



Sustainable Energy Authority of Ireland

National Energy Research,
Development & Demonstration
Funding Programme

FINAL REPORT TEMPLATE

SECTION 1: PROJECT DETAILS – FOR PUBLICATION

Project Title	Growing Energy Efficiency in the Car Market (GREENCAR): The Role of Fuel Costs in Vehicle Investment Decisions
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Report Submission Date	

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Project Summary (max 500 words)

GreenCar aims to reduce transport related emissions by encouraging individuals to purchase an electric vehicle/a more efficient vehicle. It aims to accelerate the deployment of energy efficient vehicles in the private car market by proposing a solution to overcome a behavioural barrier to market uptake.

The project builds upon a key hypothesis: that customers do not fully account for the future costs of ownership when making investment decisions regarding energy-consuming technologies. This results in an undervaluation of vehicle energy efficiency at the point of sale and a stock of vehicles with higher carbon emissions. This GREENCAR project combines a research team with over ten years of large-scale randomised control trial experience in Ireland and abroad with the second

largest car retailer in Ireland, Hyundai, to test a new energy label showing energy costs (with a digital application) in car showrooms with the goal of encouraging greater uptake of efficient vehicles.

The project combines several sources of data, including both quantitative and qualitative research data on car purchase decisions. Qualitative data collected includes focus groups with car buyers and sellers and in-depth interviews. Quantitative data was collected via two nationally representative surveys which included discrete choice experiments (DCE) and a field trial including a dedicated application to display energy cost forecasts at the point of sale to prospective consumers. The randomised controlled trial in GREENCAR represents the first of its kind in the world in the private car market. It builds vital research capacity and knowledge in this space and cements Ireland's position as a world leader in behavioural economics relating to energy policy.

The project is well positioned to provide evidence-based research to support policy design and to provide guidance and support to policy makers and public bodies to increase the deployment of efficient vehicles. Furthermore, results are likely to be generalisable to other technologies, sectors and countries, further cementing Ireland's contribution in this space.

Keywords (min 3 and max 10)

Energy labels, fuel costs, randomised controlled trial, discrete choice experiment, behavioural economics, energy efficiency gap, electric vehicles, transport

NB – Both Section 1 and Section 2 of this Final Report will be made publicly available in a Final Technical Report uploaded online to the National Energy Research Database.

In the following Section, please provide a clear overview of your project, including details of the key findings, outcomes and recommendations. The section headings below are provided as a guide, please update or add to these as best suits your project.

By submitting this project report to SEAI, you confirm you are happy for Section 1 and Section 2 of this report to be made publicly available. If you wish to request edits to this section in advance of publication, please contact SEAI at EnergyResearch@seai.ie.

SECTION 2: FINAL TECHNICAL REPORT – FOR PUBLICATION

(max 10 pages)

2.1 Executive Summary

This document describes and synthesises the overall findings from the GreenCar research project. The GreenCar research project ran between January 2020 and August 2024 and involved multiple work streams including:

- 1) The development of a theoretical model of car purchases and a review of the related international literature.
- 2) Qualitative data collection from multiple focus groups with car purchasers and sellers and in-depth interviews with sales staff.
- 3) The development of an application to display energy cost information at the point of sale and a national level Randomised Controlled Trial (RCT) with a major car manufacturer.
- 4) Two nationally representative surveys of Irish car buyers including discrete choice and energy cost labelling experiments.

The goal of the project was to gain a deeper understanding of consumer car purchase decisions, with a particular focus on the role of energy cost information in the decision-making process. The overall findings can be summarised as follows:

- Most studies suggest that consumers are inattentive to, or significantly undervalue future fuel costs when making a new car purchase (WP1). We base our theoretical framework and research hypotheses on these findings. While many studies find that consumers significantly undervalue future fuel costs, few studies have attempted to correct this via an intervention. This motivates our attempt to provide energy cost information to consumers via both online experiments and a real-world field trial.
- The online survey findings (WP3 & WP4.2) suggest that there is a growth in stated preferences towards electric vehicle (EV) drivetrains. In wave one of the study, when asked what type of engine technology they would consider on their next purchase 17% of respondents chose a battery electric vehicle (BEV) and 6% a plug-in hybrid vehicle (PHEV). These shares grew to 35% for BEVs and 11% for PHEVs in wave two of the survey. However, despite this move in stated preferences towards electric drivetrains, and even if these were to materialise, a significant gap between policy ambition for EV uptake and consumer preferences still exists.
- When studying preferences towards various characteristics of electric vehicles, consumers are mainly influenced by price and range in the Discrete Choice Experiment (DCE) in both waves of the survey (WP3 & WP4.2). Purchase price sensitivity appears to have decreased in wave two, and we observe a move in baseline car choices towards larger vehicle classes (particularly large SUVs). This is consistent with observed patterns in vehicle registrations, and will be an important consideration for policy-makers when designing the vehicle taxation system going forward, given externalities other than emissions associated with such vehicles.
- Findings from the online labelling experiments suggest that presenting energy cost information to consumers influences the probability that an individual will choose an EV option. How the energy cost and CO₂ information is framed however also matters. We find that longer-term framing (10 years) is more effective in the first wave of the survey (2020), however shorter-term framing (1 year) appears to be the most effective in wave two (2024). This may stem from uncertainty arising from volatility in energy prices, whereby consumers may place more weight on shorter-term energy forecasts. In both waves of the study, we find that aggregation of energy use costs is effective in encouraging the choice of a more efficient vehicle, therefore a practical policy recommendation may be to display forecasted energy costs over a yearly period.
- Preliminary findings from the field trial (WP4), where energy cost differences between ICE and EV vehicles were presented to consumers at the point of sale via a dedicated application, suggest that we do not observe an immediate effect of treatment on the type of vehicle purchased. In-depth interviews with sales staff confirm this, with most sales staff suggesting that the decision to purchase an EV or an ICE engine does not happen in the showroom and

can take several months of planning. Targeting consumers with information on energy cost differences between EVs and ICEs may therefore be more effective if the information is delivered in advance of the point of sale. There are a number of important limitations to the generalizations of these findings however, including the fact that an interactive format was used to display information and the challenging COVID-19 environment.

- Qualitative data from the focus groups (WP2) and interviews (WP4) allow us to both explore the barriers/enablers to EV adoption and to better interpret our quantitative results. Focus group findings suggest that key concerns relating to a switch to EV are range, charging (lack of public charging infrastructure and hassle of charging) and price. Fuel efficiency also features prominently within the household's car buying process, followed by vehicle size and safety. The benefits of switching to an EV appear to differ by customer – some will switch for environmental considerations while others are motivated by fuel savings – there appears to be no “typical” motivation. Focus group findings with consumers also suggest that most appear to distrust car sellers and conduct much of their research at home prior to entering the showroom. Sales staff interviews confirm this, and also suggest the possibility of information overload at the point of sale.
- Additional findings from the surveys indicate that consumers exhibit strong brand loyalty and conduct significant independent research prior to purchasing a new vehicle. Research on a new vehicle starts typically 2 to 6 months prior to vehicle purchase, which is consistent findings from sales staff interviews. Most respondents plan on owning their new vehicle between 4 and 6 years.
- Sources of research highlighted include independent review websites, car manufacturer websites and public forums. Most respondents appear to use a combination of sources when conducting research on their vehicle of interest. We observe a significantly increased awareness of EV supports, although there are fewer such supports in place in the second wave of our survey. Trust in manufacturer fuel economy ratings appears to be high. Respondents also report an increase in car travel, despite significantly increased fuel costs.

2.2 Introduction to Project

The focus of the GREENCAR project is on the role of **imperfect information** in the energy efficiency gap. We first discuss the state-of-the-art relating to the energy efficiency gap and then highlight the role of imperfect information and recent research addressing this aspect.

2.2.1 *The Energy Efficiency Gap*

The failure of adopters to trade lower future energy costs for higher initial investment costs (everything else equal) is known as the ‘energy paradox’ (Jaffe and Stavins, 1994a), resulting in an ‘energy efficiency gap’ (Jaffe and Stavins, 1994b).

Choosing a more energy efficient technology involves more than comparing energy savings to incremented investment costs. Unobserved adoption or transaction costs also play a role in the investment decision. For example, potential adopters must learn how a new technology fits into existing household routines (high search costs are also discussed in Hausman and Joskow (1982)) and, post-adoption, there may be qualitative deficiencies embedded in more efficient technologies (Jaffe and Stavins, 1994b). For prospective adopters of electric vehicles, there may be a disutility associated with expected changes to fuelling (charging) and driving behaviour (range).

There are, however, also many benefits associated with improving energy efficiency which need to be considered. For example, for property, improving insulation also enhances occupant comfort and future resale value (Hyland et al., 2013). There may even be ‘warm glow’ (Andreoni, 1990) motives at play given the perceived negative environmental and societal consequences of energy consumption. For business, it is possible that energy efficiency investments are used to boost corporate image and increase sales. For households, there may be equivalent status effects, particularly for visible technologies such as cars and solar panels. Such costs and benefits are agent-specific, and are likely heavily influenced by demographics, environmental attitudes and culture.

A number of potential behavioural failures may increase the size of the Energy Efficiency Gap. Hyperbolic discounting leading to 'present bias' or 'time-inconsistency' (Frederick et al., 2002; Laibson, 1997; Loewenstein and Prelec, 1992) has obvious implications for the valuation of future energy savings. High uncertainty over energy prices and savings (Sutherland, 1991) and the irreversible nature of efficiency investment (Hassett and Metcalf, 1993) may also lead to higher implicit discount rates. Furthermore, 'Prospect Theory' (Kahneman and Tversky, 1984, 1979; Tversky and Kahneman, 1986) suggests that the value change associated with a loss is significantly higher than that for an equivalent gain ('loss aversion'), that choices are driven by context (framing effects) and that decision makers overweigh certain outcomes (certainty effect). The theory helps explain why decision makers can reject an actuarially favourable (but perceived riskier) alternative and are reluctant to deviate from their status quo ('status quo bias') (Samuelson and Zeckhauser, 1988).

2.2.2 *Imperfect information and the Energy Efficiency Gap*

The focus of this project is on the role of imperfect information related to the energy savings associated with more efficient technologies in the energy efficiency gap. For example, the energy efficiency gap may simply be due to the fact that agents are unaware of the energy intensity of different goods or, perhaps more importantly, the energy intensity of their existing technologies. There may also be asymmetric information problems between buyers and sellers of goods at the point of sale – a salesperson's commission may be unrelated to the efficiency of the goods he/she sells (Carroll et al., 2016). Agents may be unaware of their energy demand or the price of energy, and are therefore unable to form energy cost expectations. It is also possible that underinvestment in energy efficiency is due to biased and inflated perceptions of costs, possibly due to lack of experience (in new technologies such as electric cars, for example). Furthermore, information on the benefits of energy efficiency may be acquired through an agent's network – a positive adoption externality – which may be an important driver for the diffusion of new energy-saving technologies.

While energy efficiency labelling provides a range of comparative non-monetary indicators, deriving an energy cost forecast is not a straightforward exercise – an agent must combine non-monetary information with evidence (and expectations) on energy prices, level of use and duration of investment. In this regard, there is evidence that households make substantial errors when converting non-monetary information into energy cost expectations (Allcott, 2011; Heinzle, 2012). The theory of bounded rationality (Simon, 1979) may be relevant here, which suggests that decision makers, while fundamentally rational, can lack the cognitive abilities to process and incorporate all available information.

It is also possible that a high implied discount rate is the result of agent 'inattention' to future energy costs (Allcott and Greenstone, 2012) and a focus on upfront investment costs. For example, Turrentine and Kurani (2007) show that car owners in the US do not keep track of past expenditures and are therefore unlikely to have 'the basic building blocks of knowledge assumed by the model of economically rational' consumers (pg. 1213). Allcott (2011) presents similar findings and shows that 40% of respondents did not think about fuel costs when buying their last vehicle (and 35% did consider fuel costs but did not do any calculation). Sallee (2014) suggests that such inattention is not necessarily irrational behaviour when there is low variation in energy costs within product groups and high investment transaction costs associated with calculating and comparing models ('rational inattention').

2.2.3 *State-of-the-art solutions to imperfect information*

Decisions regarding large investments, such as appliances, transport and buildings, are typically made infrequently and often have a long lifetime. In order to have a significant impact on the energy efficiency of these decisions, consumers should be encouraged to consider energy efficiency at the point of sale. Subsequent treatments aimed at altering usage are likely to have a significantly lower impact than a decision to purchase a more efficient product in the first place.

In an attempt to reduce the Energy Efficiency Gap and provide customers with useful energy consumption information at the point of sale, the EU mandated in 1990 that all electrical appliances for sale carry labels to indicate their energy consumption (Council Directive 92/75/EEC). A similar labelling scheme was mandated for buildings from 2010 (Directive 2010/31/EU), and cars (Directive 1999/94). The Vehicle Labelling Directive requires information on fuel economy and carbon emissions to be displayed on a label for all new cars at the point of sale. The exact design of this label varies by member state, but the majority of member states utilise the colour coded scale similar to the appliance and

building labels. While existing EU labels have been shown to improve energy efficiency decisions compared to a no-label scenario (ECOFYS, 2014), the GREENCAR project team believes that the existing energy labels neglect a key element of information required by consumers – namely usage cost in monetary terms. Such a policy has been recently implemented in the US (comparative five-year energy costs labelling).

The policy solution, provided that missing energy costs information results in investment inefficiencies, is to provide energy cost forecasts directly to households. Prior literature demonstrates that such information increases the demand for energy efficiency. In the US, Newell and Siikamäki (2014) find that the willingness-to-pay for efficient water heaters is highest when annual consumption costs are combined with more general informative aids (Energy Star and EU Efficiency Grades). Min et al. (2014) and Blasch et al. (2019) find similar effects for lightbulbs, while Andor et al. (2020) show existing EU labels combined with annual operating cost information increases the demand for more energy efficient fridges. Kallbekken et al. (2013) find that the combination of lifetime (ten-year) labels with staff training related to energy efficiency led to more efficient tumble dryer sales in Norway (mean consumption of sales down 4.9%). Other studies with smaller effects include Deutsch (2010) (tumble dryers, but no effect on other appliances) and DECC (2014) (washer-dryers, but no effect on other appliances). Furthermore, the duration of energy cost forecasts may be crucial. For example, Heinzle (2012) shows that the willingness to pay for efficient TVs is higher when ten-year costs are displayed relative to one-year. Heinzle attributes her findings to the ‘reversed pennies-a-day’ effect (following Gourville (1998)).

GREENCAR tests if the promising strategy of displaying monetary cost information can be extended from the domain which has been the focus of the majority of the literature (appliances) to a new domain (transport). GREENCAR generates a comprehensive database of empirical data on the factors consumers consider when investing by conducting focus groups, surveys, discrete choice experiments and a randomised controlled experiment.

2.3 Project Objectives

The objectives of the GreenCar project can be summarized as follows:

1. Work Package 1 – Design a theoretical model of vehicle investment decisions which includes adopter costs and benefits, and incorporates barriers to adoption identified in previous literature.
2. Work Package 2 – Use qualitative methods to identify the key factors which influence new car purchases.
3. Work Package 3 – Quantify the relative importance of vehicle attributes to buyers, including fuel type (EV versus non-EV) in a stated preference setting. Test the impact of three treatments (policy, technical and informational) on buyer willingness-to-pay for electric vehicles in a stated preference setting.
4. Work Package 4 – Explore the effects of long-run energy cost information on the demand for low-emission vehicles in a revealed preference setting.
5. Work Package 4.2 – Leverage the findings and design from previous DCE experiment and survey carried out in 2020 and carry out a repeat survey. Provide a comparative analysis of attitudes towards more energy efficient vehicle purchases in the wake of significant exogenous energy price volatility.

2.4 Summary of Key Findings/Outcomes

In what follows we briefly report on the main findings from each work-package separately.

2.4.1 Work Package 1: Theoretical Model and Related Literature

WP1 developed the theoretical investment model underpinning the GreenCar project and explored the related international literature on information provision and car purchase choices. Our theoretical framework builds on work in other fields and highlights that consumers trade off immediate costs (such

as purchase costs) against future benefits (such as reductions in energy cost) when making a car purchase decision.

These costs/benefits can be both observable (e.g. purchase price or fuel costs) or unobservable (such as comfort or inconvenience associated with charging). Furthermore, perceptions about observable costs can influence decision making, particularly when individuals lack adequate information, or are unable to convert efficiency information (such as l/100km or kWh/km) into energy use forecasts. Individuals may also exhibit multiple biases when trading off present and future costs, such as loss aversion, present bias, imperfect information, status quo bias, transaction costs, and bounded rationality. The hypotheses underlying the research project stem from this framework, whereby we expect consumers to be less likely to purchase a more efficient (or less costly to run) vehicle if the future benefits (such as reduced energy costs) are not fully accounted for in the decision-making process. The findings from the international literature support these hypotheses, since most studies suggest that consumers are generally underinformed or myopic with respect to future energy costs when purchasing a new vehicle (Allcott, 2011; Gillingham et al., 2021; OECD, 2010; Turrentine and Kurani, 2007).

2.4.2 Work Package 2: Focus Groups with Car Buyers and Sellers

Focus groups were conducted with members of the general public and car sales staff in order to gain a deeper understanding into the factors which influence consumer decision making when making a new car purchase. In total, three focus groups were carried out with car buyers, and one with car sales staff in May 2021. Our goal was to explore the key determinants/attributes of choosing a new car, the main enablers/barriers to EV adoption, and to explore buyer understanding of the CO₂/fuel cost application to be employed in WP4. Group discussions were encouraged using a series of core questions which were supported by a number of props/images (questions were amended for the salespeople focus group who were asked about their perceptions of their customer attitudes).

Findings suggest that fuel efficiency features prominently within the household's car buying process, followed by vehicle size and safety. About half of participants state that they will likely consider a switch to electric on their next purchase. The key concerns relating to a switch to EV are consistent with findings from the national survey in WP3 – range, charging (lack of public charging infrastructure and hassle of charging) and price featured prominently in the discussions.

The benefits of switching to an EV differ by customer – some will switch for environmental considerations while others are motivated by fuel savings – there appears to be no “typical” motivation. Buyers appear to conduct most of their car research at home prior to entering the showroom. In fact, many describe a distrust in car salespeople and often use the showroom as a tool to confirm their own research. This finding is important when considering treatment effect findings in WP4 and information provision at the point of sale. The CO₂/fuel cost website was largely welcomed by the groups and website recommendations (scaling and wording) were incorporated into the application design. Salesperson views of their customers' motivations are largely consistent with household's own views.

2.4.3 Work Package 3: Online Surveys and Experiment (Wave 1)

WP3 consisted of conducting a representative online survey of 2,000 Irish car buyers, with data collected between August and September, 2020. The survey explored the factors which influence electric vehicle (EV) adoption, including barriers, enablers and perceptions. A discrete choice experiment (DCE) was embedded in the survey to explore how individuals trade-off various EV characteristics. A labelling experiment further explored how different fuel efficiency labels influence the probability of switching to an EV, with respondents randomly assigned into various energy cost and CO₂ emissions framing treatment groups. In addition, a willingness-to-pay (WTP) experiment was carried out where participants expressed how much extra they would pay for a car with better fuel efficiency.

General survey questions suggest that the gap between EV purchasing intentions and national transport electrification goals is very wide. Just 23% of the sample indicated that they are planning to switch to EV (BEV or PHEV) on their next car purchase. Household characteristics (age, income, marital status, children, and property type) are not correlated with stated EV purchase intentions. However, those concerned about the environment and those with a higher degree are significantly more likely to switch. Monetary factors are also correlated with stated EV adoption. Those aware of EV financial support, those with high annual mileage, those with high fuel price increase expectations and those with low EV

depreciation expectations were all more likely to state that they will switch to an EV on their next car purchase.

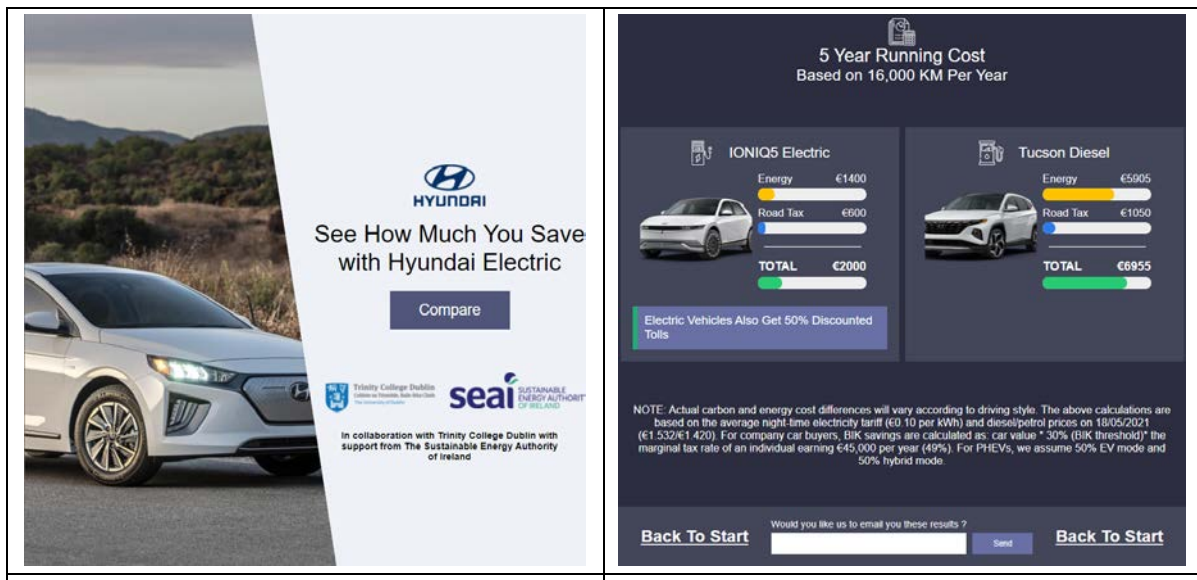
Regarding awareness of supports, just 18% of households indicated that they are aware of all three EV financial supports (vehicle grant, charger grant and toll reductions) in wave one of the survey. Road tax savings and reduced public charging prices are the most important (self-reported) supports for consumers. Irish households are concerned about several EV attributes (“moderately” or “extremely”) particularly relating to battery capacity and charging. Such concerns are negatively correlated with stated EV switch intentions. However, those who have travelled in an EV before are less concerned about all EV attributes.

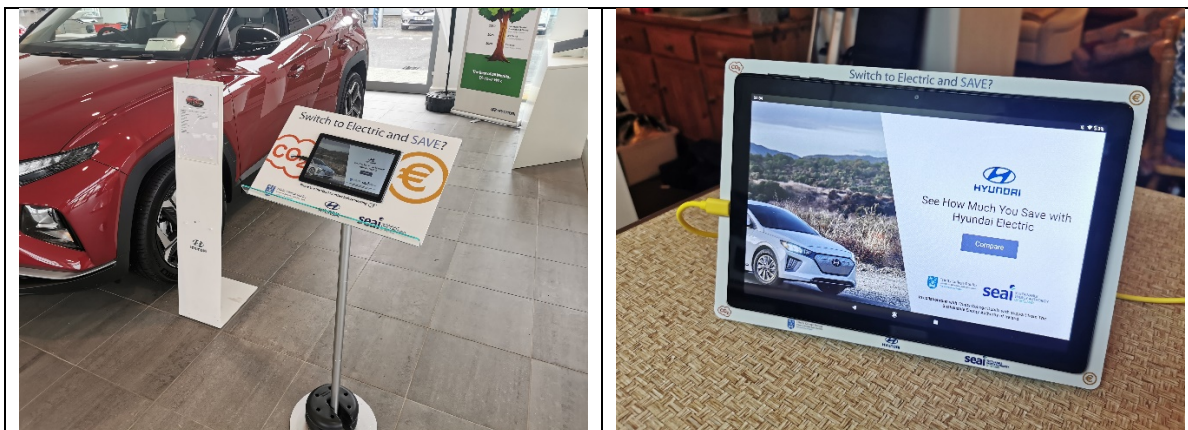
The experimental (DCE) findings suggest that while all EV attributes (price, range, boot size and ultra-fast charge capability) are statistically significant determinants of EV switch rates, price and range will likely be the key drivers for future EV adoption rates. The framing experiment suggests that EV switch rates can be increased through information and labelling. Switch rates are highest when energy efficiency is displayed in terms of long-term cost and CO₂ implications (relative to non-EVs). The willingness-to-pay experiment findings also suggest that framing fuel cost over a longer period of time increases willingness-to-pay for fuel efficiency. Willingness-to-pay for fuel efficiency is also highest with a more frequent car payments schedule (monthly versus annual, for example).

2.4.4 Work Package 4: Field Trial and Sales Staff Interviews

In WP4 we conducted a national field trial presenting environmental and energy cost information to potential new car buyers. A randomized control trial (RCT) was conducted between June 2021 and February 2022 in conjunction with Hyundai Ireland, one of Ireland’s best-selling car brands. Energy cost differences between internal combustion engine (ICE) models and electric vehicles (EV) or plug-in hybrid electric vehicles (PHEV) were presented to customers via a dedicated app developed by the GREENCAR team (Figure 1). The app also displayed environmental benefits (CO₂ emissions reduction) and other cost savings (such as half-price tolls) associated with EVs or PHEVs. The information was delivered via dedicated tablet computers placed in prominent locations within participating showrooms. Half of Hyundai Ireland’s showrooms in the Republic of Ireland chosen at random to receive treatment.

Figure 1: Website Screenshots (for IONIQ5 car choice)





Source: GreenCar design

The number of sales for the brand grew overall over the period of study, driven by a significant increase in the number of EVs and PHEVs sold in both treated and control showrooms. However, we do not find a clear effect of treatment on the number of EV or PHEV cars sold in showrooms which received treatment. We also explore the potential effect of treatment on the purchase of more efficient (better fuel economy) and less polluting cars (lower CO₂ rated) more generally and do not find that treatment induced a change in consumer preferences. Although there were no restrictions to showrooms operating during the trial period, the COVID-19 environment likely limited exposure to the treatment, which limits the generalizability of our findings.

As an additional piece of research, in order to gain a deeper understanding of consumer purchase processes and to obtain more detailed feedback on the trial we conducted in-depth interviews with sales-staff in participating trial showrooms. These shed significant light on some of the drivers/issues associated with information provision, how consumers decide on to the type of vehicle they are going to purchase, and the sources of information they draw on.

Most sales staff indicate that the decision to purchase an EV or an ICE new vehicle is a significant and complex one for most households and is not likely to change on the day of purchase or in the showroom. A significant amount of research is conducted at home and online, and this appears to be particularly true for customers who go on to purchase an EV. Cited sources of information sellers believe customers use include car websites, social media (particularly YouTube) and online forums. Some sellers indicate that they consult online forums to be able to anticipate the type of questions that will be asked in store.

The primary motivations to purchase an EV for consumers according to sellers are fuel cost savings (1) and environmental benefits (2). Other motivations include EVs being seen as desirable/luxurious, wanting the latest technology, and fear of being left behind. Cited barriers to adoption include the prohibitively high upfront cost associated with purchasing an EV, range anxiety, concerns about EV depreciation, the lack of charging infrastructure, and uncertainty about potential future maintenance costs.

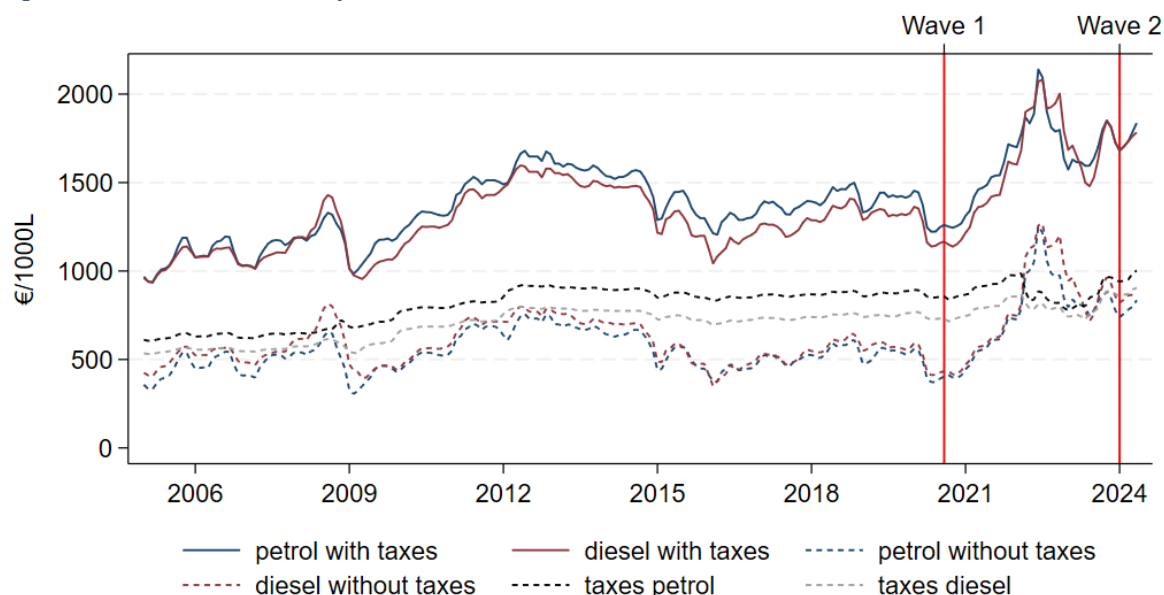
According to sellers, the demographics of new car purchasers are also very important when it comes to information provision. Most new car purchasers particularly in regional showrooms are older which may have reduced the effectiveness of our interactive intervention format. A policy recommendation stemming from this is that energy efficiency information, if presented at the point of sale, needs to be in a very simple and easy to understand format – perhaps without the need for interaction with a tablet. Coupled with the findings from the focus groups that customers generally distrust sales staff (this was also mentioned in the interviews), this suggest that information presented at the point of sale may be more effective if it is seen as impartial or comes from a trusted third-party source.

Finally, the COVID-19 environment had a significant impact on the car industry. Although showrooms were open during the trial period some sellers report that customers were less likely to spend time indoors and have seen increased emphasis on telephone and online communication. This likely impacts on the generalizability or replicability of the trial findings.

2.4.5 Work Package 4.2: Online Survey and Experiment (Wave 2)

Following significant volatility in energy prices resulting from the invasion of Ukraine, the survey and online experiment were updated and conducted on a representative sample of 800 individuals between January and March 2024. The second wave of the survey is almost identical to the first and explores the factors which influence electric vehicle (EV) adoption, including barriers, enablers, and perceptions, and how these have evolved over time. We also explore some of the issues identified in the other work packages such as consumers' own research, brand loyalty and changes in car travel behaviour.

Figure 2: Fuel Prices and Survey Timeline



Source: European Commission Weekly Oil Bulletin https://energy.ec.europa.eu/data-and-analysis/weekly-oil-bulletin_en

We find that there is an increase in stated preferences towards BEVs (Battery Electric Vehicles) and PHEVs (Plug-in Hybrid Electric Vehicles) in the second wave of the survey. In wave one of the study, when asked what type of engine technology they would consider on their next purchase 17% of respondents chose a battery electric vehicle (BEV) and 6% a plug-in hybrid vehicle (PHEV). These shares grew to 35% for BEVs and 11% PHEV in wave two of the survey.

Presenting monetary information (in €/km) in addition to emissions information (in gCO₂/km) increases the probability that an EV option will be chosen in the DCE in both waves of the survey. Framing effects have changed however, with shorter term cost framing (in €/year) being more effective in the second wave of the study, whereas longer-term (€/10year) framing was more effective in the first wave. This may stem from uncertainty over future fuel and energy prices, with individuals being perhaps more present focused in the second wave.

Preferences for other EV attributes also appear to have also evolved. While the purchase price and range attributes appear to dominate in both waves of the survey, individuals appear to be less price sensitive to purchase price differences between ICE and EV vehicles in the second wave. A further observation is the move in stated preferences towards larger vehicles (particularly larger SUVs models) in the baseline car choice of respondents in the DCE, which is consistent with national data on car purchases.

Consumers indicate strong brand loyalty and conduct significant independent research prior to purchasing a new vehicle. Research on a new vehicle starts typically 2-6 months prior to vehicle purchase, which is consistent with the findings from seller in-depth interviews. Most respondents plan on owning their new vehicle between 4 and 6 years.

Sources of research highlighted include independent review websites, car manufacturer websites and public forums. Most respondents appear to use a combination of sources when conducting research on their vehicle of interest. We observe a significantly increased awareness of EV supports, although there are fewer such supports in the second wave. Trust in manufacturer fuel economy ratings appears to be high. Respondents also report an increase in car travel, despite significantly increased fuel costs.

2.4.6 Novelty and Innovation

Describe how your project has furthered the current state-of-the-art, current knowledge or current practice. Clearly highlight the degree of novelty and innovation demonstrated by your project.

Address each innovation in a bullet point below. Add as many bullet points as you need:

- *Innovation 1: Title*
Summary (Max 2-3 sentences)
- *Innovation 2: Title*
Summary (Max 2-3 sentences)

Innovation 1: Produce a consumer decision-making framework and empirically validated model for vehicle purchases.

- *Our theoretical model is an extension of our prior work applied to a new sector – household car investments. This model is general, broad and describes the car investment decision in terms of a wide suite of potential costs and benefits, each viewed through a behavioural lens. The model allows us to identify hypotheses for testing in subsequent experiments.*

Innovation 2: develop a discrete choice experiment with randomised information interventions

- *The randomised discrete choice experiment (WP3) showed the effects of a very large combination of fuel efficiency treatment frames (7 treatments) in a controlled, hypothetical setting for this sector, considerably broader than previous research. The findings suggest that longer-term framing of the same energy cost and CO₂ information increases the probability that an individual will select an EV option.*

Innovation 3: compare demographic and social differences in consumer attitudes to energy efficiency information for vehicles.

- *The survey instruments capture a significant amount of additional demographic and attitudinal characteristics. Relative to previous literature, WP3 and WP4.2 provide a more comprehensive methodological approach and richer data.*

Innovation 4: randomized controlled trial on vehicle labelling in a real-world setting and on a national scale

- *We carry out the world's first in-person information provision experiment on a national scale with a partner car brand. A dedicated application was designed specifically for presenting energy cost differences between EV and non-EV models and installed in treated showrooms.*

Innovation 5: Conduct a repeated survey including a DCE

- *A repeated survey design allows us to capture how attitudes towards EVs have changed over time following a significant external shock to fuel prices. In addition, a repeated DCE design provides robustness to our original results and will allow us to contribute to the broader DCE literature.*

Innovation 6: Supplement quantitative data from field trial and surveys with qualitative data from in-depth interviews and focus groups.

- *Conducting in-depth interviews with sales staff allowed us to gain valuable feedback on the field trial. Discussions with sales staff also allowed us to gain a deeper understanding of consumer purchase decisions relating to EVs. A combination of qualitative and quantitative methods allows us to provide a more comprehensive overview of the issues around information provision and purchase choices*

2.5 Project Impact

Clearly position the impact of your project with reference to the needs of the Irish Energy Sector, national and international policy objectives, and SEAI's remit.

Discuss the key impacts of your project: societal, economic, technological or otherwise. Clearly identify and highlight the value of your project in the wider context.

2.5.1 Impacts on national and international policy objectives, and SEAI's remit

Nationally, renewable transport is an integral component of Ireland's decarbonising goals, particularly given our high level of transport emissions relative to other European countries. Central to Ireland's lower-carbon future is the roll-out of electric vehicles (EVs). This will require a considerable shift in buyer behaviour. Understanding the extent to which car purchasers consider future energy costs when making a new car purchase is therefore of vital importance. The trials conducted as part of GREENCAR highlight some of the behavioural barriers to the adoption of low-emission vehicles, and provide evidence on how individuals trade-off various characteristics of EVs in purchase decisions.

Two waves of surveys of the general public's perceptions and attitude towards electric vehicle adoption can provide valuable insights for policy makers looking to increase EV penetration. The GREENCAR project has demonstrated that there is demand for electric vehicles among the general public, and that this demand appears to have grown between the two survey waves. However, stated adoption of electric vehicles falls significantly short of policy intentions. Discrete choice experiments allow us to capture respondents' willingness to pay for distinct EV attributes, and to test the effects of additional information treatments such as energy cost information presentation. Standardized survey questions also capture additional demographic, attitudinal and behavioural factors associated with adoption, as well as concerns individuals may hold regarding EVs. Repeating these surveys allows us to capture how preferences evolve over time and in response to significant volatility in energy prices, which is especially important given rapidly evolving and ongoing energy crises.

Further to this, GREENCAR is aligned with a number of SEAI objectives, including the empowerment of citizens, increasing the impact of the existing grant schemes (for EVs), and enhancing SEAI decision-making through expert analysis. This project also aligns with the objective of the SEAI's Behavioural Economics Unit to steer households towards more sustainable consumption paths using tested insights from behavioural science and economics.

2.5.2 Environmental impacts

A large-scale shift to EVs would lead to significantly higher carbon savings, therefore understanding what may drive the adoption of EVs from a consumer perspective is of vital importance. In addition to CO₂ benefits, other environmental benefits may accrue relating to resource management. At both national and a European level, switching from a reliance on fossil fuels to electricity (increasingly powered by renewable energy) in the transport sector can reduce pressure on scarce natural resources, reducing the need to explore increasingly challenging contexts for extraction (such as ultra-deep offshore, arctic and shale). This can also minimise the related incremental investment costs and environmental uncertainties. Reducing energy consumption and emissions through energy efficiency also plays a role in reducing waste and associated pollution of land and water, thereby contributing to efforts to combat ocean acidification and limit negative impacts on biodiversity (IEA, 2013).

2.5.3 Social impacts

During the duration of GREENCAR, the project team has engaged with a large number of households through their direct participation in the focus groups, consumer surveys, RCT and discrete choice experiments. This engagement has the potential to increase general awareness of energy efficiency as a factor in investment decisions and potentially increase its relevance in decision-making (and therefore increase energy efficiency) across multiple aspects of the daily lives of individuals and households as a result. This engagement with the public may alter both investment decisions (and prompt them to invest in more energy efficient transport) and may also increase awareness of their ongoing energy usage and prompt them to adopt more energy efficient behaviours to reduce consumption.

2.5.4 Academic impacts

GREENCAR has the potential to significantly broaden the field of research in the area of consumer decision-making involving an energy component by developing an innovative theoretical framework which includes behavioural economics considerations. GREENCAR will continue to publish the methods, analysis and results in peer-reviewed papers but also make the models and data publicly available (where possible) to allow for the results to be replicated in other jurisdictions and disciplines. This has the potential to significantly advance the field of energy efficiency research but will also have positive implications for other related disciplines.

2.5.5 Future potential

It is reasonable to consider that should monetary usage labels be adopted by policy makers for household vehicles that similar measures could also be considered for sectors such as commercial transport, machinery, tractors and appliances in each of the agricultural, services and industrial sectors. Similarly, it could also be considered that usage labels could be adapted to include costs for the consumption of other resources such as gas (for example, boiler efficiency) and water. With this in mind, it is recommended that future projects, which could be nationally or European funded follow on from this GREENCAR research and investigate the potential for monetary usage labels for other consumer groups and resources.

2.6 Recommendations, Conclusions and Next Steps

The GreenCar project has explored some of the factors which influence consumer purchase decisions and may be important in determining whether an individual switches from an ICE to an EV drivetrain. We employed a combination of both quantitative and qualitative data and methods to gain a deeper understanding into consumer purchase process and motivations in the Irish passenger car market. Of particular study interest was the role of energy cost information provision in consumer decision making.

The international literature suggests that consumers are underinformed when it comes to future fuel costs, and we do not dispute this. However, how and when this information is presented to consumers is likely important. We do not find that presenting energy cost information at the point of sale via an interactive tablet display altered immediate purchase choices. However, qualitative data from focus groups and interviews and the quantitative data from nationally representative surveys suggest that consumers begin researching their vehicle of interest months in advance of purchase (typically 2 to 6 months in advance). Therefore, while it may be difficult to change consumers consideration set of vehicles at the point of sale, a more effective strategy of information provision may be to target consumers earlier in their own research journeys.

Much of that research is done at home and includes various sources (both online and offline). The perceived trustworthiness of this information is also important, as consumers may distrust car showroom sales staff. A need for an impartial and trusted source of information is therefore clear. A possible danger here is that in the absence of trusted sources consumers may be drawn to (perceived) impartial sources of information such as online forums and social media. Perhaps this is also an opportunity for policy to deliver objective information via these channels.

The online discrete choice experiment results highlight how individuals trade-off various EV attributes against each other. The findings suggest that price and range are the primary attributes considered by consumers in both waves of the study. However, we see a decrease in purchase price sensitivity in wave two, and a move in baseline car choices towards larger vehicle classes (in particular large SUVs). Size was also an important consideration for consumers highlighted in the qualitative data. It is also clear when looking at observed car registrations. This move in preferences towards larger vehicles needs to be considered by policymakers as further trade-offs with externalities other than emissions (such as congestion and accident risk) become more apparent.

We find that the way in which energy cost information is presented is also important. In wave one of the survey, longer duration energy cost framing (over 10 years) appears to be the most effective in influencing consumers towards the EV options. In wave two however, relatively shorter monetary framing duration (1 year) appears to be most effective. This may stem from the volatility in energy prices observed in recent years, whereby uncertainty over future fuel prices may have made individuals more

present-focused. On a practical point, it might suggest that energy cost information presented over a one-year period (as is done with car labelling in the US) could be the most effective approach.

Finally, an important implication for policy is that the car purchasing environment evolves rapidly. While stated preferences for BEVs have increased in the second wave of the survey (35%) this is far from all consumers demanding an EV on their next car purchase, which would be necessary for a complete ICE phase-out. Further research should focus on how to target difficult to reach consumers with both information and supports.

2.7 References

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