PUBLIC ACCEPTABILITY OF DIGITAL PERSONAL CARBON TRADING: A TECHNOLOGY ACCEPTANCE PERSPECTIVE FROM UK HOUSEHOLDS

Theme 3, sub-topic 3a)

☒ "Academic contribution"

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Extended abstract

Introduction

To achieve climate targets, deep decarbonization across all energy demand sectors is required. In the UK, the domestic sector accounted for 26% of total final energy demand in 2023, with residential buildings emitting around 50 Mt_{CO_2e} annually [1,2]. Addressing household emissions is therefore essential to meet emission reduction targets.

Personal carbon trading (PCT) has long been discussed as a policy instrument to incentivise low-carbon behaviour by making individual emissions visible and tradable [3]. The concept has been explored mainly during the early 2010s, and few schemes have progressed beyond the conceptual stage, citing costs, technical complexity, and political sensitivity as key barriers to implementation [4].

However, recent technological and societal developments warrant a re-examination of PCT's feasibility. Digital infrastructures could enable fully integrated platforms for carbon accounting and trading via smart meters, smartphone apps, and web interfaces. While some prototype applications for personal carbon allowances already exist, these typically lack real trading functionalities. Nonetheless, such digital systems offer the potential for real-time feedback and user interaction at significantly lower cost than earlier proposals based on banking infrastructure and physical card systems [5]. Moreover, public responses to COVID-19 and the 2021–2023 energy crisis have demonstrated a collective willingness to accept behavioural constraints and digital monitoring when framed around societal benefit [5].

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This study revisits the PCT policy proposition by examining the acceptability of a digitally mediated scheme in everyday life. In doing so, we update the evidence base on PCT and offer empirical insights into the socio-technical conditions under which such schemes might gain public traction.

Methodology

This study is based on semi-structured interviews conducted with 22 households and overall 32 participants in and around Oxford, UK. The aim was to explore the social acceptability of a digitally implemented PCT scheme, using the Technology Acceptance Model (TAM) as the guiding theoretical framework. Each interview followed a three-phase structure, as summarised in Table 1.

Table 1. Interview structure.

Phase	Content
1. Introduction to PCT	Brief explanation of PCT & digital tracking
2. Core questions	TAM based questions (see Table 2)
3. Optional reflection	Overall willingness to participate (voluntary vs. mandatory)

To support comprehension of the abstract concept of PCT, participants were shown a handout (Figure 1) illustrating key scheme components, including annual carbon allowances, behavioural impacts on the budget, and trading mechanisms. The visual provided a clear reference point for discussion and was particularly useful for engaging all household members, including minors.

The core of the interview drew on TAM constructs to investigate how participants evaluated a potential digital carbon tracking system. TAM postulates that people are more likely to adopt a new technology if they perceive it as useful and easy to use [6]. Figure 2 presents an extended version of TAM, adapted to investigate the acceptability of a digital PCT scheme. In addition to the core TAM constructs, such as perceived usefulness, perceived ease of use, attitude toward use, and behavioural intention, the model incorporates three key extensions: (1) External variables, such as environmental attitude, technophilia, access to visualisation tools, and online ability influence perceived usefulness and ease of use. (2) Concerns and perceived barriers, which may negatively affect perceived usefulness and attitude towards use. (3) Contextual moderators (marked with an asterisk) to qualify the strength and direction of relationships between constructs, such as links between attitude and intention of use.

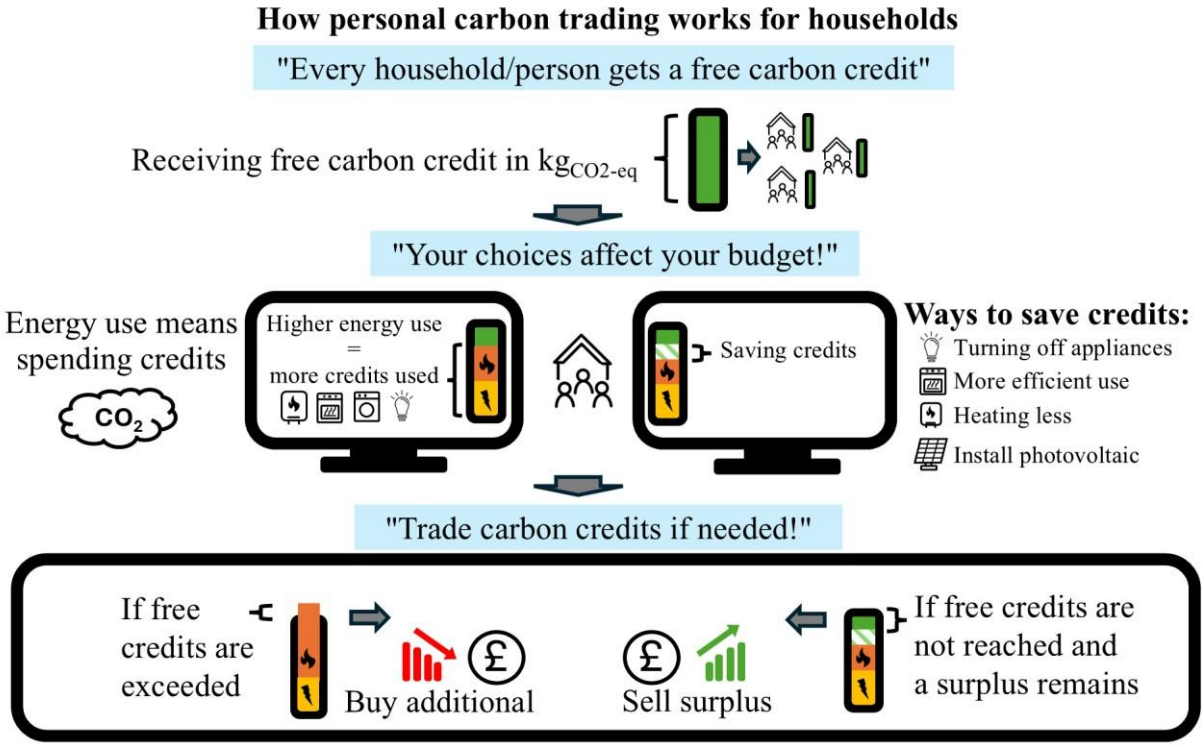

Figure 1. Visualisation to introduce the concept of personal carbon trading to the interview participants.

Among these contextual moderators, we also include voluntariness of use, which was identified by Venkatesh et al. (2003) as a key moderating variable in TAM. This reflects the policyrelevant distinction between voluntary participation and mandatory implementation, which is expected to moderate the relationship between perceived usefulness and behavioural intention to use [7].

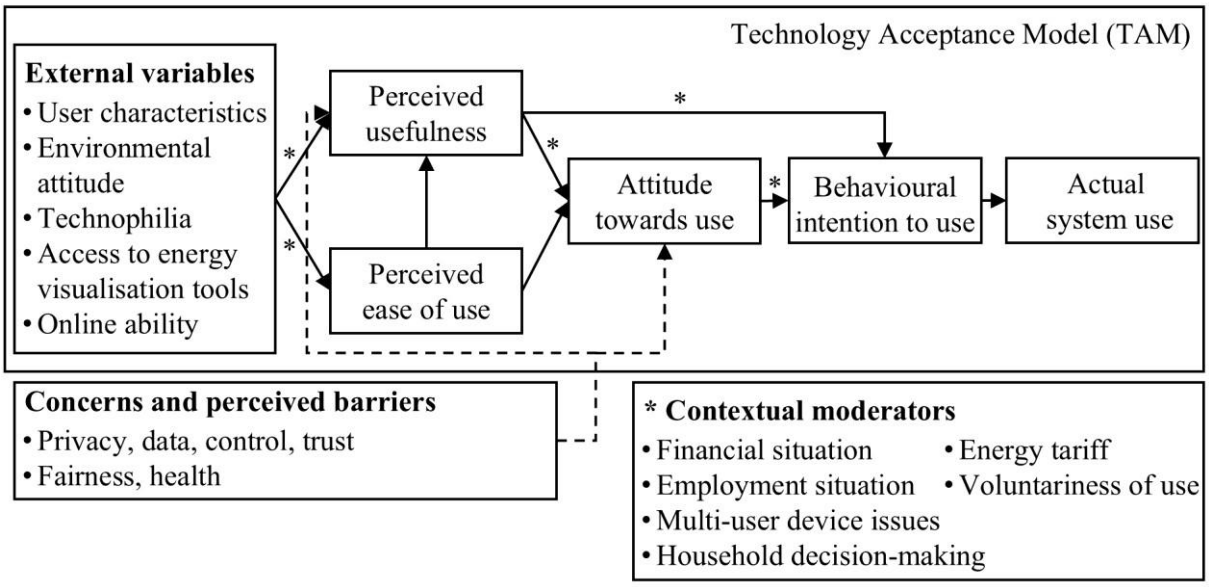

Figure 2. Theoretical framework of this study. The Technology Acceptance Model (TAM) extended for concerns and perceived barriers, and contextual moderators.

Questions targeted perceived usefulness, ease of use, user attitudes, and behavioural intentions. An additional question addressed concerns and barriers, including privacy and digital trust. The full question set is shown in Table 2.

Table 2. Core Interview Questions (TAM-Based) and optional questions to reflect on overall acceptability of personal carbon trading.

	Interview question
TAM category	
Perceived Usefulness	If you could track your carbon budget through an app or website, do you think it would help you use less energy at home? Why or why not?
Perceived Ease of Use	What would make a carbon tracking app or website easy or difficult for you to use?
Attitude Toward Use	Would you enjoy checking your carbon budget on an app or website, or would you rather get automated updates (e.g., push-notifications on the phone, emails, or no updates at all)? Why?
Behavioural Intention	Since the system automatically tracks your carbon emissions, how often do you think you would actively check your carbon budget? Daily, weekly, or only when needed?
Concerns & Barriers	Do you have any concerns about using a digital carbon tracker? (For example, privacy, difficulty using it, or sharing data with energy providers?)
Overall acceptability	
PCT Acceptability	Would you be open to participating in a Personal Carbon Trading (PCT) scheme voluntarily, or would you only consider it if it were mandatory? Why?

Participants were recruited from a larger living lab of households as part of the 'iDODDLE' project and represented a range of demographic and housing characteristics [8]. Interviews were conducted online or in person with all willing household members to gain intra-household perspectives. The interviews were audio-recorded and transcribed verbatim. Transcripts were analysed using qualitative content analysis. The coding framework was developed iteratively and aligned with the TAM constructs, while also capturing emergent themes related to digital trust, design preferences, and PCT acceptability. Supplementary survey and interview data from previous living lab activities was added as external variables or contextual moderators to support interpretation and triangulation e.g., participants' technology affinity and environmental attitudes, and their financial and employment situation.

Results

Participants largely supported the idea of digitally tracking personal carbon budgets, with 62% finding it potentially useful and improved energy literacy cited as a key motivator. Ease of use centred on the need for clear visualisations and simple feedback, with many participants valuing suggestions or alerts tailored to specific devices or personal usage patterns. Performance comparisons over time (e.g., monthly or annual energy use) were also frequently mentioned, while features such as AI-driven insights, gamification, and financial feedback came up, but less often.

Attitudes toward use showed a clear preference for active engagement: of around 80% who would interact with such a system, 68% preferred checking the interface regularly, 12% favoured regular prompts, 12% prompts and checking, and 8% prompts for unusual consumption or being close to exceeding the cap. Of all participants who would check the interface, around 80% said they would check the interface daily; while 20% preferred weekly or monthly use. Fairness (n=15) was the most frequently raised concern, with many fearing that wealthier individuals would be unaffected while lower-income households could be disproportionately impacted (n=7). Participants also highlighted inequalities linked to age (n=4), family status (n=5), disabilities (n=3), tenancy (n=2), and work-from-home

arrangements (n=2). Another major concern related to potential mental and physical health effects (n=9), including anxiety from constant monitoring or risks from underheating homes.

Additional concerns included data privacy (n=6), perceived loss of personal control (n=6), and methods of carbon allocation (n=7).

Behavioural intention varied strongly with policy framing, between mandatory and voluntary participation. 53% of all participants were willing to take part in a voluntary scheme. Support dropped notably under a mandatory framing, with 88% opposed to compulsory participation, while 6% did not clarify their intentions on these points. Overall acceptability was supported by 56% of participants, 38% opposed the scheme, and 6% did not answer. While this analysis focuses on core TAM dimensions, the influence of additional external variables and contextual moderators will be examined in more detail in subsequent analyses.

Discussion and Conclusion

Overall, digital carbon tracking was viewed as useful and acceptable by the majority of the participants, particularly under a voluntary scheme. Designing PCT tools with actionable, comparative, and personalised feedback could help sustain consumer engagement, but must also balance transparency with minimal cognitive burden.

These findings align with TAM. Perceived usefulness was reflected in motivations like energy literacy and perceived ease of use in preferences for simplicity and visual clarity. Attitude toward use was generally positive, with most participants preferring to engage regularly and check their performance themselves, and behavioural intention varied significantly based on voluntariness of use, underscoring the relevance of contextual framing.

Concerns around fairness, privacy, and mental wellbeing remain. Future research should explore whether explicitly integrating and communicating safeguards within PCT prototypes can help address these concerns, build public trust, and examine how these prototypes could be tested in real-world pilot studies.

Acknowledgements

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