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Consumer Preferences for Low-Carbon Futures: A Structural Equation Model Based on the Domestic Hydrogen Acceptance Framework

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Abstract : Hydrogen-fueled technologies are rapidly advancing as a critical component of the low-carbon energy transition. In countries historically reliant on natural gas for home heating, such as the UK, hydrogen may prove fundamental for decarbonizing the residential sector, alongside other technologies such as heat pumps and district heat networks. While the UK government is set to take a long-term policy decision on the role of domestic hydrogen by 2026, there are considerable uncertainties regarding consumer preferences for 'hydrogen homes' (i.e., hydrogen-fueled appliances for space heating, hot water, and cooking. In comparison to other hydrogen energy technologies, such as road transport applications, to date, few studies have engaged with the social acceptance aspects of the domestic hydrogen transition, resulting in a stark knowledge deficit and pronounced risk to policymaking efforts. In response, this study aims to safeguard against undesirable policy measures by revealing the underlying relationships between the factors of domestic hydrogen acceptance and their respective dimensions: attitudinal, socio-political, community, market, and behavioral acceptance. The study employs an online survey (n=~2100) to gauge how different UK householders perceive the proposition of switching from natural gas to hydrogen-fueled appliances. In addition to accounting for housing characteristics (i.e., housing tenure, property type and number of occupants per dwelling) and several other socio-structural variables (e.g. age, gender, and location), the study explores the impacts of consumer heterogeneity on hydrogen acceptance by recruiting respondents from across five distinct groups: (1) fuel poor householders, (2) technology engaged householders, (3) environmentally engaged householders, (4) technology and environmentally engaged householders, and (5) a baseline group (n=~700) which filters out each of the smaller targeted groups (n=~350). This research design reflects the notion that supporting a socially fair and efficient transition to hydrogen will require parallel engagement with potential early adopters and demographic groups impacted by fuel poverty while also accounting strongly for public attitudes towards net zero. Employing a second-order multigroup confirmatory factor analysis (CFA) in Mplus, the proposed hydrogen acceptance model is tested to fit the data through a partial least squares (PLS) approach. In addition to testing differences between and within groups, the findings provide policymakers with critical insights regarding the significance of knowledge and awareness, safety perceptions, perceived community impacts, cost factors, and trust in key actors and stakeholders as potential explanatory factors of hydrogen acceptance. Preliminary results suggest that knowledge and awareness of hydrogen are positively associated with support for domestic hydrogen at the household, community, and national levels. However, with the exception of technology and/or environmentally engaged citizens, much of the population remains unfamiliar with hydrogen and somewhat skeptical of its application in homes. Knowledge and awareness present as critical to facilitating positive safety perceptions, alongside higher levels of trust and more favorable expectations for community benefits, appliance performance, and potential cost savings. Based on these preliminary findings, policymakers should be put on red alert about diffusing hydrogen into the public consciousness in alignment with energy security, fuel poverty, and net-zero agendas.

Keywords : hydrogen homes, social acceptance, consumer heterogeneity, heat decarbonization
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