Population

The data were collected via computer-assisted telephone interviews (CATI), utilizing an adaptive survey design to identify the respective target population, which was *house-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.*

2.4. Sample

Using a quota sampling approach, the final sample of 1,012 Irish home owners was split equally across the four technologies. The quotas were based on region, gender and age to ensure an overall approximation of the population and more importantly, comparability of the four subsamples. Table 1.1 shows some socio-demographic comparisons between the subsamples for each technology and the overall population. The figures indicate that the overall spread between gender, age groups and region is fairly homogeneous between the four technologies and the overall population of Irish home owners. Although the figures are, strictly speaking, not nationally representative, each subsample reflects a close approximation of home owners in Ireland.

Table 1.1: Comparison of Subsamples 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
	Total	100.0	100.0	100.0	100.0	
AGE GROUP	15–24	0.8	3.0	2.6	2.2	100.0*
	25–34	18.7	20.1	12.8	16.1	
	35–44	20.3	19.7	23.3	20.5	20.0*
	45–59	36.9	34.6	33.0	31.7	45.0
	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
	Total	100.0	100.0	100.0	100.0	100.0

*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.

The next part of the study evaluates Irish home owners' willingness to pay for microgeneration technologies. The findings show that WTP varies significantly between the four technologies, providing scope for further research around attitudes and perceptions of these technologies, which is presented in Part III. Based on these findings, Part IV evaluates people's intention to buy microgeneration technologies and their underlying motivations.

Part II

Willingness to Pay for Microgeneration Technologies

1. Introduction

This part of the report evaluates Irish home owners' willingness to pay (WTP) for solar panels, micro wind turbines, solar water heaters and wood pellet boilers. It also evaluates the influence of socio-demographic and housing characteristics on WTP.

In the survey a *stated preference method*[5] was utilized to estimate WTP for the technologies. Home owners were given a 'scenario' in which they were presented with actual cost figures for the respective microgeneration technologies. Respondents were asked to imagine that installing the microgeneration technology on/at their house would result in average annual energy cost savings of about €500 (€200 for solar water heaters). It was pointed out that the energy comes from a renewable source and would therefore reduce the greenhouse gas emissions of their household. Respondents were then asked whether they would be willing to pay one of €2,000, €5,000, €7,000, €10,000 or €15,000. Those who stated "yes" in the first question were presented with a next higher amount and asked whether they would pay €5,000, €7,000, €10,000, €15,000 or €20,000,[6] respectively. Home owners who stated "no" were asked whether they would be willing to pay €1,000, €2,000, €5,000, €7,000 or €10,000, respectively. The different starting bids were used to minimize starting point bias in the answers.

2. Findings on Willingness to Pay for Microgeneration Technologies

The results presented in Table 2.1 show that WTP for solar water heaters is the lowest, at €2,591. This comes as no surprise, as respondents were presented with a significantly lower annual energy-cost savings figure of €200, compared to €500 for the other microgeneration technologies. The median[7] WTP for micro wind turbines, solar panels and wood pellet boilers is €5,169, €4,254 and €3,500 respectively.

[5] Stated preference methods generally use information from survey data and are commonly applied to investigate WTP for non-market goods. In comparison, revealed preference methods such as the hedonic pricing approach are based on actual choice decisions that are observable in the market place. Generally speaking, either method could be used to estimate the WTP for microgeneration technologies. 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 are more feasible to estimate home owners' WTP.

[6] 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.

[7] The median was chosen since the mean is more affected by outliers (i.e. high bidding values), which can give disproportionate weight to a few respondents with exceptionally high WTP. 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)

Further, the results indicate that, in light of the respective savings in energy costs, the average accepted payback period is about 13 years for solar water heaters, 10 years for micro wind turbines, 8.5 years for solar panels and 7 years for wood pellet boilers. The signficiant differences in consumers' WTP for the indiviudal technologies is suprising, since all consumers were presented with the same energy-cost savings in the survey. One explanation is that consumers do not base their decisions purely on rational cost–benefit evaluations but are likely to take other factors into consideration (see Part III).

Table 2.1: Irish Home Owners' Median Willingness to Pay for Microgeneration Technologies

Median WTP	**Lower Bound** (95% Confidence Interval)	**Upper Bound** (95% Confidence Interval)	**Average Accepted Payback Period**
Wood Pellet Boilers			
€3,500	€2,895	€4,081	7 years
Small Wind Turbines			
€5,169	€4,409	€6,030	10 years
Solar Panels			
€4,254	€3,555	€4,959	8.5 years
Solar Water Heaters			
€2,591	€1,930	€3,232	13 years

Source: own calculations.

In comparison, market data (SEAI, 2010) show that a wood pellet boiler, which can save up to €500 of annual energy costs, would require an investment of between €10,000 and €16,000. A 5 kW micro wind turbine or a 3 kW solar panel system costs between €20,000 and €25,000. Solar water heating systems can be installed for approximately €2,400–€5,000.

Table 2.2: Average Real Costs for Microgeneration Technologies in Ireland

	Real Costs			
Technology	**Costs**	**kW**	**Simple Payback**	**Grants**
Wood Pellet Boilers	€10,000–€16,000			Up to €2,500
Micro Wind Turbines	€20,000– €25,000	~5	12–15 years	
Photovoltaic Panels	€20,000– €25,000	~3	40 years	
Solar Thermal Heaters	€2,400–€5,000			Up to €1,800

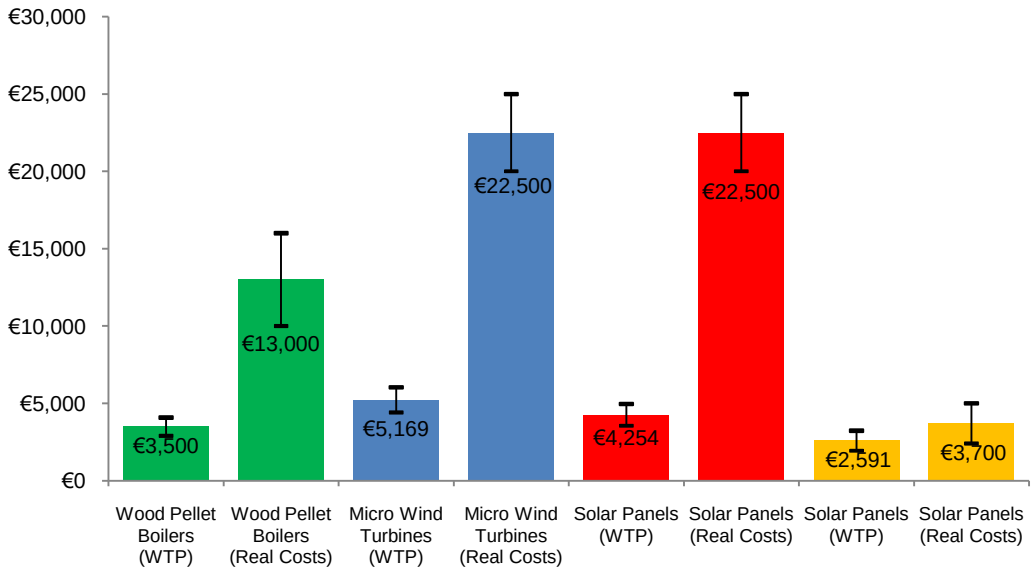
Source: SEAI Estimates.

The results show that Irish home owners' WTP for microgeneration technologies is significantly lower than market prices. This suggests that for the uptake of microgeneration technologies to increase, market prices of the respective technologies must fall significantly or the Irish government must revise its

support schemes and offer more generous grants or increase the Renewable Energy Feed-in Tariff (REFIT). The only exceptions are solar water heaters, for which WTP appears to match market prices.

These results seem to match market data which show that most of the microgeneration technologies sold under the Greener Home Scheme are solar water heaters (SEAI, 2010). The discrepancies between median WTP and average real costs are illustrated in Figure 1.1. The data reveal that the largest difference exists for solar panels, closely followed by micro wind turbines. Again, WTP for solar water heaters and their real costs appear to be very close. The real costs for wood pellet boilers significantly exceed people's WTP; however, given the available grant aid as well as overall lower costs, the discrepancy is lower than for micro wind or solar panels. An important implication is that grant aid for solar water heaters might no longer be needed, since home owners' WTP is close to actual market prices. Instead financial support could be targeted towards other microgeneration technologies such as- solar or wind.

Figure 2.1: Discrepancy between (Median) Willingness to Pay and (Average) Real Costs



Source: SEAI estimates and own calculations, including 95% confidence intervals.

3. Factors influencing Willingness to Pay for Microgeneration Technologies

Previous research has shown that certain consumer segments are more likely to adopt microgeneration technologies, renewable energy or energy efficiency measures than others (e.g. O'Doherty et al., 2008; Zarnikau, 2003). This study also assessed the influence of socio-demographic variables on WTP, segmenting home owners by *age*, *gender*, *education*, *social class*, *type of ownership*, *household size* and

region. Further, the impact of housing characteristics was evaluated, controlling for *age*, *type*, *size and energy efficiency* of the dwelling.

The results presented in Table 2.3, however, show no coherent influence of socio-demographic or housing characteristics on home owners' WTP. Interpreting the results is therefore difficult, as no systematic effects could be detected.

The findings show that people who own their houses (as opposed to paying back a mortgage) have a higher WTP for wood pellet boilers and small wind turbines but are not willing to pay more for solar panels or solar water heaters. People with high and medium levels of education have higher WTP for solar panels, whereas middle-class home owners have a lower WTP for solar water heaters. People living in urban areas, on the other hand, have a higher WTP for solar water heaters. The results also show that older people have a lower WTP for wood pellet boilers. However, if an inverted-U-shaped relationship (as opposed to a linear relationship) for age and WTP is assumed, it can be seen that younger *and* older people both have lower WTP than middle-aged home owners. Housing characteristics have even less influence on WTP. For solar panels only, people living in relatively new (i.e. built after 1990) and bigger houses have a lower WTP.

Table 2.3: Socio-demographic Influences on WTP

		Wood Pellet	Std Err.	**Small Wind**	Std Err.	**Solar Panel**	Std Err.	**Solar Water Heater**	Std Err.
	Female	n.s.	–	n.s.	–	n.s.	–	n.s.	–
	Age	**-.0532****	.0255	n.s.	–	n.s.	–	**–.0397***	0.222
Gender & Age	Age^2	**0.000351***	.0002	n.s.	–	n.s.	–	n.s.	–
	Household Size	n.s.	–	n.s.	–	n.s.	–	n.s.	–
	High Education	n.s.	–	n.s.	–	**.587*****	.214	n.s.	–
	Medium Education	n.s.	–	n.s.	–	**.438***	.228	n.s.	–
	Upper Class	n.s.	–	n.s.	–	n.s.	–	n.s.	–
Education & Social Class	Middle Class	n.s.	–	n.s.	–	n.s.	–	**–0.502****	**0.199**
	Owner Outright	**.510****	.180	**.4222****	–	n.s.	–	n.s.	–
	Detached Home	n.s.	–	n.s.	–	n.s.	–	n.s.	–
	Semi Detached Home	n.s.	–	n.s.	–	n.s.	–	n.s.	–
	Dwelling built after 1990	n.s.	–	n.s.	–	**–.589*****	–	n.s.	–
	Dwelling built before 1931	n.s.	–	n.s.	–	n.s.	–	n.s.	–
	Energy Efficiency of Building	n.s.	–	n.s.	–	n.s.	–	n.s.	–
Housing Characteristics	Size of Dwelling	n.s.	–	n.s.	–	**–.167***	.098	n.s.	–
	Urban	n.s.	–	n.s.	–	n.s.	–	**.391***	**.232**
Region	Rural	n.s.	–	n.s.	–	**.338***	.197	n.s.	–
	Constant	**9.242*****	**1.307**	**8.621*****	**1.531**	**9.562*****	**1.566**	**7.391*****	**1.295**
	ρ								
	N	252		250		251		246	
	Wald χ^2 (18)	91.72***		86.55***		107.31***		92.34***	
	Log Pseudo-likelihood	–249.764		–286.285		–266.114		–242.0198	
Statistics									

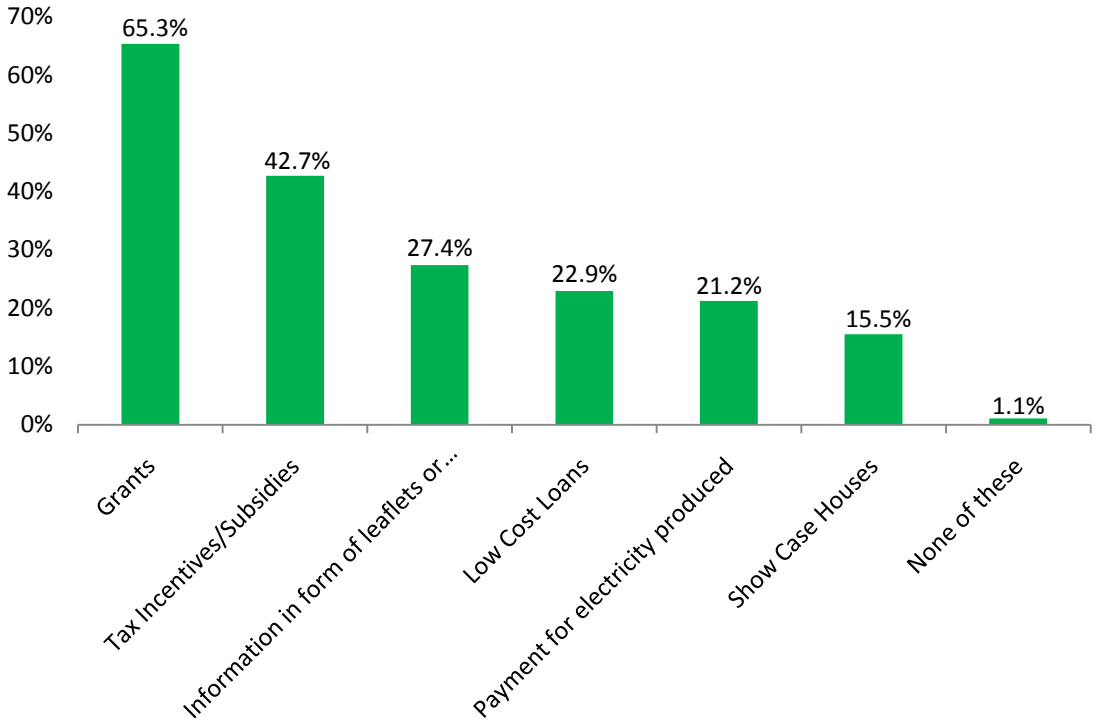
Source: own calculations; by individuals clustered; *** $p < .01$, ** $p < .05$, * $p < .1$. n.s. = not significant.

4. Irish Home Owners' Preferred Support Policies

In a next step home owners were presented with a number of support schemes and asked to name the two that they would find most helpful. The policies were identified via discussions with microgeneration experts and home owners. The previous section has shown that WTP for most microgeneration technologies is significantly lower than actual market prices. It therefore is not surprising that when home owners were asked about their two preferred support schemes for microgeneration technologies, those most named were government grants (65.3%) and tax incentives/subsidies (42.7%). One of the most popular support schemes in Europe is feed-in-tariffs, which allow owners of microgeneration

technologies to sell the produced electricity for a fixed price (€/kWh) back to main electricity providers. Yet only 21% of Irish home owners stated a preference of money for electricity produced, which might simply be due to low awareness of such a policy. Further, information was the third most preferred support scheme (27.4%), indicating that people are still unsure about the application of microgeneration technologies. Low-cost loans were preferred by approximately 23% of home owners. Figure 2.2 also indicates that about 15.5% would like to see showcase houses with microgeneration technologies.

Figure 2.2: Preferred Policy Support Schemes for Microgeneration Technologies



Source: Own calculations.

5. Key Findings

Overall, **t**he findings suggest that real costs for solar panels, micro wind turbines and wood pellet boilers are significantly higher than Irish home owners' WTP. Solar water heaters are the exception, as is confirmed by current installation figures under the Greener Home Scheme. The findings suggest that prices for solar panels and micro wind turbines have to fall the most before a significant increase in adoption can be expected. On the other hand, grant-aid for solar water heaters might no longer be needed, since Irish home owners' WTP is close to actual market prices.

Socio-demographic differences of home owners or their housing characteristics do not contribute much to the understanding of why some people are willing to pay more for microgeneration than others. Although it is likely that WTP for microgeneration increases with income, the socio-demographic variables tested in this study provide no coherent insights into which segments of home owners ought to be targeted first.

In terms of the preferred support policy, the most of home owners would prefer financial support in the form of grant aid or tax incentives. Given the large gap between WTP and market prices for solar panels, micro wind turbines and wood pellet boilers (see Part II), grant aid for these technologies can be very costly. Support policies for micro wind turbines and solar panels in particular would have bridge a gap of about three-quarters of the actual market price.

More viable support policies could be microfinancing options, where upfront investment is partly or entirely provided by financial institutions or energy providers and recouped via annual energy savings. Further, providers of microfinance can buy these technologies 'in bulk' and thus reduce total capital costs and, ultimately, pay-back periods. Solar water heaters, on the other hand, appear to be in no need of any support policy.

Finally, the analysis suggests that if home owners acted rationally (i.e. on the basis of financial return), WTP for solar panels, micro wind turbines and wood pellet boilers should be the same.[8] The findings above have however shown that WTP for the respective technologies is quite different, suggesting that home owners not only value the energy-cost savings but also consider other attributes of microgeneration. Subjective perceptions of product characteristics and general attitudes as well as social influences are likely to provide better explanations as to why home owners have different WTP for the respective technologies.

Part III therefore takes a closer look at home owners' attitudes and perceptions of microgeneration technologies, and compares them across the four technologies and different types of home owner. It thus sheds more light on why home owners are willing to pay more for some microgeneration technologies than for others.

[8] Solar water heaters are the only exception, as respondents were told in the scenario that annual energy cost savings would amount to €200 as opposed to €500 for the other technologies.

Part III

Attitudes to and Perceptions of Microgeneration Technologies

1. Introduction

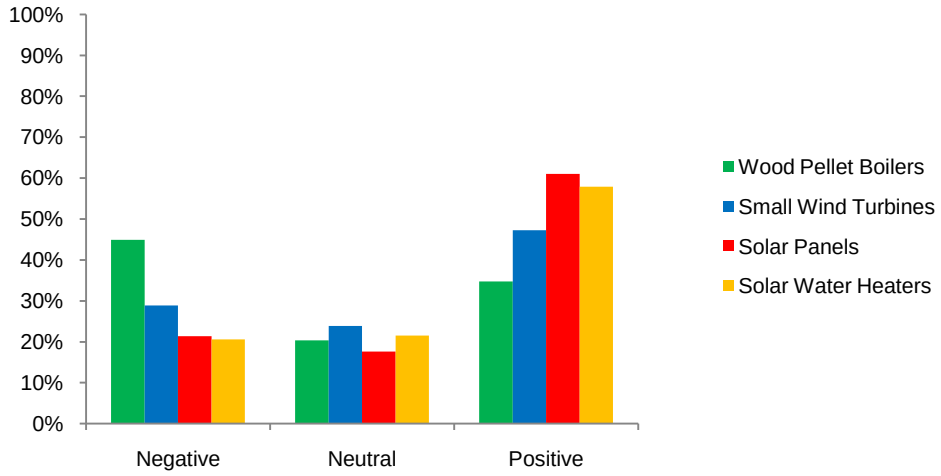
Part III provides an overview of Irish home owners' general attitudes to and perceptions of solar panels, solar water heaters, micro wind turbines and wood pellet boilers. An analysis of variance (ANOVA)[9] was conducted to test for statistical significance of these differences between the four technologies. Section 3.2 compares home owners' attitudes and perceived social pressure, followed by an evaluation of perceptions of benefits as well as risks and barriers associated with microgeneration technologies. The final section discusses home owners' environmental attitudes and preferred support policies.

2. Attitudes and Social Norms Regarding Microgeneration Technologies

Figure 3.1 shows Irish home owners' attitudes to microgeneration, broken down by the individual technologies. The findings indicate that a majority of people have a positive attitude to solar panels (61%) and solar water heaters (58%). On the other hand, home owners seem to have less favourable attitudes towards wood pellet boilers, with about 45% claiming to have a negative attitude. Around 50% have a favourable attitude to small wind turbines.

[9] ANOVA is a statistical technique to test for significant differences between means in different groups (e.g. microgeneration technologies). For a more detailed discussion please refer to for example, Freedman (2005).

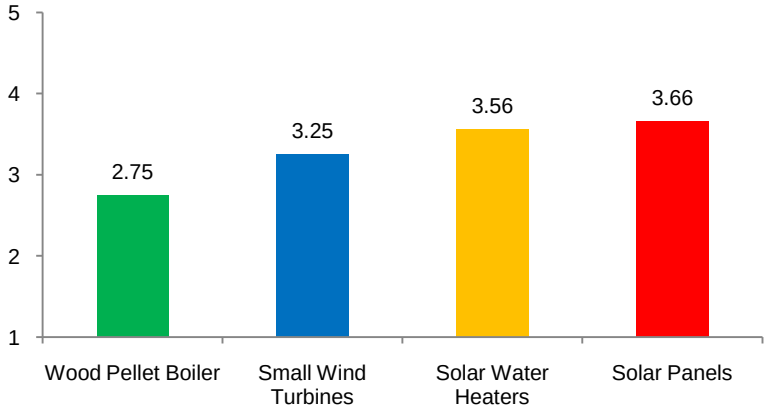
Figure 3.1: Attitudes of Irish Home Owners (%) to Microgeneration Technologies



Q3A1: Installing *X* in/on your house in the next 12 months would be very good. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

The ANOVA results also reveal that attitudes are significantly different between the four technologies, except for solar water heaters and solar panels (Figure 3.2). This might be due to the fact that both solar panels and solar water heaters utilise sunlight to produce electricity/hot water, which might be perceived as more positive than wind or biomass. Again, the results show that Irish home owners' attitudes are significantly more negative towards wood pellet boilers. One explanation might be the negative press coverage wood pellet boilers received in regard to issues around the supply of fuel (i.e. wood pellets), general levels of efficiencies of this technology or faulty installations (e.g. *The Irish Times*, 12 October 2009).

Figure 3.2: Comparison of Overall Attitudes (Index) to Microgeneration Technologies

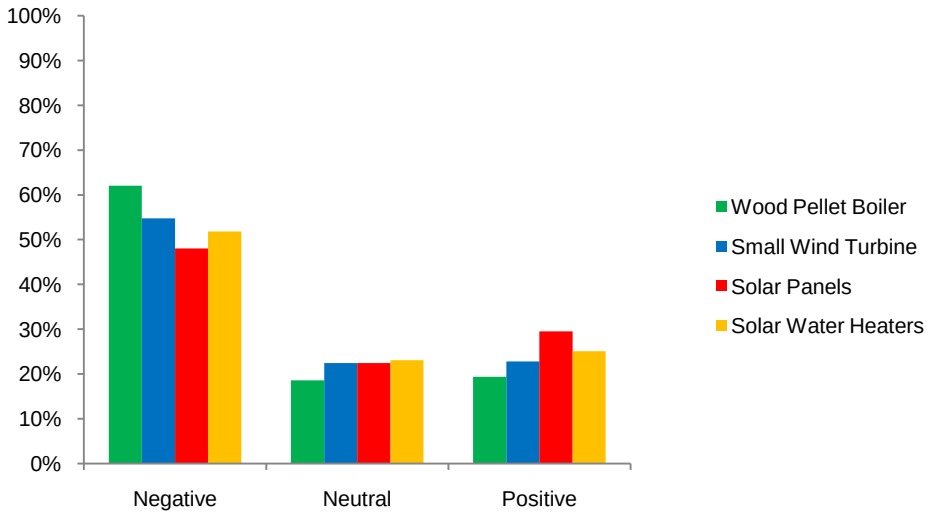


ANOVA Results: Differences significant (.05), except for solar panels and solar water heaters. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

Next home owners were asked if their friends and families would support or encourage them in their decision to install a microgeneration technology at their house. These so called subjective norms reflect

the perceived social influence or pressure home owners experience in their immediate environment. As shown in Figure 3.3, the majority of people claim to experience no positive social influence from significant others such as friends and families to install a microgeneration technology.

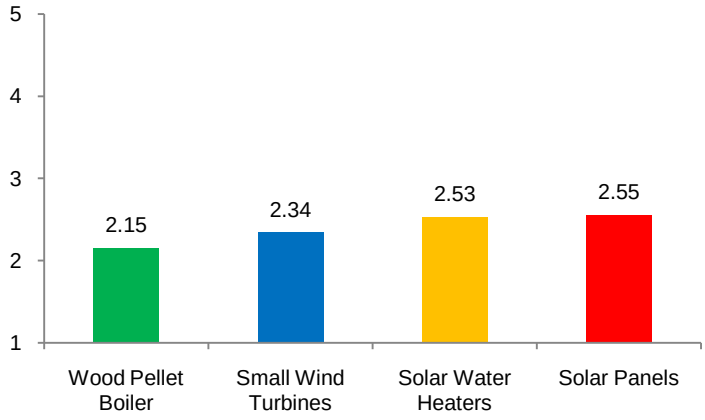
Figure 3.3: Subjective Norms of Irish Home Owners regarding Microgeneration Technologies



Q3SN4: The people in your life whose opinion you value most would encourage you to install *x* on your house in the next 12 months.

However, the histogram shows that the perceived positive social pressure is higher for solar panels (30%) and solar water heaters (25%) than for micro wind turbines (23%) or wood pellet boilers (19%). The comparison of mean differences between the technologies confirms these findings. Figure 3.4 shows a statistically significant difference between wood pellet boilers and solar panels and solar water heaters respectively. Differences in subjective norms between small wind turbines and other technologies appear not to be statistically significant. One explanation for the relatively higher social pressure experienced regarding solar panels and solar water heaters might be the clear visibility of these technologies and, more importantly, the relatively high rate of diffusion of solar water heaters in Ireland. However, this explanation does not seem to hold for micro wind turbines, possibly due to a higher level of social risk (see Section 4.2) associated with this technology. Despite their clear visibility, people may be more concerned about the level of noise or the level of safety of the turbine.

Figure 3.4: Comparison of Social Norms (Index) regarding Microgeneration Technologies



ANOVA results: Differences significant (.05) for wood pellet boilers and solar water heaters, and wood pellet boilers and solar panels. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

2.1. Key Findings

The findings firstly indicate that attitudes to microgeneration technologies are generally very positive. The only exception appears to be wood pellet boilers. One explanation might be negative media coverage and/or negative word of mouth, which can have an adverse effect on people's attitudes and perceptions and ultimately undermine the promotion of microgeneration technologies.

Second, the generally slow uptake of these technologies indicates that attitudes do not have a major impact on home owners' buying decisions. Thus, we need a clearer understanding of why people hold positive attitudes but yet do not invest in microgeneration technologies. The next section will take a closer look at the perception of specific product characteristics.

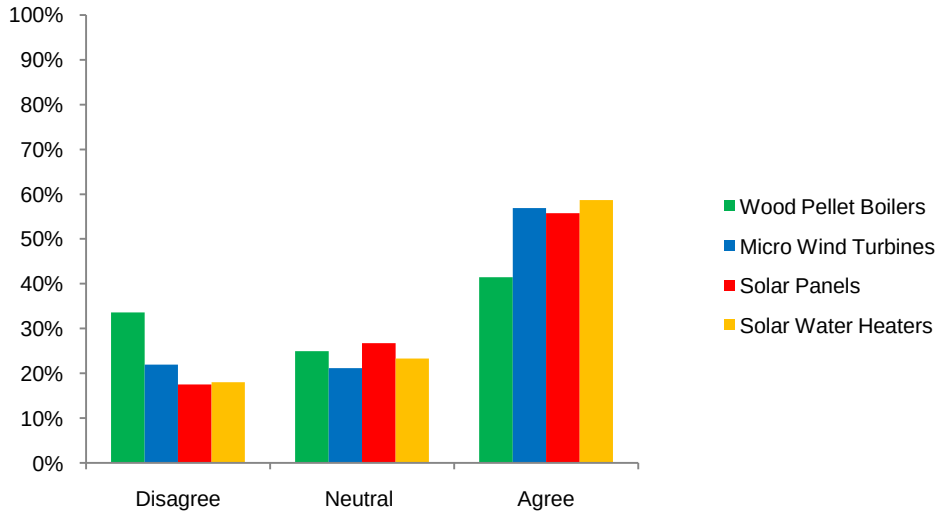
Third, findings indicate that most home owners experience no or low social pressure to invest in microgeneration technologies. The following sections, however, will show that social influences often have a direct effect on people's intention to buy a microgeneration technology. Positive social pressure might be encouraged via showcase houses in highly populated areas. The visible application of these technologies not only is likely to raise general awareness, but would also provide opportunities to learn about these technologies through, for example, neighbours' experiences. Showcase installations are therefore likely to increase the level of social pressure and give people opportunities to familiarise themselves with microgeneration technologies.

3. Benefit Perceptions of Microgeneration Technologies

This section takes a closer look at Irish home owners' perceptions of certain *benefits* associated with microgeneration technologies. In exploratory face-to-face interviews, the benefits most often associated with microgeneration technologies were *energy savings*, *a reduction in CO_2 emissions* and *self-sufficiency/independence* from conventional sources of energy such as oil and gas. Hence, home owners were asked about their perceptions with regard to these three benefits.

The findings clearly indicate that a majority of people believe that investing in a microgeneration technology would reduce their energy costs. Similarly to the attitudes outlined above, Figure 3.5 shows that relatively fewer people (41%) believe wood pellet boilers would help them reduce energy costs.

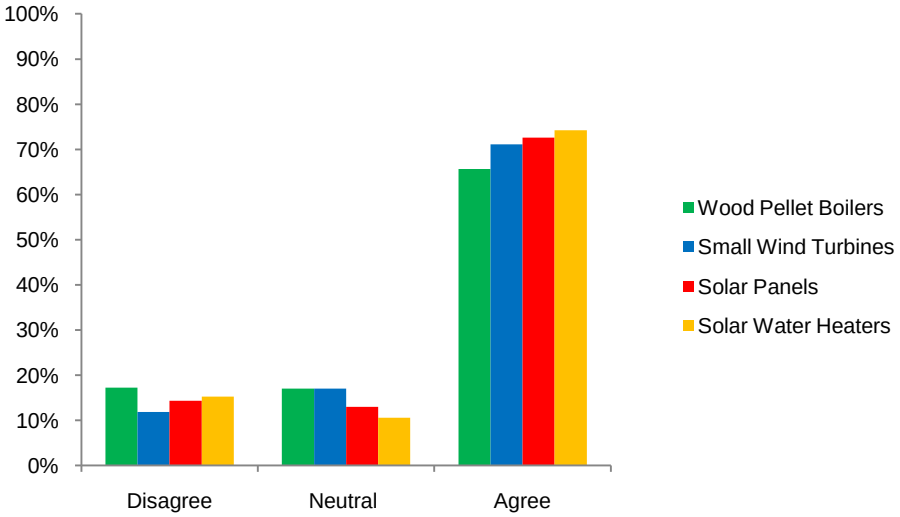
Figure 3.5: Irish Home Owners' Perceptions of Advantages: Energy Cost Savings



Q4PRA1a: Installing *X* in/on your house would reduce your monthly energy bill significantly. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

Figure 3.6 shows a similar picture for the reduction in CO_2 emissions. Again, a majority of people believe that installing a microgeneration technology on their house would significantly reduce their emissions (74% for solar panels, 73% for solar water heaters, 71% for micro wind turbines and 66% for wood pellet boilers.).

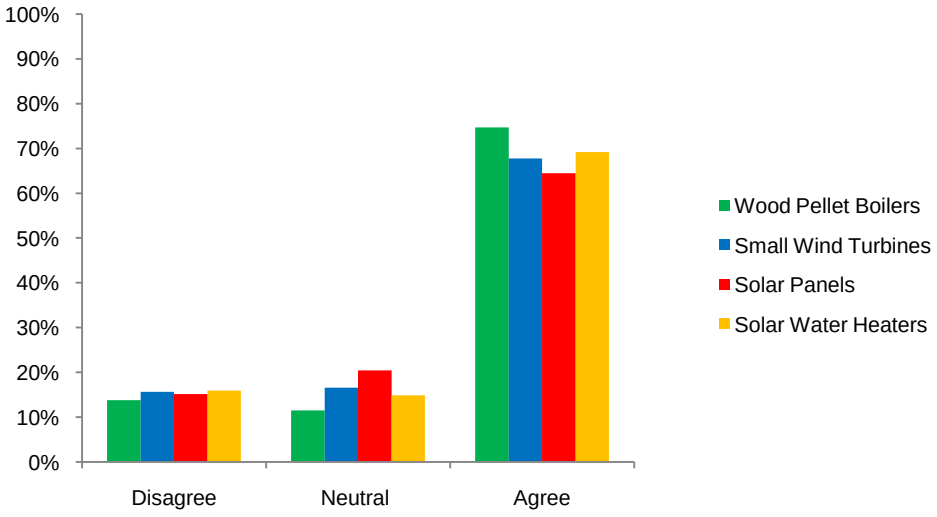
Figure 3.6: Irish Home Owners' Perceptions of Advantages: Reduction of CO2 Emissions



Q4PRA2b: By installing X in/on your house you would help to significantly reduce greenhouse gases. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

Surprisingly, a slightly different pattern emerges when looking at people's perceptions of being independent from conventional sources of energy. Figure 3.7 shows that a higher percentage of home owners (75%) believe that wood pellet boilers would reduce their dependence on oil and gas, as compared to micro wind turbines (68%), solar panels (64%) or solar water heaters (69%). One explanation might be Ireland's relatively long dependence on solid fossil fuels such as peat and coal. Older generations especially are likely to remember times before central heating, and might therefore see wood as a more reliable alternative to gas and oil. However, the overall level of benefits associated with microgeneration is very high for all technologies.

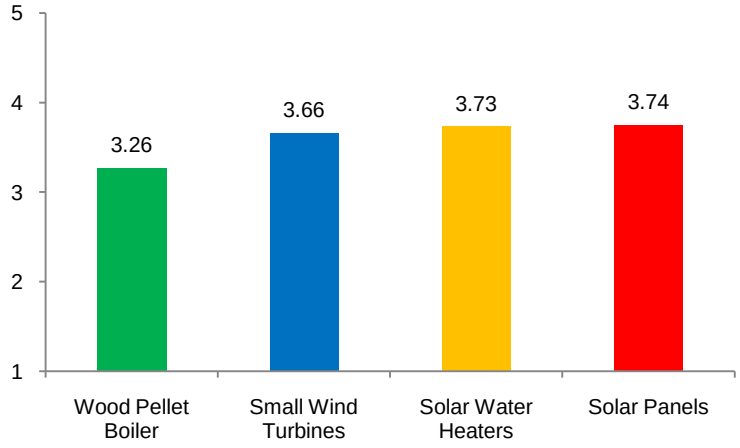
Figure 3.7: Irish Home Owners' Perceptions of Advantages: Independence from Oil and Gas



Q4PRA3c: Installing *X* in/on your house would reduce your dependence on oil or gas. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

Testing for overall differences in the level of perceived benefits, the results from the ANOVA (Figure 3.8) indicate that the level of benefits associated with solar panels, solar water heaters and small wind turbines is fairly similar and thus no statistically significant differences were detected. On the other hand, the level of benefits associated with wood pellet boilers is somewhat lower, which matches previous findings on attitudes.

Figure 3.8: Comparison of Perceived Benefits (Index)



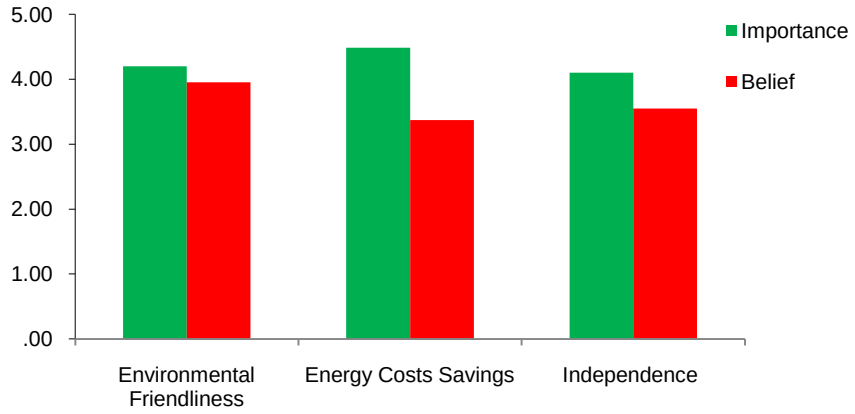
ANOVA results: Differences significant (.05) for wood pellet boilers and all other technologies. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

3.1. Importance of Benefits to Buying Decisions

Home owners were also asked about the importance of these benefits in regard to their buying decisions. The answers are plotted along with the belief that microgeneration technology will actually achieve this outcome (i.e. benefit). Figure 3.9 can thus be interpreted as 'wish' versus 'reality'. Overall, the findings show that energy costs savings are regarded as most important for the buying decision, followed by environmental friendliness and independence from energy providers.

More importantly, however, the histogram shows that significantly fewer people actually believe that microgeneration technologies will yield these benefits. This discrepancy is particularly large for energy-cost savings. Although home owners regard such savings as very important, few people believe that microgeneration technologies are *actually* cost-effective. However, the wish–reality difference is small for environmental friendliness. Independence is perceived as the least important benefit in terms of home owners' buying decisions. However, fewer people believe that buying a microgeneration technology would actually make them independent from conventional sources of fuel such as oil and gas.

Figure 3.9: Importance of Benefits versus Beliefs about Benefits Actually Occurring When Buying a Microgeneration Technology



Q11IPRA1, IPRA2, IPRA3: Benefit would be very important (5)/not important at all (1) for me, when thinking about installing an *X*.

3.2. Key Findings

The results indicate that the majority of home owners believe that microgeneration technologies have several advantages over conventional systems. While the data show a similar pattern for micro wind turbines, solar panels and solar water heaters, wood pellet boilers seem to be perceived differently by home owners. The figures above show that fewer home owners believe that wood pellet boilers would save energy costs and are good for the environment. On the other hand, relatively more people believe that wood pellet boilers are a realistic alternative to conventional fuels, making them independent from conventional sources of energy such as oil and gas. These findings might be interpreted in light of Ireland's relatively long experience with solid fossil fuels such as coal and peat, which the older generations in particular are likely to have experienced.

When comparing the perceived importance of these benefits to home owners' assessment as to these technologies actually providing these benefits, the results show some discrepancies. In particular, potential energy costs savings are seen as very important, yet the majority of home owners do not believe that investing in microgeneration technologies would yield significant reductions in energy costs. The same is true for the assessment of the reliability of the technologies. Whereas most people state that having an independent source of energy is important to them, significantly fewer people actually believe that microgeneration technologies can achieve this. The discrepancy is smallest for environmental friendliness, indicating that people genuinely believe that buying a microgeneration technology will have a positive impact on the environment.

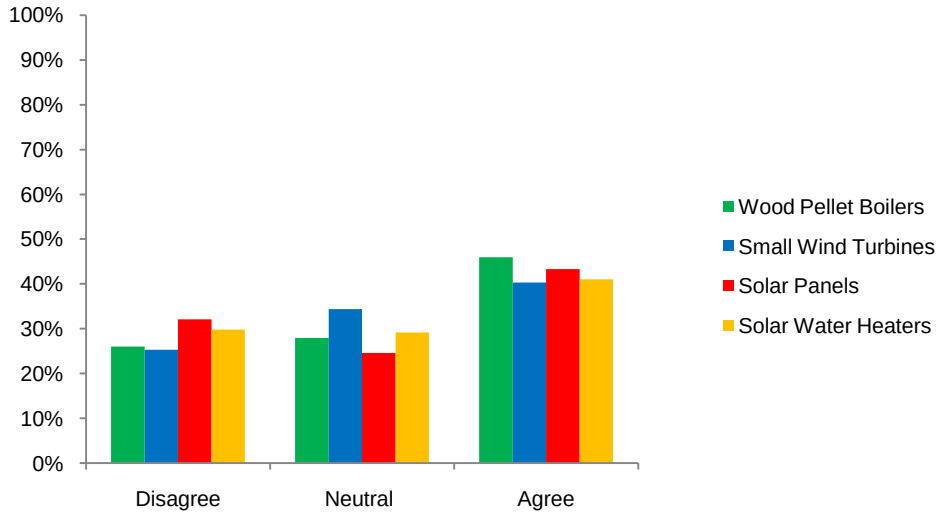
Overall the findings indicate that benefits such as financial viability and reliability, where they exist, need to be communicated more clearly in order to overcome these discrepancies in home owners' perceptions.

4. Perceptions of Risks

Following on from the discussion of benefits, this section provides an overview of the level of various *risks* associated with microgeneration technologies. Again, exploratory face-to-face interviews had revealed that home owners were most often worried about the *financial viability*, *reliability* and the *opinion of local residents* in relation to installing a microgeneration technology at their house. These three types of risk can generally be classified as *financial*, *performance* and *social risk* respectively.

Overall the level of risk or uncertainty associated with microgeneration appears very high, and Figure 3.10 shows that a majority of people are concerned that investing in a microgeneration technology would not pay off financially. This risk perception is highest for wood pellet boilers (46%), which mirrors earlier findings around the perception of energy-saving benefits (Part II, Section 5).

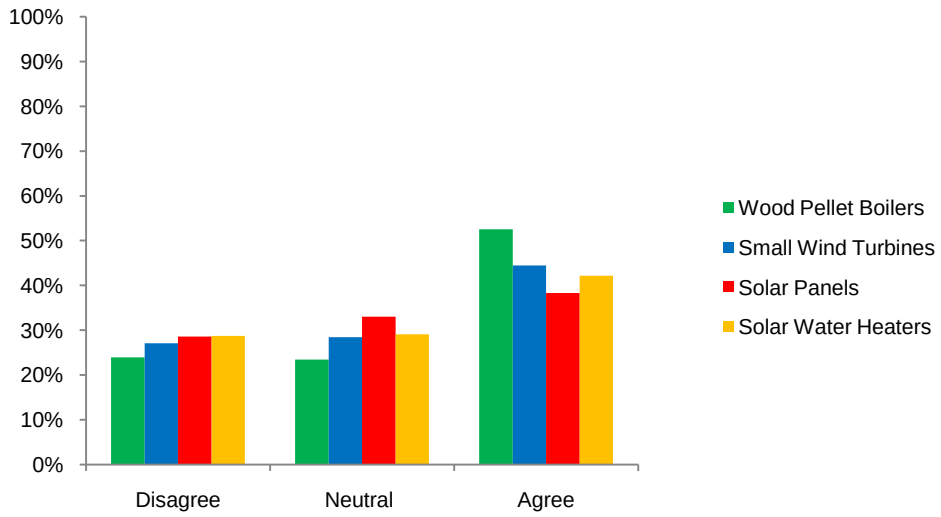
Figure 3.10: Irish Home Owners' Perceptions of Risks: Financial Risk



Q5PR1a: When thinking about installing *X* in/on your house, you would be concerned that the financial investment would not pay off. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

A similar picture emerges for the risk that people associate with the performance of microgeneration technologies. Again, the overall level of perceived uncertainty is relatively high, with the highest level of performance risk associated with wood pellet boilers (53%). With regard to the other technologies, about 45% of the interviewed home owners worry how reliable wind turbines would be. The risk associated with solar panels (38%) and solar water heaters (42%), however, is somewhat lower.

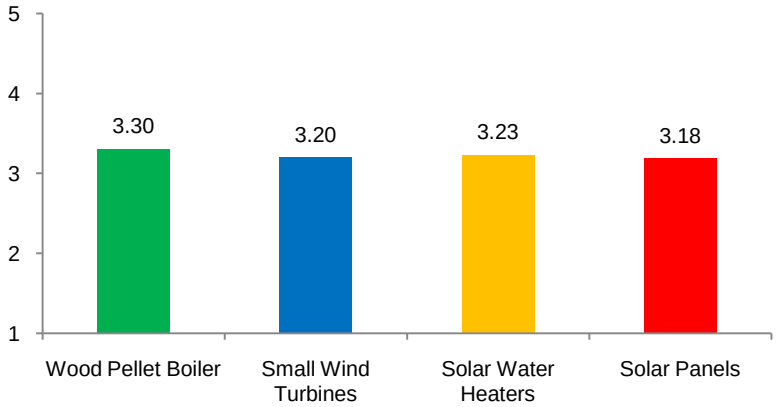
Figure 3.11: Irish Home Owners' Perceptions of Risks: Performance Risk (Reliability)



Q5PR2a = When thinking about installing *X* in/on your house, you would worry about how dependable and reliable they would be. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

The ANOVA analysis clearly shows that mean differences in perceived financial and performance risk[10] do not vary between the respective technologies and are thus statistically non-significant. This indicates that the overall level of uncertainty associated with microgeneration is still relatively high across the different technologies, implying that none of these technologies has so far established itself as a reliable and financially viable source of energy.

Figure 3.12: Comparison of Perceived Financial & Performance Risk (Index)



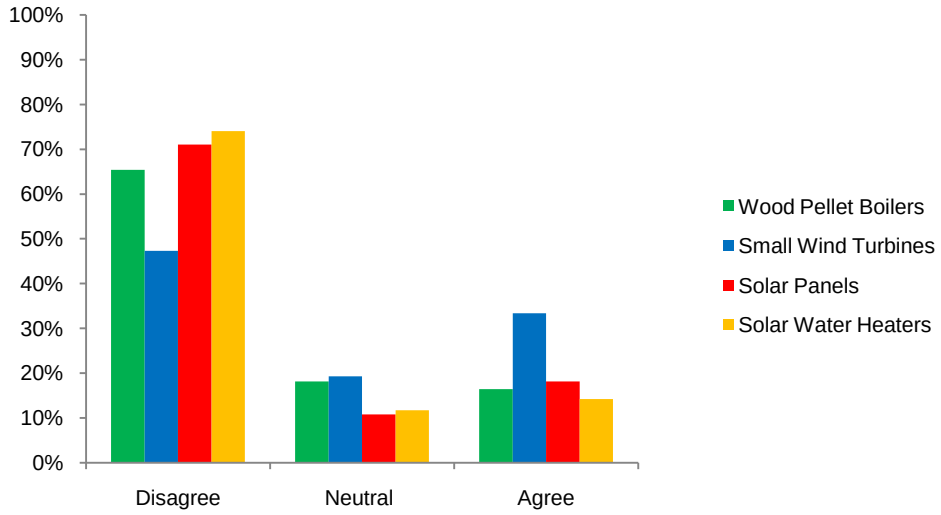
*ANOVA Results: Differences Non-significant (.05). Measured from 'strongly disagree' (1) to 'strongly agree' (5).

When asked about the level of social risk associated with these new technologies, the great majority of home owners believed that local residents would not disagree with them installing a microgeneration

[10] The two types of risk were grouped, as a confirmatory factor analysis had revealed that financial and performance (i.e. reliability) risks are underlying the same factor. This makes sense, as the reliability of microgeneration technology highly influences its financial performance, i.e. energy savings.

technology on/in their home (see Figure 3.13). The only exception is small wind turbines: over 33% of home owners would be worried that local residents might disapprove of them installing this technology. These findings indicate that home owners associate other problems with small wind turbines, such as the potential level of noise or the general level of safety.

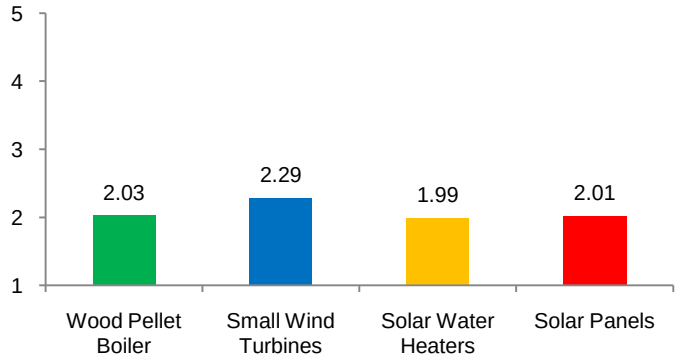
Figure 3.13: Irish Home Owners' Perceptions of Social Risk



Q5PR3b: When thinking about installing *X* in/on your house you would be worried that the local residents might not be happy. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

The ANOVA between the four technologies confirms that the level of perceived social risk is significantly higher for wind turbines than for the other technologies. All other differences are not statistically significant (Figure 3.14).

Figure 3.14: Comparison of Perceived Social Risk (Index)



ANOVA results: Differences significant (.05); wind turbines are different from other technologies. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

4.1. Key Findings

The results discussed above show that home owners express a high level of uncertainty regarding microgeneration technologies. More than half of all home owners in Ireland state they would worry about the financial viability and reliability of the four discussed technologies. Wood pellet boilers especially seem to be associated with high uncertainty regarding performance.

When asked about the social risk associated with microgeneration technologies, a majority of people claim to not worry about what neighbours or local residents might think. The only exception is micro wind turbines, with about one third of the respondents stating that they believe local people might object. Small wind turbines have a higher level of visibility compared to the other technologies, and home owners might also worry about the level of noise wind turbines might create or the overall level of safety.

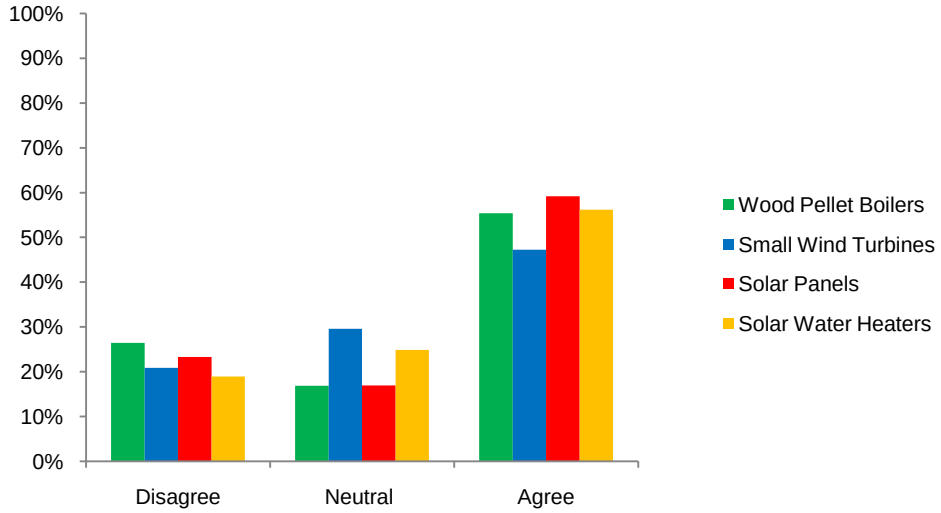
5. Perceptions of Potential Barriers

This section looks at potential *barriers* that prevent home owners from investing in microgeneration technologies. Based on exploratory face-to-face interviews with Irish home owners and an extensive review of the available literature, five key barriers were identified: *costs* (i.e. upfront investment required to purchase the technology), *compatibility with daily routines and habits* (i.e. degree to which the technologies are perceived to interfere with day-to-day living), *complexity* (i.e. degree to which the technologies are perceived as being difficult to use or understand), *trialability* (i.e. degree to which the technologies can be tried before adoption) and *compatibility with infrastructure* (i.e. degree to which the installation of the technologies is perceived as difficult, disruptive or costly).

5.1. Initial Costs

Figure 3.15 shows that almost half of all interviewed home owners stated that the initial costs for a microgeneration technology would be too high, preventing them from investing in the respective technologies. The initial costs appear to be a greater problem for solar panels (59%) and wood pellet boilers (55%) than for solar water heaters (52%) and small wind turbines (47%). However, this may be partly explained by more people falling into the neutral category, indicating that a greater number of home owners might not know how much a solar water heater or small wind turbine actually costs.

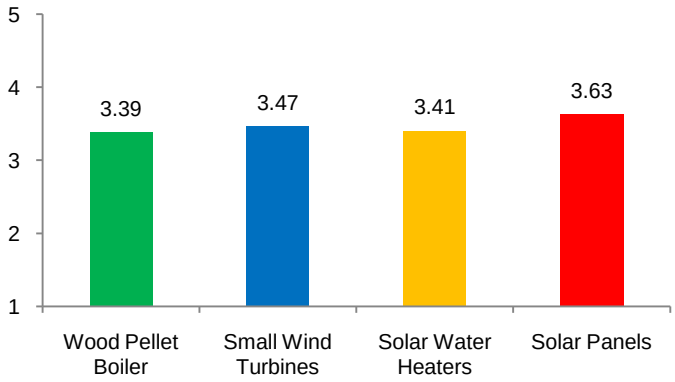
Figure 3.15: Irish Home Owners' Perceptions of Barriers: Initial Costs



Q8IC3: The initial cost of installing *X* in/on your house would be too high for you. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

The ANOVA confirms these results, showing that the majority of people agree that the initial costs are a key barrier. However, Figure 3.16 shows that no statistically significant differences could be detected between perceptions of the initial costs of the four microgeneration technologies. This implies that microgeneration technologies in general have a reputation for being too costly.

Figure 3.16: Comparison of Perceived Cost Barrier (Index)

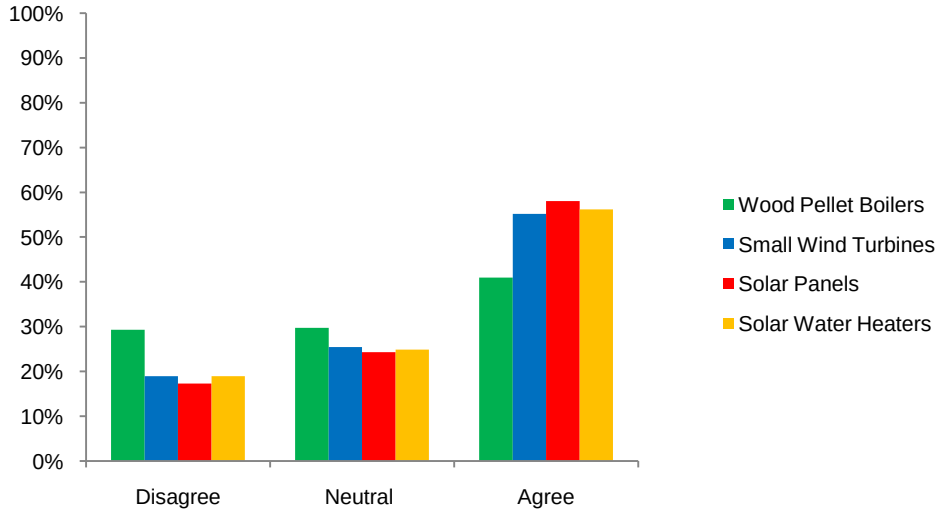


ANOVA results: Differences non-significant (.05). Measured from 'strongly disagree' (1) to 'strongly agree' (5).

5.2. Compatibility with Daily Routines and Habits

When asked about compatibility with daily routines and habits, the majority of people agreed that installing a microgeneration technology would not require significant changes. The smallest majority was in the case of wood pellet boilers. Figure 3.17 shows that about 30% of home owners believe that in order to operate a wood pellet boiler they would have to change their habits and routines, compared to less than 20% for all other technologies.

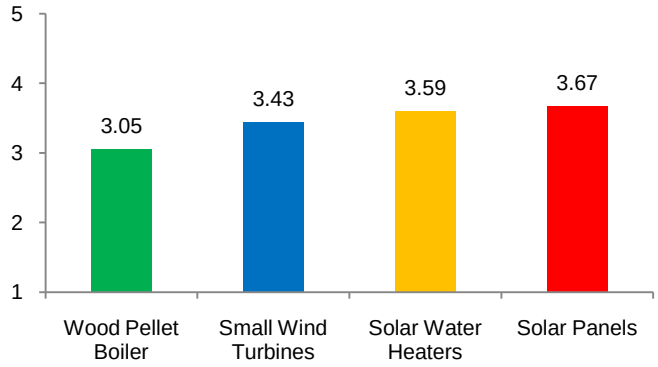
Table 3.17: Irish Home Owners' Perceptions of Barriers: Compatibility with Daily Usage Routines



Q7Com2a: To use *X* would not require significant changes in your existing daily routines. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

These results are statistically significant and the ANOVA confirms differences in home owners' perception of compatibility for wood pellet boilers in comparison to the other microgeneration technologies. These findings, presented in Figure 3.18, indicate that people associate greater inconvenience with operating a wood pellet boiler (i.e., ordering, storing and handling of pellets) in terms of being forced to change their daily routines and habits.

Figure 3.18: Comparison of Perceived Compatibility Barrier (Index)

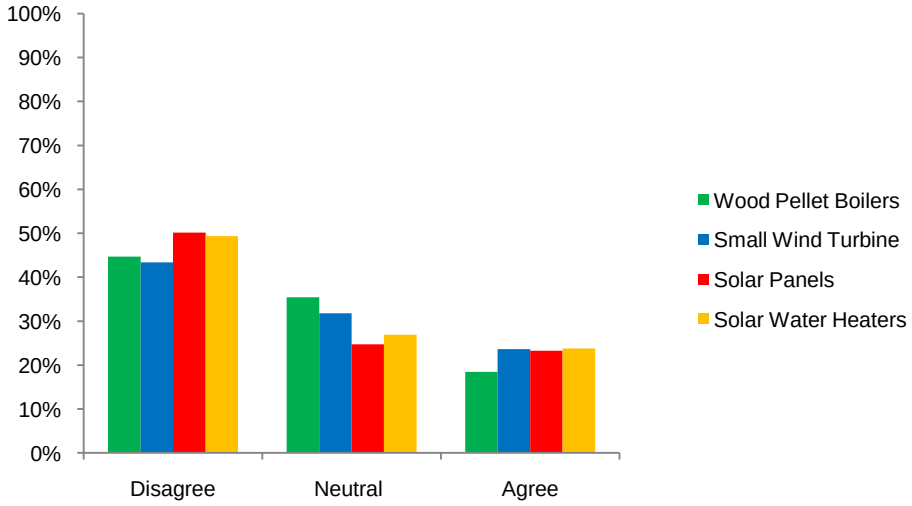


*ANOVA Results: Differences significant (.05) between wood pellet boilers and other microgeneration technologies. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

5.3. Complexity of Technology

Another barrier often associated with microgeneration is the complexity of these innovations, i.e. the difficulty home owners might experience in understanding and using them. Somewhat surprisingly, Figure 3.19 shows that a majority of people did not think that microgeneration technologies would be difficult to use and/or understand. Further, 20–30% of the interviewed home owners stated that they were neutral regarding the complexity of microgeneration technologies, suggesting that a lot of people simply do not know enough to give an informed answer.

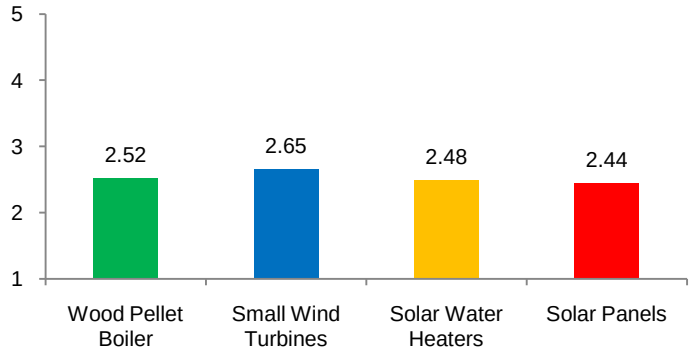
Figure 3.19: Irish Home Owners' Perceptions of Barriers: Complexity of Technology



Q8PC1: *X* are very complex products. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

Comparing the perceived complexity between the four technologies shows no statistically significant differences, indicating that microgeneration in general is perceived by home owners as relatively easy to understand and use.

Figure 3.20: Comparison of Perceived Complexity Barrier (Index)

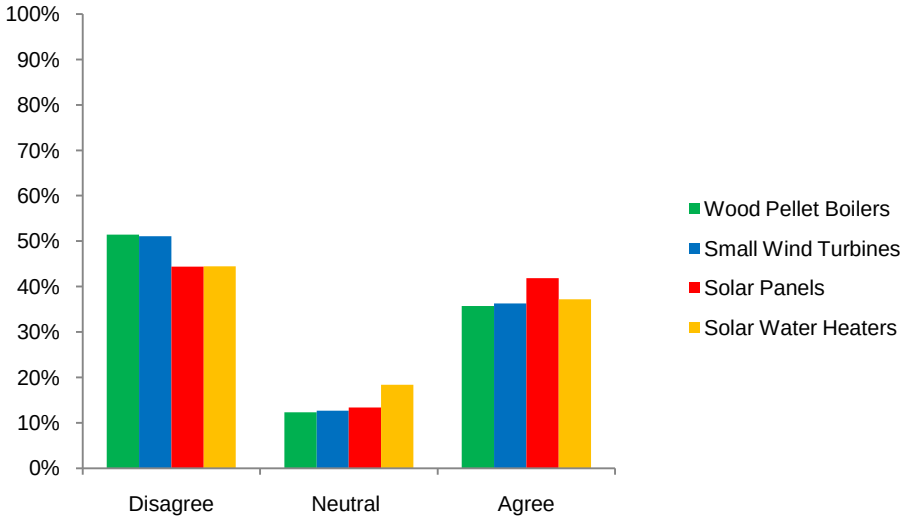


ANOVA results: Differences not significant (.05).

5.4. Trialability of Technology

Many consumer goods and innovations can be tried before a purchase decision is made, and/or potential buyers can draw on other people's experiences (see Figure 3.21). Microgeneration technologies on the other hand are high-cost, high-involvement products, which makes it impossible for home owners to try and buy any of the four technologies. Further, the uptake of these technologies in Ireland (as in many European countries) has been very slow and home owners often cannot consult other home owners about their experiences. When asked if they knew where they could satisfactorily see types of the respective microgeneration technology working, more people said that they did not (40–50%) than that they did (30–40%).

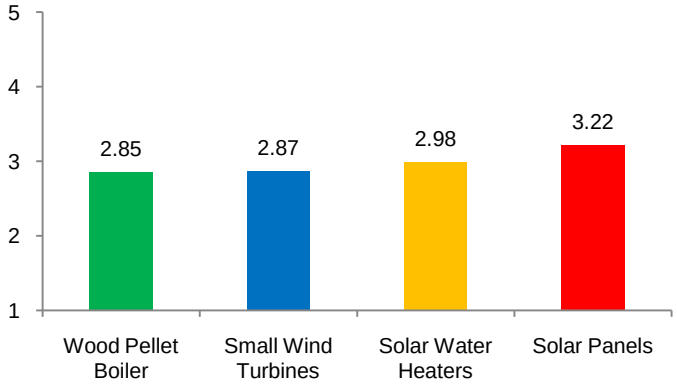
Figure 3.21: Irish Home Owners' Perceptions of Barriers: Trialability of Microgeneration Technologies



Q8TR1: You know where you could go to satisfactorily see various types of *X* working. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

There are, however, significant differences between the four technologies in terms of these perceptions. The ANOVA revealed that significantly more people agreed that – compared to small wind turbines and wood pellet boilers – they knew where to see various types of solar panel working. This might be due to the high visibility of solar panels compared to wood pellet boilers, as well as the higher uptake rate in comparison to small wind turbines.

Figure 3.22: Comparison of Perceived Trialability (Index)

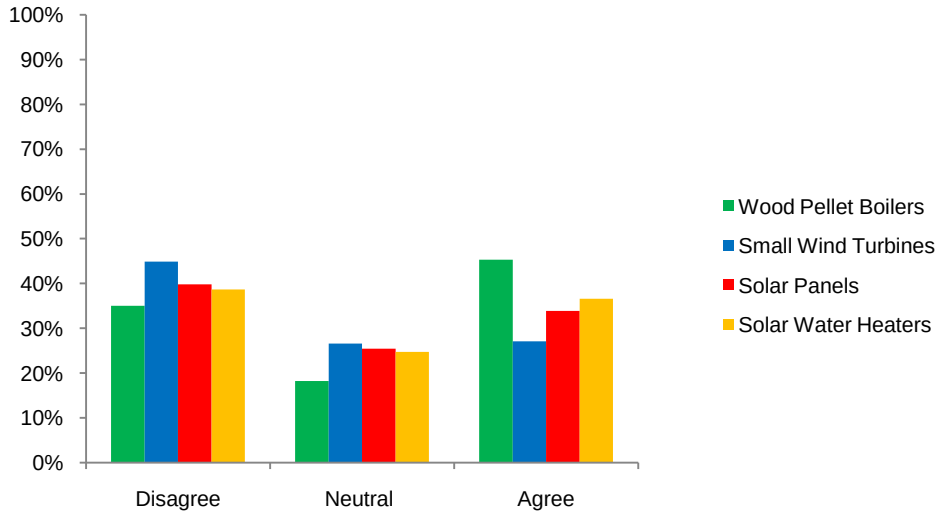


ANOVA results: Differences significant (.05). Solar panels and wood pellet boilers, and solar panels and micro wind turbines.

5.5. Compatibility with Infrastructure

The face-to-face interviews with home owners also revealed that one major barrier associated with microgeneration was the disruption caused by the actual installation of microgeneration technologies. The results presented in Figure 3.23 show that about 45% of home owners believe that wood pellet boilers could only be installed with major additional work. However, only 27% of respondents believe that installing a small wind turbine would be disruptive.

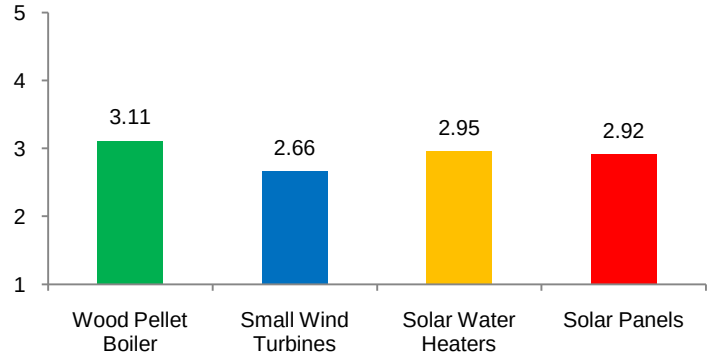
Figure 3.23: Irish Home Owners' Perceptions of Barriers: Disruption through Installation



Q8COM1b: X could only be installed in/on your house with major additional work. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

While the differences between small wind turbines and wood pellet boilers are statistically significant, no statistically significant differences could be detected between the other technologies. Again, the results suggest that wood pellet boilers might be seen as more disruptive due to storage space required, whereas solar water heaters and solar panels are relatively easy to install on the roof. Similarly, small wind turbines are often installed remotely from the house and are likely to be perceived as causing little disruption to the actual dwelling.

Figure 3.24: Comparison of Disruption Barrier (Index)



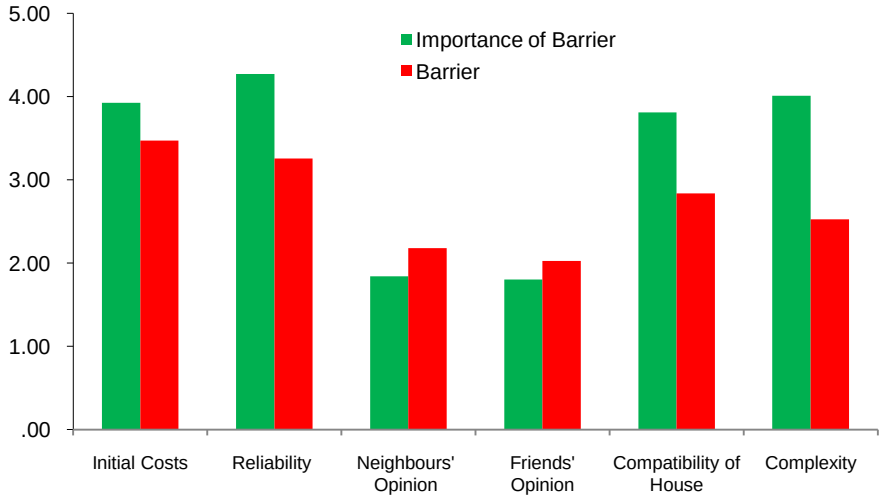
*ANOVA results: Differences significant (.05). Wood pellet boilers and small wind turbines.

5.6. Barrier and Perceived Importance of Barrier

Home owners were further asked how important they thought these barriers are in regard to their buying decisions. The answers were plotted against the perception of the existence of this barrier.

Figure 3.25 shows that initial cost and the reliability of microgeneration technologies are perceived as the key barriers. Further, the histogram shows that home owners consider these barriers as very important factors influencing their buying decisions. Complexity and compatibility of the house were not perceived as such strong barriers, yet most home owners agree that they are important criteria in their buying decision. On the other hand, friends' and family's opinion (i.e. social risk) is not regarded as a barrier and is also not perceived as an important influence on the buying decision.

Figure 3.25: Perceived Existence of Barriers versus Importance of Barrier



Q11IPR1–ICOM2: Barrier X would be very important (5)/not important at all (1) for me, when thinking about buying an *X*. Q5–8: *X* could only be installed in/on your Barrier *X*. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

5.7. Key Findings

The discussion above has shown that the initial costs of microgeneration technologies as well as the uncertainty regarding reliability are perceived as key barriers. The results hold across all four technologies and no differences between micro wind, solar panels, solar water heaters and wood pellet boilers could be detected. Further, the results indicate that the perceived compatibility of microgeneration with the existing infrastructure (i.e. dwelling) is a barrier. The finding implies that many home owners believe that a microgeneration technology could only be installed by retrofitting the house, entailing extra cost and causing disruptions.

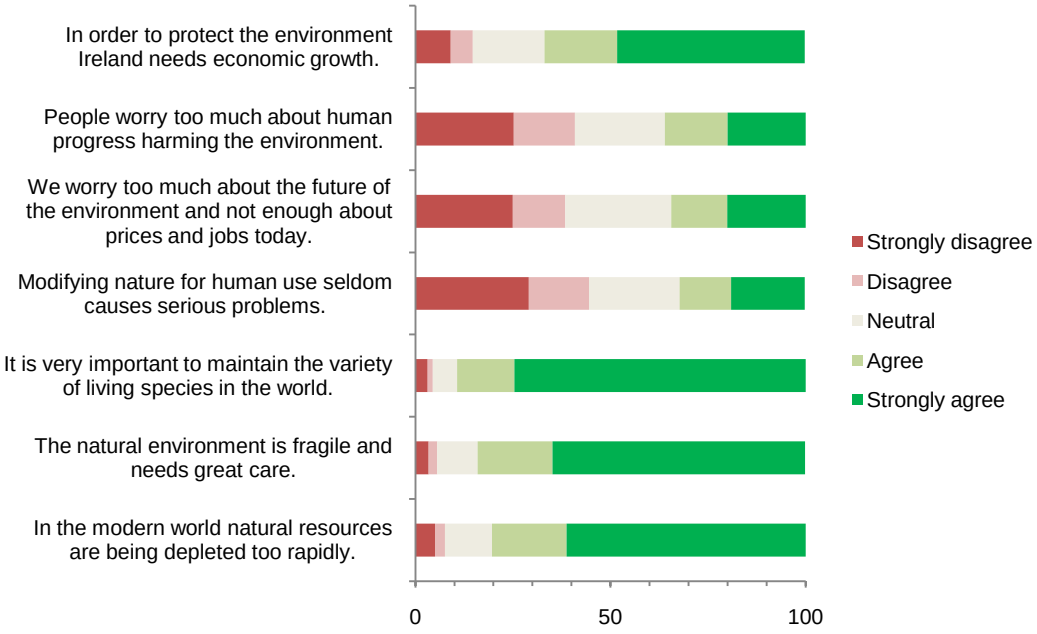
In particular, the installation of wood pellet boilers is believed to be very disruptive. The same holds for compatibility with daily routines and habits. While most home owners believe that solar panels, solar thermal heaters and wind turbines would not interfere with their daily lives, significantly more people are concerned about the daily usage of wood pellet boilers. Further, the results indicate that the four technologies are not perceived as very complex products by Irish home owners, and almost half the respondents stated that they knew where they could see a microgeneration technology operating.

6. Attitudes towards the Environment

This study also assessed Irish home owners' general values regarding the *environment*, *economic growth* and *social change*. In order to understand the complex relationship between these three factors, the New Environmental Paradigm Scale (NEP) was utilised. The theoretical basis for the NEP was established by Dunlap and Van Liere (1978) and resulted from the observation that in western countries people were starting to value the environment and fauna more, realising that resources on this planet are finite as well as 'placing less emphasis on economic growth and adopting a more sceptical attitude towards science and technology' (Kelly et al., 2003).

In an Irish report on environmental attitudes, Kelly et al (2003) adjusted the NEP to test it with the Irish population. They developed seven questions that aimed to investigate the relationship between people's perceptions of *economic growth*, *social change* and *environmental values* (i.e. biocentricity). The same questions were used in this study; the (descriptive) answers are illustrated in Figure 3.26.

Figure 3.26: New Environmental Paradigm Scale Items and Descriptive Findings (%)



Sources: Scale adapted from Kelly et al. (2003); own calculations.

Regarding biocentricity, respondents were presented with two statements: 'It is very important to maintain the variety of living species in the world' and 'the natural environment is fragile and needs great care'. Figure 3.26 shows that a great majority of home owners agree or strongly agree with both the first (89.3%) and the second (84%) statements. The findings indicate that most home owners in Ireland believe that nature is fragile and in need of our care and attention. Further, people's opinion regarding the relationship between economic growth and the natural environment (i.e. limits of growth) was examined: people were asked whether they agree or disagree that 'in the modern world natural resources are being depleted too rapidly'. Again, the results indicate that a great majority of Irish home owners (80.4%) believe that there are limits to growth and that our natural resources should be protected.

The second aspect of the NEP concerned economic growth in relation to the environment. Home owners were presented with two statements: 'We worry too much about the future of the environment and not enough about prices and jobs today', 'In order to protect the environment Ireland needs economic growth'. Almost 66.7% of respondents agreed or strongly agreed with the latter statement; over one third (34.4%) of home owners agreed or strongly agreed with the former statement, suggesting that they value economic stability over the environment. These responses are somewhat contrary to the above answers on biocentricity. However, the survey was conducted in a recessionary climate (November 2009) and the rapid increase in unemployment and decline in economic growth are likely to have influenced people's answers.

Regarding social change, home owners were asked whether they agree or disagree that ‘people worry too much about human progress harming the environment’ and ‘modifying nature for human use seldom causes serious problems’. The results show that about 36.1% agree or strongly agree with the first statement and 32.1% with the second statement.

6.1. Key Findings

Overall, the results suggest that Irish home owners value the environment and biodiversity very highly and most home owners believe that it should be protected. However, the majority (66.7%) also believe that in order to protect the environment, Ireland needs economic growth. This result might be influenced the recessionary times during which the interviews were conducted, but might also suggest that people perceive economic growth and environmental protection as not mutually exclusive. Many people might believe in more sustainable forms of economic growth. For example, the growth of ‘green industries’ such as the renewable energy sector has the potential not only to reduce greenhouse gas emissions but also to create jobs and spur economic growth.

Part IV

Comparison of Home Owners

1. Introduction

Part IV evaluates home owners' intention to buy and install microgeneration technology and how home owners differ in their attitudes and perceptions. During the computer-assisted telephone interviews, the respondents were led through two sets of questions, classifying them into three distinct groups. In a first step, respondents were asked about their intention to buy the respective microgeneration technology within the next 12 months. Respondents who said that they had an intention were classified as *potential adopters*.

Respondents who expressed no intention were asked a second set of questions. These aimed to identify respondents' general openness to invest in the technology at some stage in the future. Thus, respondents who said they had no intention to buy the technology in question within the next 12 months, but could generally see themselves buying it at some later stage, were classified as *undecided*. Those who stated they had no interest of buying the microgeneration technology at any time in the future were classified as *rejecters*. The following compares the socio-demographic backgrounds, attitudes and perceptions of these three groups of home owners.

2. Potential Adopters, Undecided and Rejecters

Figure 4.1 shows the overall split between three categories of Irish home owners across all four technologies.

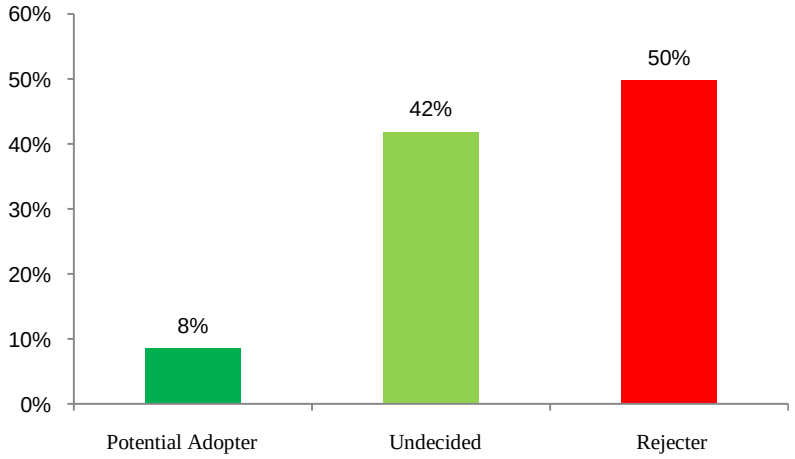
- **Potential adopters** = Home owners who intend to buy the respective microgeneration technology within the next 12 months.
- **Undecided** = Home owners who have no direct intention to buy a microgeneration technology but are generally open to the idea.
- **Rejecters** = Home owners who cannot see themselves buying the respective technology at any stage.

According to the survey, about 8% of home owners are intending to buy a microgeneration technology within the next 12 months. However, these findings need to be interpreted with care, as stated intentions often do not reflect purchasing behaviour accurately. Such intentions are usually deflated on the basis of

past market research data. For example, Belk (1985) notes that on average only 43% of 'intenders' actually purchase. Due to a lack of market research data in this product category we cannot verify these findings in this study, and thus only present the 'stated intentions'.

The results further show that about 50% of home owners completely reject the idea of buying a microgeneration technology. About 42% of people stated that they were generally open to the idea of adopting a microgeneration technology at some stage in the future, yet had no immediate intention to do so.

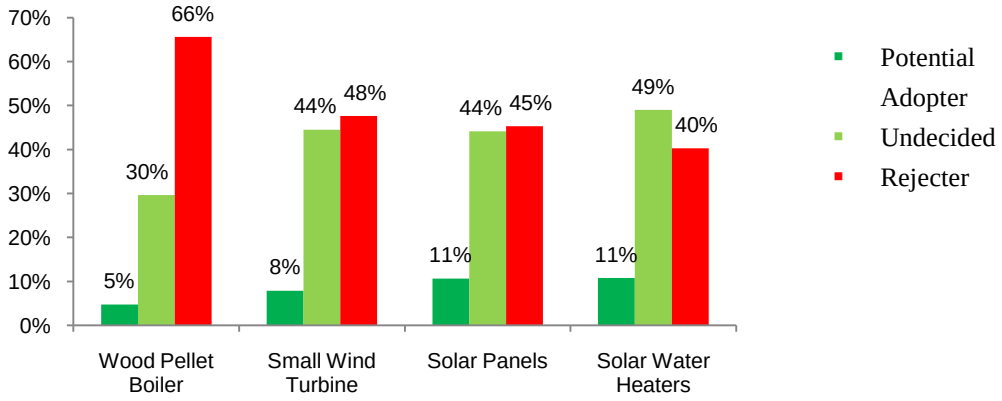
Figure 4.1: Comparison of Types of Home Owner



See text for definitions of 'potential adopter', 'undecided' and 'rejecter'.

Comparing home owners' intention to buy between the four technologies, Figure 4.2 shows that compared to wood pellet boilers (5%) and small wind turbines (8%), significantly more people are intending to buy solar panels (11 %) and solar water heaters (11 %). The level of rejection is highest for wood pellet boilers (66%). Further, about 48% reject the idea of ever buying a small wind turbine. Almost 50% of people were undecided about solar water heaters and generally open to the idea of buying this technology in the future. Figure 4.2 shows that in regard to micro wind turbines, solar panels and solar water heaters the split between undecided and rejecters is fairly equal.

Figure 4.2: Comparison of Types of Adopters across Microgeneration Technologies



Source: Own calculations.

2.1. Differences in Personal Characteristics of Types of Adopter

In a third step, the socio-demographic profiles of adopters, undecided and rejecters were compared to identify significant differences. Again, an ANOVA was conducted to test whether the means of these three groups are statistically different from each other. In the analysis *type of adopter* was treated as a (categorical) independent variable, aiming to explain differences in *age* in years, *education* (i.e. highest level completed to date), *household size* (i.e. number of people living in the dwelling), *knowledge* (self-assessed) and *awareness of microgeneration technologies* (i.e. number of technologies heard of).

The data presented in Table 4.1 indicate that the socio-demographic characteristics of adopters are fairly equal compared to the overall sample and between groups. However, the results from the ANOVA revealed that there are significant differences between adopters, undecided and rejecters in age, knowledge and the number of people living in the household.

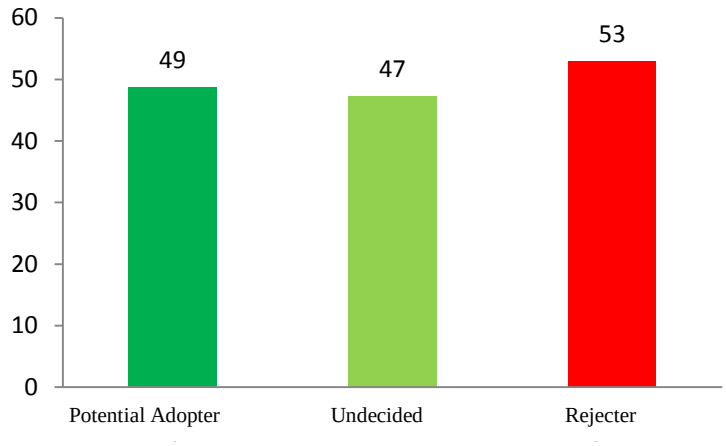
Table 4.1: Socio-demographic Profile of Types of Adopter (%)

Variable		Adopter (*n* = 86)	Indifferent (*n* = 423)	Rejecter (*n* = 503)	Overall (*n* = 1012)
Gender	Male	57.0	52.0	49.9	51.4
	Female	43.0	48.0	50.1	48.6
Age	15–24	5.8	3.1	1.4	2.5
	25–34	15.1	20.3	14.1	16.8
	35–44	24.4	23.4	18.9	21.2
	45–59	34.9	35.5	33.0	34.2
	60+	19.8	17.7	32.6	25.3
Region	Dublin	18.6	17.0	23.7	20.5
	Rest of Leinster	33.7	32.6	28.4	30.6
	Munster	25.6	29.1	27.6	28.1
	Connacht/Ulster	22.1	21.3	20.3	20.8
Social Class	Upper class	14.0	12.8	12.3	12.6
	Upper middle class	25.6	26.0	28.0	27.0
	Middle class	24.4	23.4	16.9	20.3
	Working class	23.3	27.0	32.8	29.5
	Farmers	10.5	9.5	9.1	9.4
	Refused	2.3	1.4	.8	1.2
Type of House	Detached house/bungalow	67.4	59.3	55.3	58.0
	Semi-detached house/bungalow	25.6	28.4	33.4	30.6
	Terraced house	7.0	12.3	11.3	11.4

Source: Own calculations.

The findings presented in Figure 4.3 show that home owners who reject microgeneration technologies are on average older than those who are undecided or intending to adopt. Further, adopters are on average older than the indifferent, but these differences are not statistically significant.

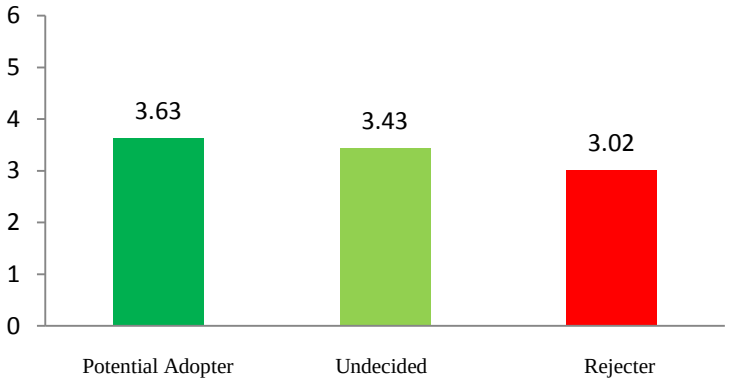
Figure 4.3: Average Age of Types of Adopter (Years)



Source: Own calculations. Differences significant (0.05) for indifferent–rejecter (Dunnett T3) test because of heteroscedasticity.

The analysis also shows that rejecters are, on average, living in households with fewer people (Figure 4.4). This is likely to be related to the higher average age of the rejecter group, as children of older home owners are likely to have left their parents' house. It can be argued that home owners with children have relatively greater energy demands and the potential energy-cost savings from buying a microgeneration technology are likely to be higher. This would explain why rejecters are, on average, older that undecided or potential adopters.

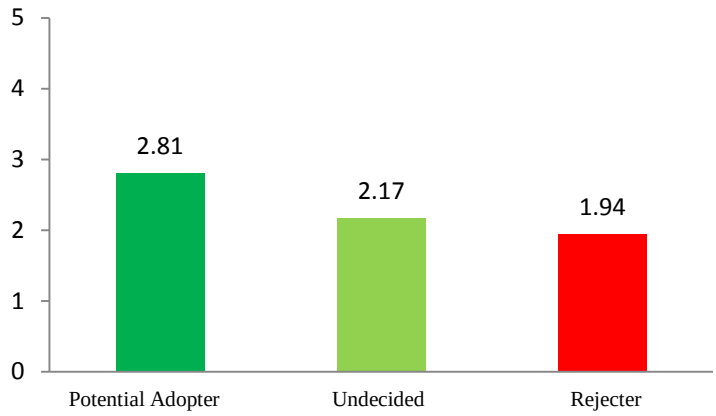
Figure 4.4: Average Number of People Living in the Household by Types of Adopter



Source: Own calculations. Differences significant (0.05) except for indifferent–adopters

The analysis also shows statistically significant differences in subjective knowledge between the three groups. Not surprisingly, potential adopters seem to have better knowledge of costs and savings as well as maintenance and installation requirements, compared to the other two groups. Rejecters claim to have the lowest level of knowledge, indicating a generally lower level of interest in microgeneration technologies within this group.

Figure 4.5: Subjective Knowledge (Index) by Type of Home Owner



Q10: How knowledgeable are you regarding: the cost of *X*/the installation requirements for *X* on your house/maintenance and service needs of *X*/the cost savings that *X* can make over the course of a year. Differences significant (0.05). Measured from 'extremely unfamiliar' (1) to 'extremely familiar' (5).

Although the causality between knowledge and intention has yet to be established, it can be speculated that educating people about microgeneration does have a positive effect on their intention to invest in these technologies. On the other hand, home owners who are intending to buy are likely to have informed themselves about the technology in question and are thus more knowledgeable than those who have not.

Finally, when comparing the three groups in terms of their overall level of awareness for microgeneration technologies and level of education, no statistically significant differences could be detected.

2.2. Differences in Housing Characteristics

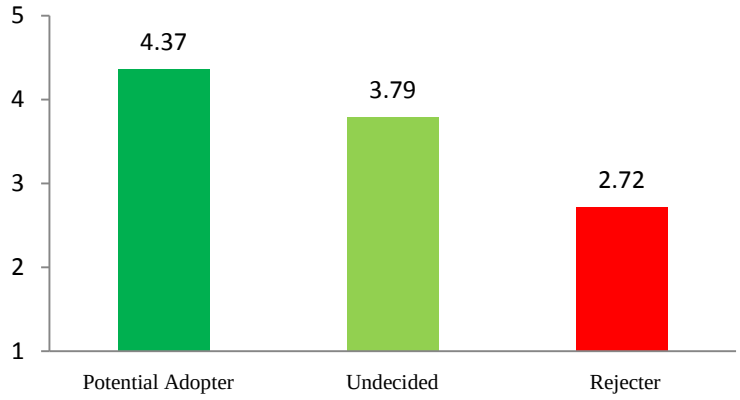
Following the comparison in personal profiles, a similar analysis was conducted to test for differences in housing characteristics, using the type of home owner (adopter, undecided, rejecter) and the type of house (detached, semi-detached, terraced) as explanatory variables to explain the *size of the house* (number of bedrooms), *the age of the house* (in decades) and the *number of energy efficiency measures installed*. The ANOVA, however, showed no statistically significant differences in housing characteristics between the three groups.

2.3. Differences in Attitudes

After testing for differences in the socio-demographic profile of home owners and the characteristics of their dwelling, this section evaluates differences in attitudes and perceptions between the three groups of adopters.

Figure 4.6 clearly shows that overall attitudes towards installing a microgeneration technology differ significantly between the three groups of home owner. As expected, adopters have the most positive attitudes towards microgeneration, followed by undecided and rejecters. As measured on a scale from 1 (strongly disagree) to 5 (strongly agree), where 3 (neither agree nor disagree) constitutes the midpoint, Figure 4.6 shows that rejecters have on average a negative attitude. Adopters and those classified as undecided, on the other hand, both have positive attitudes towards microgeneration.

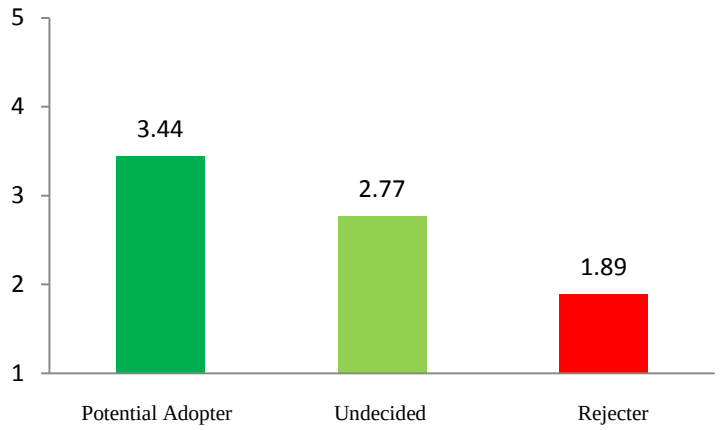
Figure 4.6: Attitudes to installing Microgeneration Technology (α = .86)



E.g. Q3A1: Installing *X* on your house in the next 12 months would be very good. Measured from 'strongly disagree' (1) to 'strongly agree' (5). Differences significant (0.05) (Dunnett T3 because of heteroscedasticity).

A similar picture emerges when comparing the perceived social pressure (i.e. subjective norms) between the three groups of home owners, as illustrated in Figure 4.7. The ANOVA shows that differences between the three groups are all statistically significant. Further, adopters claim to experience relatively high levels of encouragement and support from significant others such as friends and family. In contrast, rejecters claim to experience hardly any social influence regarding the adoption of microgeneration technologies. The undecided are somewhat in the middle, yet their subjective norms are significantly higher than those of rejecters.

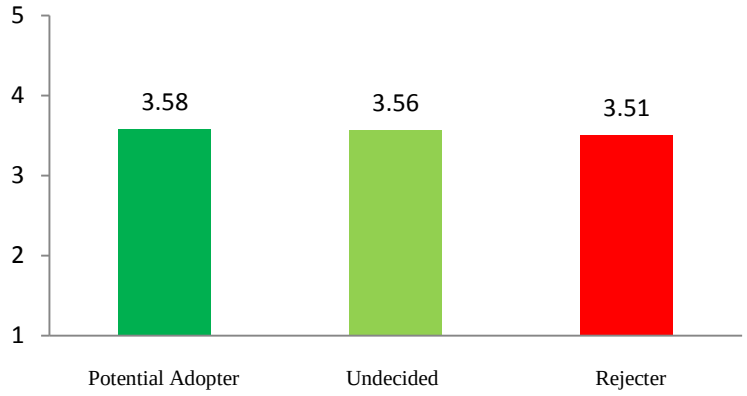
Figure 4.7: Subjective Norms (α = .82)



E.g. Q3SN1: Most people who are important to you think that you should install *X* on your house in the next 12 months. Measured from 'strongly disagree' (1) to 'strongly agree' (5). Differences significant (0.05)

In a last step, the mean differences in home owners' environmental attitudes (NEP) were evaluated. As shown in Figure 4.8, the ANOVA shows no statistically significant differences in environmental attitudes between the three groups. The results suggest that people have a generally positive attitude towards the environment, yet this does not seem to translate into an intention to buy a microgeneration technology.

Figure 4.8: Attitudes to the Environment (NEP)



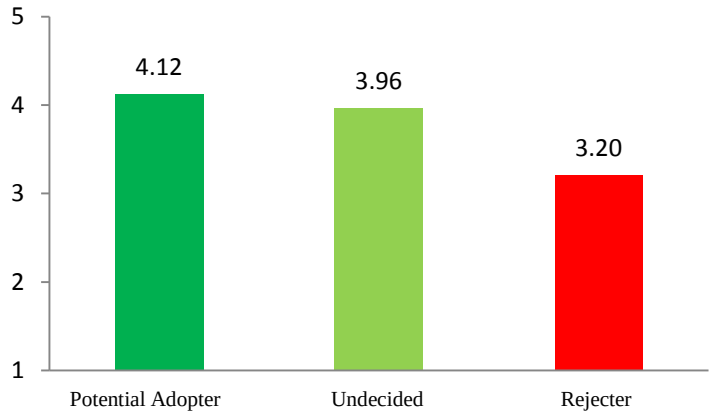
Differences non-significant (.05).

Overall the findings show that there are significant differences in the level of attitudes and perceived social norms between the groups and that both factors are likely to have a strong influence on people's decision to buy a microgeneration technology.

2.4. Differences in Perceptions of Benefits

When comparing the perceptions of benefits associated with microgeneration technologies, a similar pattern emerges. The ANOVA in Figure 4.9 shows that adopters and undecided both associate higher levels of benefits (i.e., energy savings, CO_2 emission reductions and independence) with buying a microgeneration technology than rejecters. The differences between undecided home owners and adopters, however, turn out to be statistically non-significant. This finding is not surprising, as undecided home owners are likely to associate benefits with microgeneration technologies, yet there might be other barriers that prevent them from forming an immediate intention to buy a microgeneration technology.

Figure 4.9: Perceptions of Overall Benefits (Cronbach's α = .76)



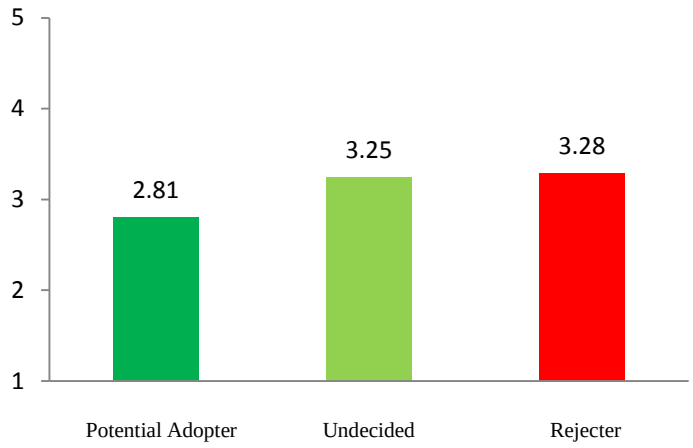
E.g. Q4PRA1a: Installing *X* on your house would reduce your monthly energy bill significantly. Differences significant (.05), except for adopter–undecided. Measured from 'strongly disagree' (1) to 'strongly agree' (5).

2.5. Differences in Perceptions of Risk

Almost the opposite is true for the perception of functional or performance risk (see Figure 4.10). Adopters associate significantly lower levels of risk with microgeneration technologies than undecided or rejecters. One explanation might be that, as seen earlier, adopters have higher levels of knowledge, which is likely to have reduced the overall level of uncertainty associated with microgeneration technologies. Another explanation might be that early adopters are generally more innovative and willing to take greater risks regarding new technologies.

Further, the results show no statistically significant difference between undecided and rejecters. Again, this could imply that risk is a general obstacle to form a buying intention but does not explain whether or not someone generally rejects the idea of installing a microgeneration technology at their house.

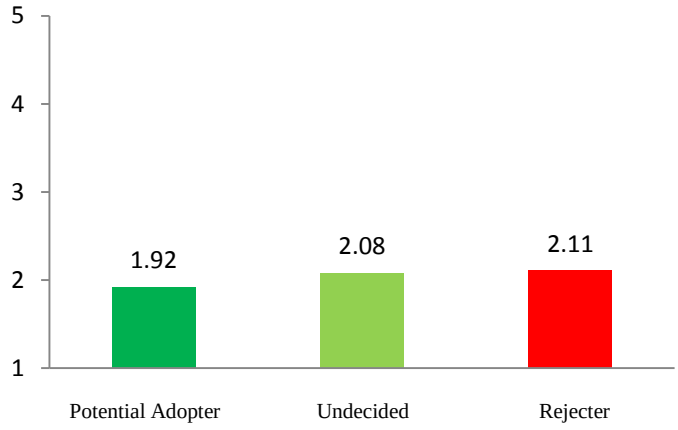
Figure 4.10: Perceptions of Functional/Performance Risk (α = .86)



E.g. Q5PR1a: When thinking about installing *X* on your house, you would be concerned that the financial investment would not pay off. Differences significant (.05) except for indifferent–rejecters (Dunnett T3 because of heteroscedasticity). Measured from 'strongly disagree' (1) to 'strongly agree' (5).

When the levels of social risk associated with microgeneration technologies were compared, no statistically significant differences between the three groups could be detected. Figure 4.11 shows that the overall perceptions of social risk are relatively low, indicating that home owners do not believe that neighbours or local residents disagree with them installing a microgeneration technology. Thus, social risk does not seem to be an issue that prevents home owners from investing in microgeneration.

Figure 4.11: Perceptions of Social Risk (α = .76)



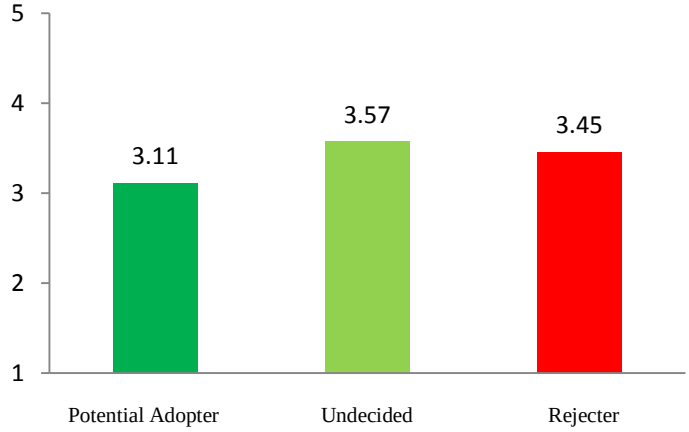
E.g. Q5PR3b: When thinking about installing *X* on your house, you would be worried that the local residents might not be happy. Differences non-significant (.05). Measured from 'strongly disagree' (1) to 'strongly agree' (5).

2.6. Differences in Perceptions of Barriers

2.6.1. Perceived Initial Cost

This section evaluates differences in the perception of barriers, starting with the upfront investment or initial cost of microgeneration technologies (see Figure 4.12). The comparison of the three groups shows significant differences between adopters and the undecided group, whereas no differences could be detected for undecided and rejecters. The findings suggest that the initial costs are a key barrier for people who are thinking about adopting a microgeneration technology. For the indifferent, the graph shows that the initial costs seem to be relatively more important, preventing them from adopting a microgeneration technology in the short term. However, home owners who reject the technologies completely, might do so for other reasons that upfront costs.

Figure 4.12: Perceptions of Initial Costs (α = .89)

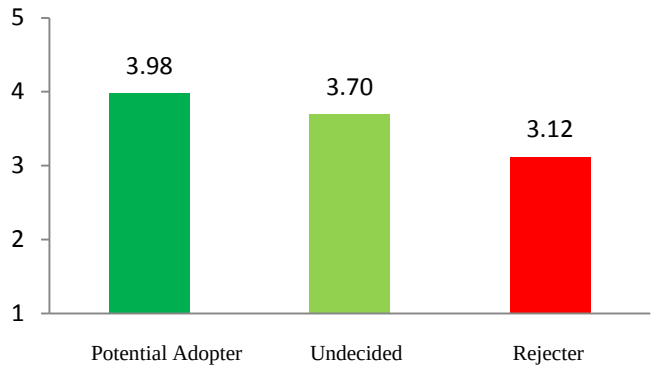


E.g. Q8IC3: The initial cost of installing *X* on your house would be too high for you. Differences significant (.05) only for indifferent–adopter (Dunnett T3 because of heteroscedasticity). Measured from 'strongly disagree' (1) to 'strongly agree' (5).

2.6.2. Perceived Compatibility with Daily Routines and Habits

When asked how they perceived the usage of the respective technology in terms of compatibility with their daily routines and habits, the majority of respondents believed that they would not have to change much in order to use microgeneration technologies. Figure 4.13 illustrates the results from the ANOVA, showing statistically significant differences between the three groups. As expected, those classified as potential adopters see the least problems with using a microgeneration technology, followed by the undecided and rejecters. What is interesting, however, is that unlike initial costs the differences between undecided and rejecters are significant. Again, this might indicate that barriers other than cost have an influence on whether or not home owners can generally see themselves installing a microgeneration technology.

Figure 4.13: Perceptions of Compatibility with Daily Routines and Habits (α = .83)

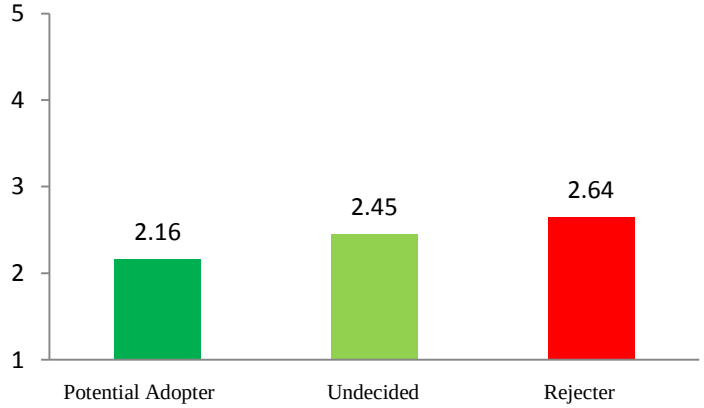


E.g. Q7COM2a: To use *X* would not require significant changes in your existing daily routines. Differences significant (.05) (Dunnett T3 because of heteroscedasticity) Measured from 'strongly disagree' (1) to 'strongly agree' (5).

2.6.3. Perceived Complexity

Another barrier often associated with microgeneration technologies is the complexity, or the amount of information required to make an informed buying decision. Yet the results from the survey show that most home owners perceive microgeneration as not difficult to use or understand (Figure 4.14). The group comparison, however, show that the three groups are significantly different from each other in their perception of complexity. Again, the group of rejecters associates, on average, a higher level of complexity with microgeneration technologies than undecided or potential adopters.

Figure 4.14: Perceptions of Complexity (α = .78)

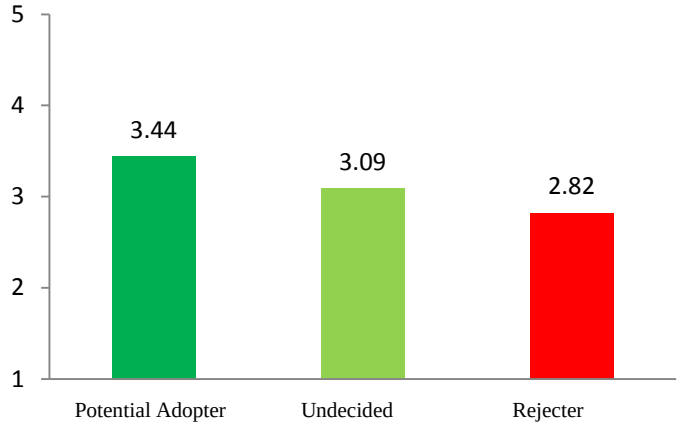


E.g. Q8PC1: *X* are very complex products. Differences significant (.05). Measured from 'strongly disagree' (1) to 'strongly agree' (5).

2.6.4. Perceived Trialability

As with most innovations in the early stages of market penetration, people may not be able to draw on other people's experiences with these new technologies. This lack of trialability is a significant barrier for home owners to buy a microgeneration technology. The results from the ANOVA shown in Figure 4.15 seem to confirm that potential adopters claim more often to be able to try out the respective technology before actually buying it.

Figure 4.15: Perceptions of Trialability (α =.68, without Q8TR2)



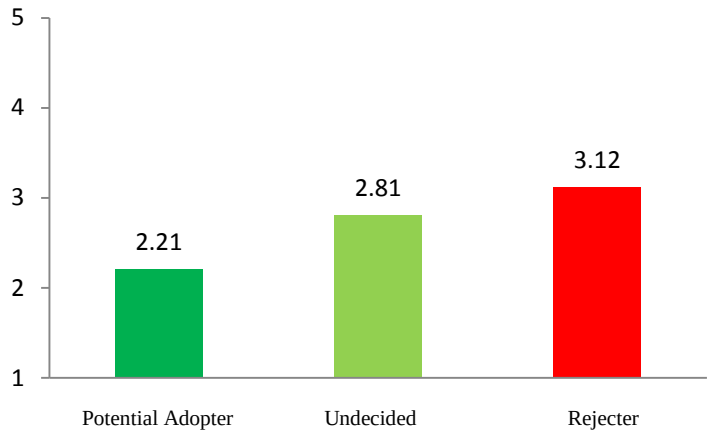
E.g. Q8TR1: You know where you could go to satisfactorily see various types of *X* working. Differences significant (.05). Measured from 'strongly disagree' (1) to 'strongly agree' (5).

Rejecters claim to have the lowest chance of seeing a microgeneration technology working. The results seem to suggest that trialability is a significant barrier and that the visibility of microgeneration technologies is an important factor for their diffusion in consumer markets.

2.6.5. Perceived Potential Disruption through Installation

The disruption caused by retrofitting the house is a barrier often identified by home owners. The results from the ANOVA show significant differences between the three groups (see Figure 4.16). Whereas most adopters and undecided do not believe that fitting a microgeneration technology would cause much disruption, it appears to be a significant obstacle for rejecters. The results indicate that people who completely reject the idea of buying a microgeneration technology may do so because they believe that the technology can only be installed with major additional work at their house.

Figure 4.16: Perceptions of Potential Disruption (α = .83, without Q8COM1)



E.g. Q8COM1b: *X* could only be installed on your house with major additional work. Differences significant (.05). Measured from 'strongly disagree' (1) to 'strongly agree' (5).

3. Key Findings

The analysis has shown that across all four technologies, about 8% of homes can be classified as potential adopters. Past research, however, has shown that estimates of 'intention to buy' need to be deflated and that the true proportion of home owners that are likely to install a microgeneration technology might be closer to 2–3%. About 42% of home owners can generally see themselves investing in microgeneration at some stage in the future (i.e. undecided) and about 50% reject the idea completely (i.e. rejecters).

The findings show that rejecters are on average older, live in households with fewer people and are less knowledgeable regarding microgeneration than the two other groups. Further, unlike adopters and undecided, rejecters have negative attitudes towards microgeneration and say that they experience no positive social pressure.

The results also show that initial costs are a significant barrier for the undecided as well as rejecters. However, the findings indicate that the latter group rejects microgeneration technologies not only for financial reasons. For example, relatively more rejecters believe that microgeneration is not compatible with their daily routines and habits. They perceive microgeneration technologies as more difficult to use, and understand and believe that the respective technology could only be installed at their house with major additional work. For the indifferent, however, the upfront costs appear to be the key barrier. The technology that the highest proportion of Irish homes say they reject is wood pellet boilers (66%).

Part V

Policy Implications

Attitudes and Perceptions Need to Be Accounted for in Promotional Campaigns

The analysis shows that attitudes and perceptions differ significantly between the four microgeneration technologies. Wood pellet boilers in particular are perceived as less favourable, which might be related to some of the negative press coverage in regard to pellet supplies and the reliability of boilers.

The findings imply that any promotional campaign that aims to increase the uptake of microgeneration should be tailored towards the individual technology, taking account of home owners' needs and reservations. Suppliers and installers in particular will have a key role to play in overcoming some of the negative perceptions and providing people with the right information about potential cost savings as well as installation and usage requirements.

Increasing 'Social Pressure' is Likely to Boost Uptake of Microgeneration

The findings suggest that due to good visibility and a relatively high level of solar water heater uptake, a large number of home owners already experience positive social pressure to adopt this technology. Evidence from the innovation literature suggests that social pressure is a strong driver of diffusion of new technologies. Showcase installations in identified (e.g. high-income/high-density) areas can be one way not only to increase awareness but to 'spread the word', increase social pressure and ultimately speed up adoption.

The Gap between Willingness to Pay and Market Prices Needs to be Bridged

There is great market potential for microgeneration technologies, with approximately 50% of home owners stating that they can see themselves installing a microgeneration technology in the near or medium-term future.

Yet there remains a significant gap between home owners' willingness to pay and actual market prices of solar panels, wood pellet boilers and micro wind turbines. (The exception is solar water heaters, for which WTP matches market prices.) In order for them to diffuse into mainstream markets, prices for these technologies must drop significantly or policies must be implemented to bridge home owners' WTP and market prices. Given the large gap, the provision of grant aid, subsidies or tax incentives aiming to increase the uptake of microgeneration can be very costly. Given the high WTP for solar water heaters, the non-provision of grant aid for this technology should also be considered.

Micro-Loans/Micro-Finance Might Provide a More Viable Support Mechanism

A financially more viable solution than grant aid could be micro-loans/micro-finance for home owners, provided by financial institutions or energy suppliers. Such loans would lower or eliminate the high upfront investment for home owners, and repayments could be financed via monthly or annual energy savings. Further, providers of micro-loans could chose to buy the technologies in bulk, generate economies of scale and ultimately lower the prices for microgeneration. They would also have greater control over choosing qualified and experienced installers, eliminating some of the uncertainties around the quality and safety of installations.

Renewable Energy Feed in Tariff (REFIT)

REFIT is an important policy tool to encourage the uptake of renewable energy technologies. It imposes obligations on regional and national utility companies to offers households and business access to the grid as well as long-term contracts with fixed prices for the electricity produced from, for example, microgeneration. Although Ireland introduced such a REFIT for electricity produced by microgeneration technologies, the offered price of €0.19/kWh is not sufficient to encourage significant market development. This compares to, for example, up to €0.49, €0.328, €0.512, €0.413 and €0.34/kWh for solar electricity in Germany, the Czech Republic, France, the United Kingdom and Spain respectively.

Overall, the evidence shows that the early introduction of relatively generous feed-in tariffs has been a successful key driver of the diffusion of microgeneration technology, with often positive knock-on effects for industry, employment and economic growth. However, such benefits need to be carefully assessed against the overall costs of introducing a REFIT.

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Appendix 1 – Willingness to Pay

Empirical Model

In the scenario Irish home owners faced two bids .The response to the first bid (B_i) determined the level of the second bid (i.e. B_i^u if B_i accepted; and B_i^l if B_i rejected). This led four possible outcomes to the WTP scenario: 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:

$$\pi^{yy}(B_i, B_i^u) = 1 - G(B_i^u; \theta)$$
$$\pi^{nn}(B_i, B_i^l) = 1 - G(B_i^l; \theta)$$
$$\pi^{yn}(B_i, B_i^u) = G(B_i^u; \theta) - G(B_i; \theta)$$
$$\pi^{ny}(B_i, B_i^l) = G(B_i; \theta) - G(B_i^l; \theta)$$

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

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

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

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", $d_i^{yy} = 1$ and zero otherwise). The *ML* estimator for the above defined model $\hat{\theta}$ is the solution for the first-order condition:

$$\partial \ln L(\hat{\theta})/\partial\, \theta = 0$$

In order to calculate the mean and median WTP and the respective confidence intervals, the method introduced by Krinsky and Robb (1986) was employed. This method has yielded robust results, particularly for small to medium sample sizes (e.g. Cooper, 1994).

Appendix 2 – Questionnaire

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**

ASK TO SPEAK
Under 15..... 1
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
CONTINUE
No..... 2
ASK TO SPEAK TO PERSON WHO IS IN CHARGE OF THESE

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
Flat/Apartment in a converted house (including bed sit)	5 **CLOSE**
Caravan/Mobile Home	6
Others	7

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
Others	4
CLOSE	
DK	5

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

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 'very likely', or any number in between. I'll repeat that scale – 1 means 'very unlikely' and 5 means 'very likely', or any number in between.
READ OUT. RANDOMISE.

		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

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 *concerns* about installing **<*Solar panels*>** on their house. So in this section I would like to ask you a few questions regarding specific risk 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..**READ OUT. RANDOMISE ATTRIBUTES.**

		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 not 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 *not* 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 panels*>** on your house, you would be concerned that they would not provide the level of benefits you would be expecting.	1	2	3	4	5	6
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
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
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
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	1	2	3	4	5	6

	improve your standing in the local area.						
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

COM1b	<***Solar panels***> could only be installed on your house with major additional work.	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
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**]? **RANDOMISE ATTRIBUTES.**

		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.12a **WTP 1** In this final part, I am going to present you with an 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 <u>NEXT LOWER</u> VALUE.
IF ANSWER IS 'YES', ASK QUESTION 12b WITH <u>NEXT HIGHER</u> 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.13a 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**]? **<u>RANDOMISE ATTRIBUTES</u>.**

		Most helpful policy
PP1	Information in form of leaflets or brochures or websites	1
PP2	Grants	2
PP3	Low cost loans	3
PP4	Showcase 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/Inter Cert/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.