MOVING THE NEEDLE:A COMPARATIVE STUDY ON ADOPTION PREFERENCES OF CLEAN ENERGY TECHNOLOGIES IN HOUSEHOLDS

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Overview

Clean energy technologies (CET), such as, solar photovoltaic (PV) panels, electric vehicles (EV) and heat pumps are not only considered essential for sustainable energy transition but also important in advancing economic opportunities and promoting energy security (IEA, 2024; Ozkaya, 2022). Clean energy technologies can be described as renewable, less environmentally disruptive technologies used to power the global community.[1] Nations and governments are prioritizing investment, production and deployment of CETs across sectoral supply chains through enabling policy measures. The Climate Action Plan 2024 (CAP 2024) for Ireland sets out an ambitious roadmap for deployment of these CETs over next few years to deliver on Ireland's climate ambition towards a sustainable, low-carbon, and climate-resilient future. Notwithstanding their potential benefits, uptake of CETs, such as electric vehicles, heat pumps and solar photovoltaic panels in Irish households remains slow and short of expectations, necessitating critical reflection and targeted policy measures. Barring few exceptions (SEAI, 2024; Mukherjee & Ryan, 2020), however, there is little empirical evidence on factors underlying the reluctance of Irish households to adopt CETs despite their professed favourable opinions (MacUidhir, Gallachoir, Curtis, & Rogan, 2022).

In this article, we study three important CETs for households- rooftop solar PV, heat pumps and electric vehicles using original primary data from 1225 nationally-representative Irish households. We compare actual adoption versus stated preferences using survey responses that not only includes a range of information on physical ownership, building characteristics and socio-demographic profiles but also attempts to capture their preferences on sustainability concerns, pro-environmental identities (Dermody, Koenig-Lewis, Zhao, & Hanmer-Lloyd, 2018; Steg, Shwom, & Dietz, 2018; Whitmarsh & O'Neill, 2010), technology preferences (Plötz, Schneider, Globisch, & Dütschke, 2014; Rogers, 1962) and heterogeneities in terms of behavioural inertia (Blasch & Daminato, 2020; Li, Liu, & Liu, 2016) as well as perceptions of discomfort or hassles associated with installation, operation and maintenanceof these technologies (Shakeel, Yousaf, Irfan, & Rajala, 2023; Kowalska-Pyzalska, Maciejowska, Suszczyński, Sznajd-Weron, & Weron, 2014; Snape, Boait, & Rylatt, 2015).

Our two-part study using a mix of econometric and machine-learning models explores the following questions:

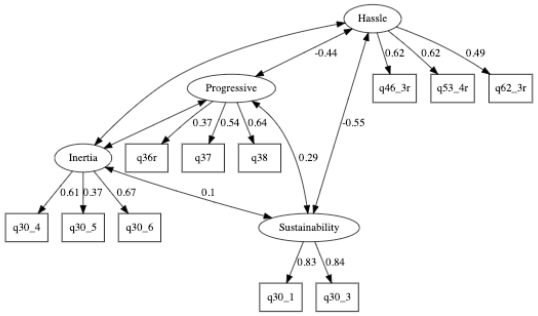
1. What are the key factors underlying actual adoption of rooftop solar PV, heat pumps and electric vehicles in Irish households?
2. How the stated preferences for different clean energy technologies adoption compare with their actual adoption/ownership across Irish households?

Methods-In this study, we use a mix of analytical methods and modelling techniques from a multi-disciplinary perspective to compare the factors underlying actual adoption of CETs in Irish households with their stated preference to adopt . Our empirical analysis using R software is in two parts: first, we identify latent variables (i) sustainability, (ii) behavioural inertia, (iii) progressive attitude towards technology and risk taking, and (iv) hassle factor using confirmatory factor analysis using structural equation modelling approach. Next, we conduct binomial and ordinal logit regressions for actual adoption of all three technologies together (Model I) followed by stated adoption preferences of individual technologies (Model-II, III, IV) using the four factors identified from first part as explanatory variables and socio-demographic, physical, and techno-economic factors as control variables. We also test for the consistency of results using machine learning methods.

Results-Early results from our two-part analysis from the structural equation model (figure 1) showing the path diagram and the binomial and multinomial logit regressions results (table1) are brought out below. Whereas the progressive nature, inertia and sustainability behaviours of respondents are positively correlated, hassle factor is negatively correlated with varying significance levels to other latent variables. suggest clear distinction between factors underlying adoption of technologies and their stated preferences to adopt. A schematic measurement model to identify latent factors gives consistent results in line with previous literature and also passes fitness tests.

Table 1: Binomial and Multinomial logit regression results

[1] https://dergipark.org.tr/en/pub/cetj



	Model I (All)	Model II (PV)	Model III (HP)	Model IV (EV)
Adopted/Preference	Adoption	Preference	Preference	Preference
Measured scale	Two (0,1)	Three (1,2,3)	Three (1,2,3)	Three (1,2,3)
Intercept	0.0012*** (1.073)			
Age group	1.232! (0.10)	0.846* (0.068)	0.908 (0.068)	1.054 (0.070)
Received grant	5.704*** (0.29)	1.297 (0.233)	0.807 (0.238)	1.831** (0.231)
Income	1.000** (0.00)	1.033 (0.043)	1.005 (0.043)	1.098* (0.259)
Energy burden	1.034! (0.00)	1.000 (0.000)	1.000 (0.000)	1.00 (0.000)
qf_ednlevel	0.912 (0.09)	1.171* (0.064)	1.125 (0.067)	1.375*** (0.062)
q1_typeprop	1.011(0.14)	1.081 (0.125)	0.800 ((0.136)	0.716** (0.114)
q5r_yearbuilt	0.503*** (0.11)	1.084 (0.081)	1.22*(0.085)	1.147. (0.081)
Work home(q10_wfh)	1.882* (0.31)	1.109 (0.256)	0.874(0.256)	0.708 (0.236)
Sustainability	1.061(0.23)	0.717* (0.168)	1.049 (0.185)	1.006 (0.171)
Hassle	1.324(0.36)	0.670! (0.216)	0.855! (0.241)	1.047 (0.224)
Inertia	1.065(0.28)	1.819* (0.235)	1.142 (0.255)	1.372 (0.234)
Progressive	1.760(0.69)	1.568*** (0.070)	0.950 (0.078)	1.181* (0.078)
1/2		1.728***	1.317***(0.042)	2.5*** (0.027)
2/3		4.894***	6.428*** (0.150)	26.8*** (0.101)

Note: Significance codes: '***' 0.001 '**' 0.01 '*' 0.05 '!' 0.1

Fig.1: Path diagram from the significant structural equation model results

Table 1 above shows the the results from the binomial and multinomial ordinal logit regression to identify and compare the factors underlying actual adoption and their stated preferences by Irish households. It reveals a clear distinction between the role, nature and extent of physical, behavioural and socio-demographic factors. Whereas, the role of physical and socio-demographic factors, such as, income, age-groups, education level and property vintage appear significant, their relationship does not appear to be consistent and straightforward, requiring further research.

Conclusions-From a climate policy perspective, it is not only important to understand what are the key factors underlying Irish households' decision to adopt different CETs but also to identify why people choose to wait and watch despite their favourable opinion and stated preferences. Our study makes many novel contributions to the contemporary literature on adoption of clean energy technologies in residential households. Using original empirical data, it suggests signigficant association between the socio-behavioural factors such as, progressive attitude and adoption preference for CET adoption but also cautions that they do not translate on their own for actual adoption, requiring more nuanced and targeted policy measures. Further, the behavioural factors such as discomfort and hassle factors appear to be acting in different direction to the generally favourable attitudes towards sustainable technologies. We believe that our study will not only address an important literature gap in Irish residential households' behaviours in terms of their adoption of CETs but also provide useful insights for better informed policy decisions in the future.

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