‘Taking charge’

Measuring electric vehicle users’ propensity to adopt smart charging processes at the workplace

iDODDLE — Studying the Impacts of Digitalised Daily Life on Climate Change

May 16th, 2025 | 25th Swiss Transport Research Conference (STRC)

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My educational background blends entrepreneurship w/ operations research

Study Background & PhD Research Group

Marcel Seger

PhD Student (3rd year)

iDODDLE

Research Project

Environmental *Change* Institute

Educational Track

2022 - today

DPhil (PhD) in Geography & the Environment at the Environmental Change Institute (ECI), University of Oxford

2019 - 2022

Honours Degree in Technology Management at Center for Digital Technology & Management (CDTM)

2014 - 2022

B.Sc. & M.Sc. in Management & Technology (Industrial Engineering, Operations Research) at TU Munich

Key Information & Context

Research Objective

Studying the impacts of digitalised daily life on climate change across the domains food, home, energy, and mobility

Methods

Primary data collection with 'living lab' households for qualitatively rich insights on, i.a., technology adoption

Funding

Fully funded research scheme by European Research Council, Consolidator Grant ID #101003083

Agenda

Roll-out of extensive EV charging infrastructure on employee car park

Case study: Context-relevant information

RQ1	What are the benefits of coordinated EV workplace charging for firms?

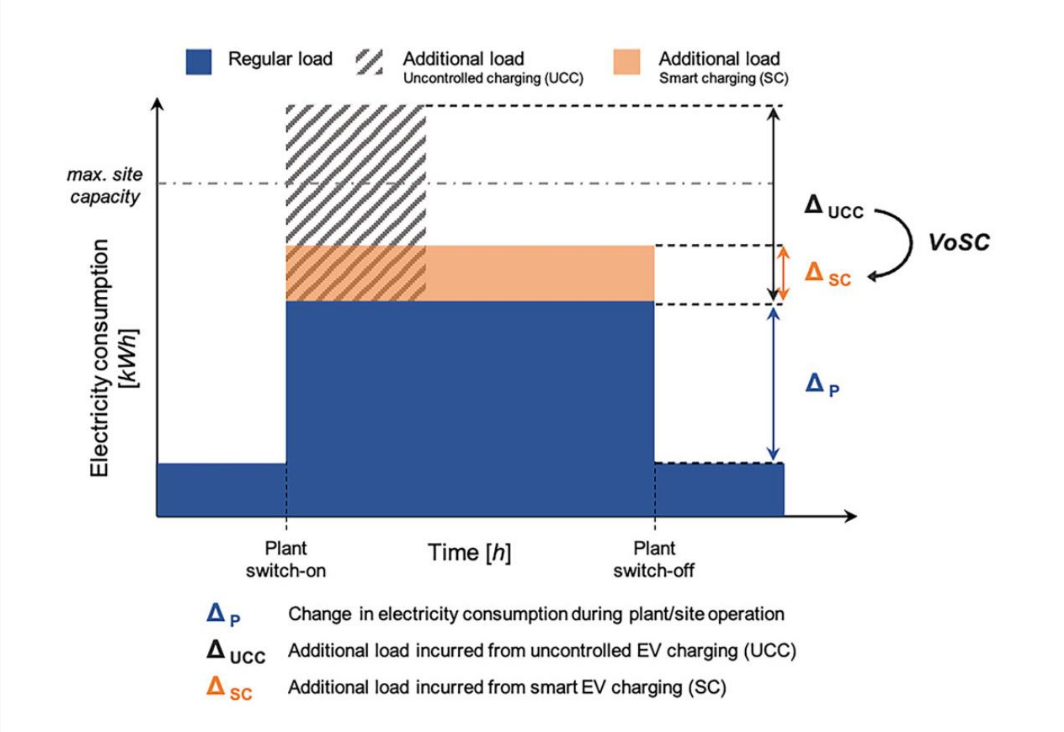


Fig. 1 | Schematic electricity consumption profile of industrial site.

Fig. 2 | Aerial image of employee car park.

SC strategies yield 28% lower peak loads while reducing charging costs by 9%

Overview of key results

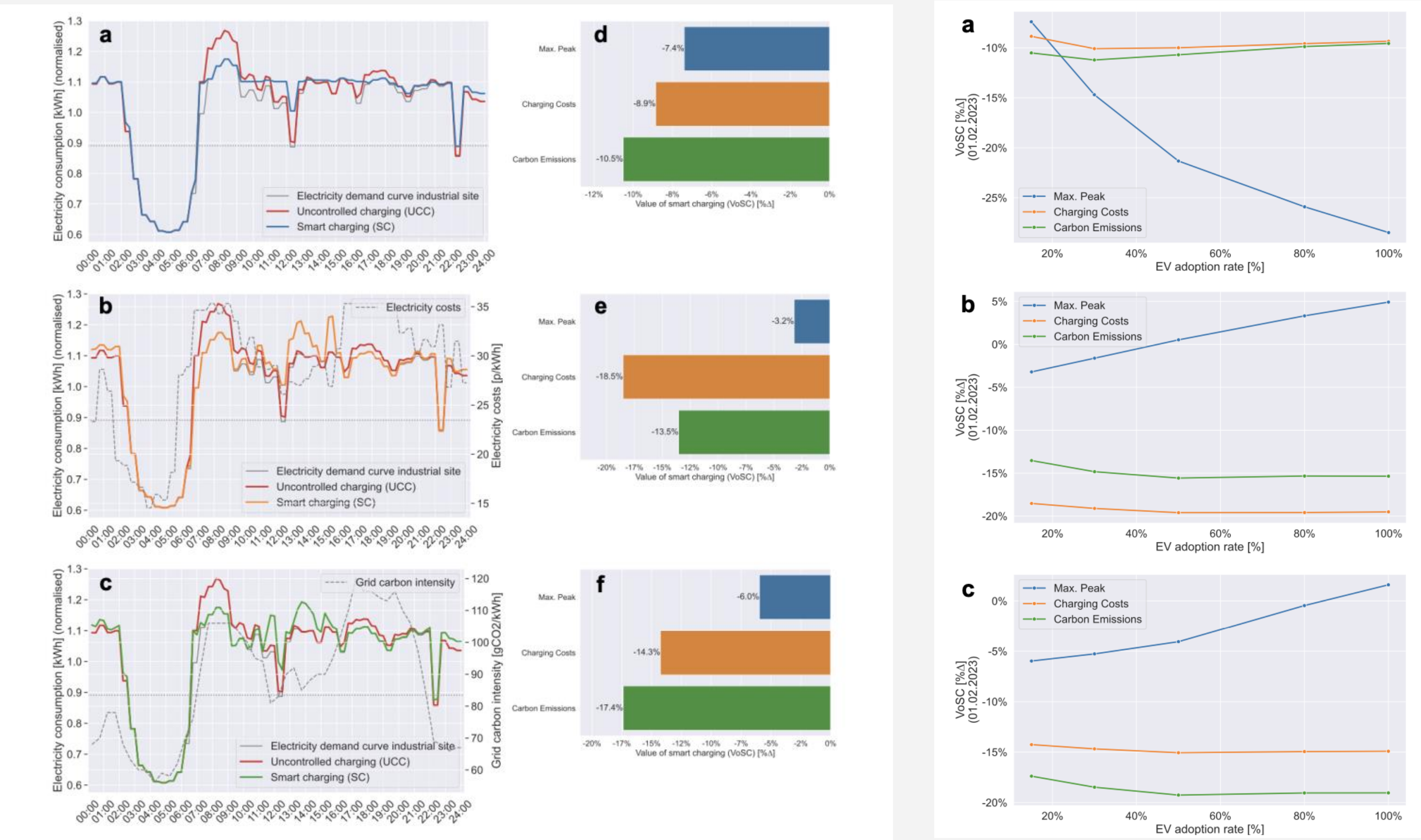
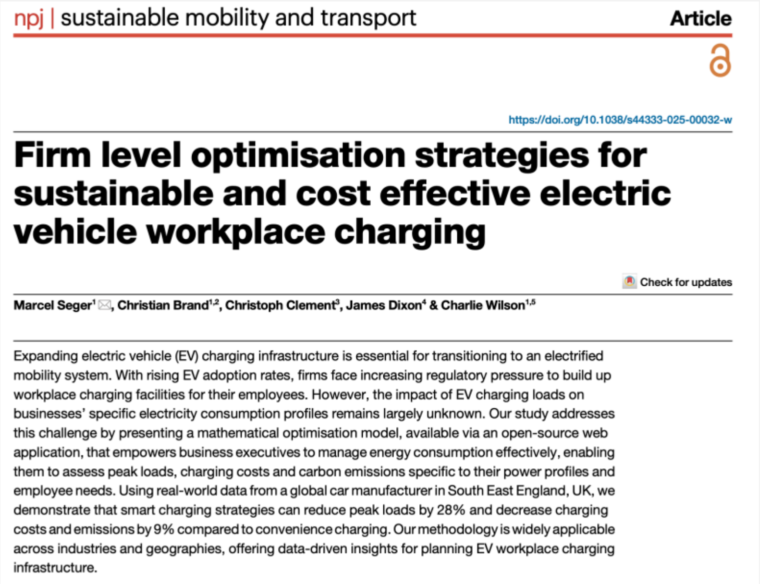


Fig. 3 | Charging profiles differentiated by model type and different EV adoption rates


npj | sustainable mobility and transport

Article

https://doi.org/10.1038/s44333-025-00032-w

Firm level optimisation strategies for sustainable and cost effective electric vehicle workplace charging

Check for updates

Marcel Seger[1], Christian Brand[1,2], Christoph Clement[3], James Dixon[4] & Charlie Wilson[1,5]

Expanding electric vehicle (EV) charging infrastructure is essential for transitioning to an electrified mobility system. With rising EV adoption rates, firms face increasing regulatory pressure to build up workplace charging facilities for their employees. However, the impact of EV charging loads on businesses' specific electricity consumption profiles remains largely unknown. Our study addresses this challenge by presenting a mathematical optimisation model, available via an open-source web application, that empowers business executives to manage energy consumption effectively, enabling them to assess peak loads, charging costs and carbon emissions specific to their power profiles and employee needs. Using real-world data from a global car manufacturer in South East England, UK, we demonstrate that smart charging strategies can reduce peak loads by 28% and decrease charging costs and emissions by 9% compared to convenience charging. Our methodology is widely applicable across industries and geographies, offering data-driven insights for planning EV workplace charging infrastructure.

Full publication available here:
https://www.nature.com/articles/s44333-025-00032-w

Developing a digital artefact as decision support tool for practitioners

Design science research with iterative design cycles

RQ2	How can business executives make more informed decisions in the process of installing and operating EV workplace charging infrastructure?

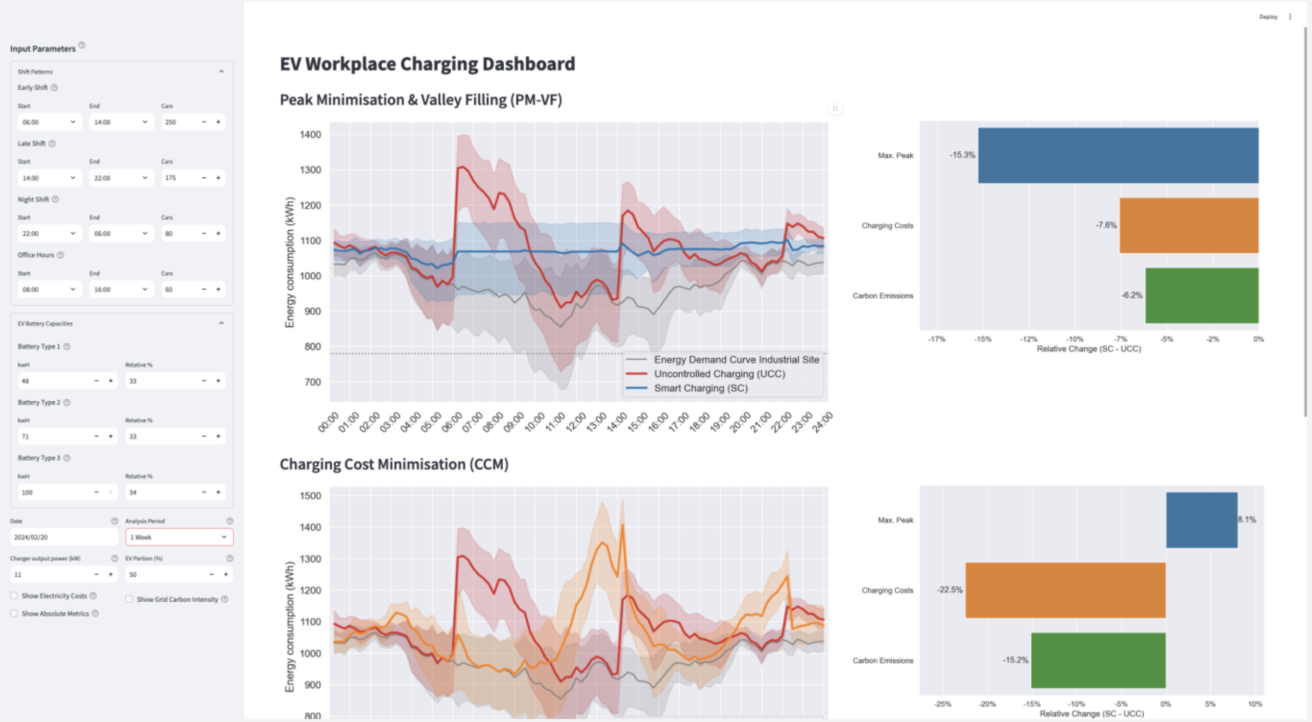


Fig. 4 | Screenshot of open-source web application (Version 2)

Title:

"A Design Science Research Approach to Making the Invisible Count: Predictive Modelling of Electric Vehicle Workplace Charging Loads"

Methodological approach:

Design Science Research (Peffers et al., 2007)

Openly accessible here:
https://ev-workplace-charging.streamlit.app/

Workplace commuters' responses to diff charging strategies remain unclear

Enforcement of new regulations and its effects

RQ3 In how far are EV users willing to adopt different workplace charging strategies?

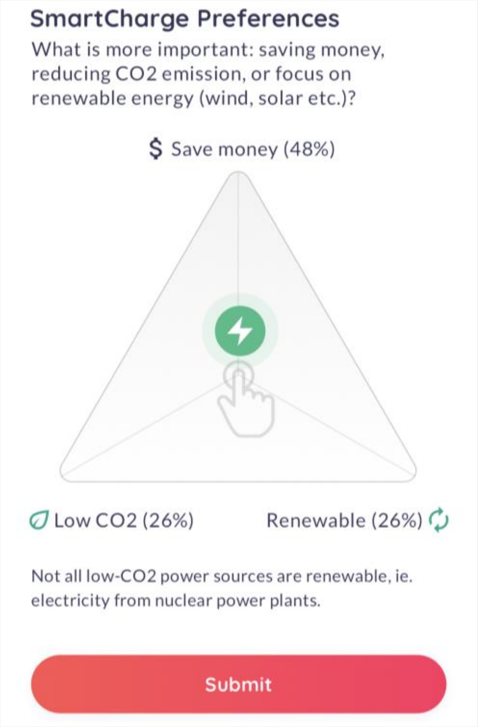


Fig. 5 | Screenshot of Monta's EV charging app (Monta, 2024)

Regulatory context:

- Enforcement of recent EU laws add regulatory pressure for firms
  - Corporate Sustainability Reporting Directive (CSRD): more stringent reporting of Scope 3 emissions, including employees' commute practices to the workplace
  - Energy performance of buildings (EPBD): legal requirement to provide min. 1x charging station on business car parks w/ >20 parking spots ('GEIG' in Germany – in effect since 01.01.2025)

Real-world implementation / Problem context:

- Businesses start investing into the build-out of EV workplace charging infrastructure
- However, the management of charging loads, especially as EV adoption rates grow, tends to be overlook
- Firms are facing complex trade-off space to choose suitable charging strategy, weighing off between peak-, charging cost-, and carbon emission minimisation
- Employees' responses and willingness to adopt various charging strategies specifically in the workplace context remains unknown → motivation for our study
- Growth start-ups MONTA, an EV charge points operator, is eliciting consumers' preferences for smart charging (in a home charging setting) through their app (cf. **Fig 5**).

Extensive prior research on EV characteristics and EV charging strategies

State of (academic) literature

RQ3	In how far are EV users willing to adopt different workplace charging strategies?

- Approach: Structured literature review across Scopus and Web of Science using search string:
  - **“TITLE-ABS-KEY** (("electric vehicle" *OR* "ev" OR "plug-in hybrid" *OR* "phev" *OR* "pev") *AND* ("charging" *OR* " smart charging" *OR* "vehicle-to-grid" *OR* "v2g") *AND* ("consumer preference" *OR* “user preference” *OR* "charging choice" *OR* "willingness to accept" *OR* "willingness to pay" *OR* "demand side flexibility" *OR* "financial compensation"))
  - Yield: **717** unique publications; currently evaluating its fit based on title and abstract
- Extensive research on consumer preferences for EVs / alternative fuel vehicles in early 2010s using Discrete Choice Experiments (Hidrue et al., 2011; Jensen et al., 2013; Hackbarth and Madlener, 2013)
  - Common attributes:
    - **Car specific**: Driving range, fuel cost saving, pollution reduction, performance, purchase price, battery lifetime, acceleration (Jensen et al., 2013)
    - **Charging specific**: Charging time, CO2 emissions, charging cost / monthly electricity bill, availability of charging information, availability of charging service, station accessibility, % of green electricity, source of green electricity, guaranteed minimum charge, program type (Time-of-Use, smart charging, V2G), override functionality (Moon et al., 2018; Wen et al., 2025) ; for Vehicle-to-Grid (V2G) specifically: Guaranteed minimum driving range, average length of required plug in time per day (Parsons et al., 2014)
    - **Other**: EV user experience, policy incentives, contribution to local environmental ambitions (Hackbarth and Madlener, 2013; Noel et al., 2019; Wen et al., 2025)
- **Identified research gap:**
  - Focus on **workplace commuters** (EV users (early adopters) vs. soon-to-be adopters (early majority)); measuring impact of **digital skills** and **competencies** as intermediary constructs to predicts users’ charging choices

Augmenting TAM constructs by wider digital skills & competencies variables

Preliminary hybrid model framework (*work-in-progress*)

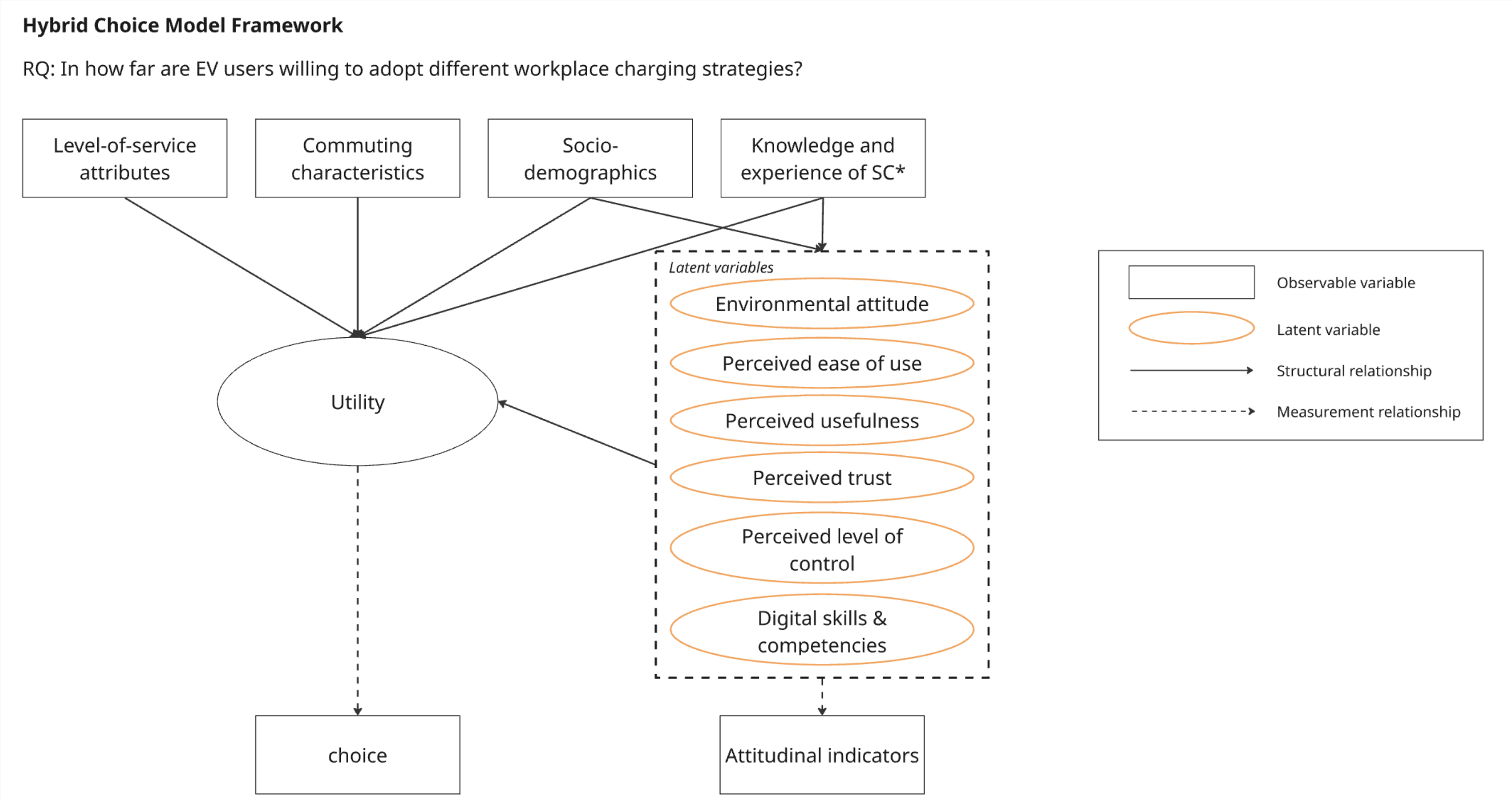


Fig. 6 | Preliminary model framework

Sample

- current EV owners/leasers and prospective ones (intentions to switch to EV within next five years)
- Workplace commuters (by car)
- Residents in UK or Germany
- Aim: 1,000 participants in total

Focus on workplace charging to assesses EV users' willingness to accept

Overview of choice task (V1)

Attributes / Charging strategy (›)	**Option A** [Smart charging]	**Option B** [Time-of-use]	**Option C** [Uncontrolled charging]	**Option D** [V2G] (tbd)
Charging start time ('Flexibility')	Controlled by algorithm	Scheduled by user	Immediate upon plug-in	Controlled by algorithm
Departure battery level (% SoC)	100%	80%	90%	70%
Monthly charging costs [£/€] (for 1,000 km)	30 £/€	48 £/€	60 £/€	15 £/€
Carbon emissions reduction	40%	20%	10%	40%
Contribution towards firm's sustainability goals	Yes, through emissions reductions	Yes, through emissions- and electricity peak load reductions	None	Yes, through emissions- and electricity peak load reductions
Scheduling/tracking functionalities	No scheduling; real-time tracking via smartphone app	Day-ahead entry (via desktop); no tracking	No scheduling, no tracking	No scheduling; real-time tracking via smartphone app
Override option	Always allowed	Limited per month	Not allowed	Limited per month
Choice	o	o	o	o

Tab. 3 | Preliminary design of choice task

Focus on workplace charging to assesses EV users' willingness to accept

Overview of choice task (V2)

Programme type	Departure battery level (% SoC)	Monthly charging costs [£/€] (for 1,000 km)	Carbon emissions reduction	Contribution towards firm's sustainability goals	Scheduling/tracking functionalities	Override option
Time-of-Use Charging > Charge at pre-specified time > Scheduled by user	80%	48 £/€	20%	Yes, through emissions- and electricity peak load reductions	Day-ahead entry (via desktop); no tracking	Not allowed

Would you be interested in participating in this EV managed charging programme?
- o Yes
- o No

Tab. 4 | Preliminary design of choice task (binary choice)

Thank you!

Any Questions?

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Pros and Cons: Binary vs. Multi-Alternative Choice Designs

Overview

Feature	Binary	Multi-Alternative Choice
Simplicity	Easy to understand, less cognitive burden	More cognitively demanding, especially with many attributes
Design complexity	Easier to implement (factorial design, vignettes)	Requires careful experimental design and statistical efficiency
Data richness	Limited insight—can't infer substitution effects	Enables estimation of trade-offs between attributes
Analytical methods	Logistic regression, simpler modelling	Requires multinomial logit or mixed logit models
Interpretability of results	Simple marginal effects, intuitive	Requires more advanced interpretation of relative preferences

Tab. 5 | Pros and Cons: Binary vs multi-alternative choice design

Q: Which study design reflects workplace commuters' real-world decision making more closely?

Reference study investigating commuters' travel mode and parking options for private autonomous vehicles

Reference study by Xue et al. (2024)

RQ 3 In how far are EV users willing to adopt different workplace charging strategies?

Components of hybrid choice model

- **Structural model**
  - Capturing relationship between sociodemographic and knowledge & experience of AVs and latent variable (LV) (see *Figure*)

$$LV_n^q = \alpha_n + \beta_n SK_q + \varphi_n^q,\ \ \varphi_n^q \sim N(0, \sigma_{\varphi_n})$$

- **Measurement model**
  - Capturing the observed values of the indicators using ordered probit model (attitudinal statements were rated on a 5-point Likert Scale)

$$IND_{n,r}^{q^*} = \delta_{n,r} + \theta_{n,r} LV_n^q + \zeta_{n,r}^q, \zeta_{n,r}^q \sim N(0, \sigma_{\zeta_{n,r}})$$

$$IND_{n,r}^q = \begin{cases} j_{n,r}^1,\ \ if\, \tau_{n,r}^0 < IND_{n,r}^{q^*} < \tau_{n,r}^1 \\ j_{n,r}^2,\ \ if\, \tau_{n,r}^1 \leqslant IND_{n,r}^{q^*} < \tau_{n,r}^2 \\ \vdots \\ j_{n,r}^k,\ \ if\, \tau_{n,r}^{k-1} \leqslant IND_{n,r}^{q^*} < \tau_{n,r}^k \\ \vdots \\ j_{n,r}^5,\ \ if\, \tau_{n,r}^4 \leqslant IND_{n,r}^{q^*} < \tau_{n,r}^5 \end{cases}$$

- **Discrete choice model**
  - Two-level nested logit (NL) model accounting for varying characteristics of respondents (e.g. ownership of car: yes/no)

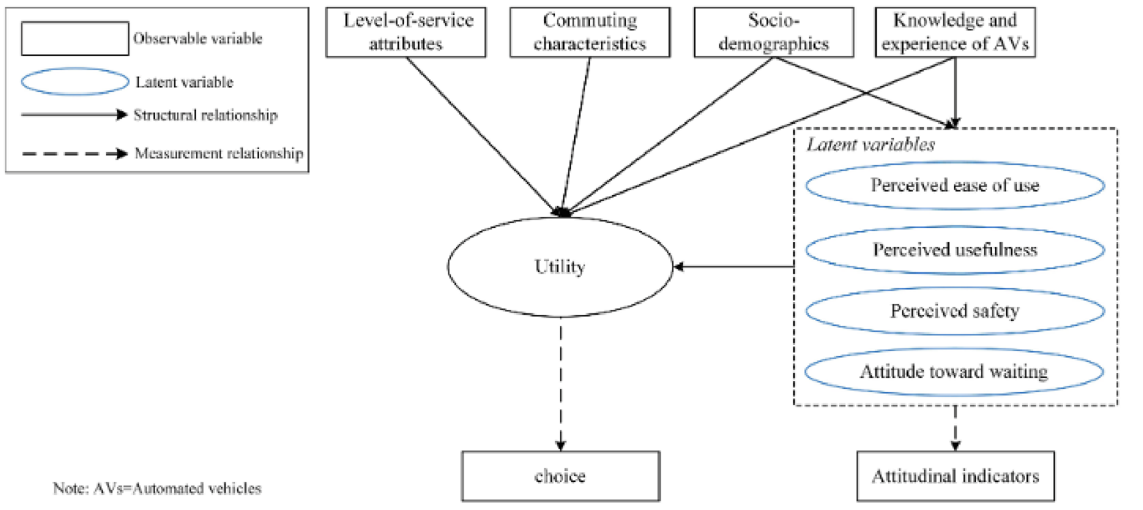

Fig. 4. Illustration of the hybrid choice model framework for this study.

Xue, F., Yao, E., Cherchi, E., Correia, G.H.D.A., 2024. Modeling the joint choice behavior of commuters' travel mode and parking options for private autonomous vehicles. *Transportation Research Part C: Emerging Technologies* 159, 104471. https://doi.org/10.1016/j.trc.2023.104471

Reference study to elicit participation in demand-side flexibility using EVs / heat pumps (UK)

Reference study by Wen et al. (2025)

RQ 3 In how far are EV users willing to adopt different workplace charging strategies?

Table 1
Experimental attributes and levels.

Attribute	Attribute levels	
	Electric vehicles	Heat pumps
Program type	Time-of-use charging; Smart charging; Vehicle-to-Grid (V2G) charging	Time-of-use heating; Smart pre-heating control; Flexible control
Annual electricity bill savings	£48; £240; £600	£36; £120; £240
Carbon emissions reduction	10 %; 30 %; 80 %	15 %; 30 %; 40 %
Contribution to local environmental ambitions	None; Supporting local carbon emission reduction ambitions; Supporting local carbon emission reduction ambitions *and* reducing local air pollution	As for electric vehicles

Programme Type	Annual (Monthly) Savings	Carbon Emissions Reduction	Contribute to Local Environmental Ambitions
Time-of-Use Charging - Charge at pre-specified time - Supplier not involved	£600 (£50)	10%	Yes - Supporting local carbon emissions reduction ambitions

Would you be interested in participating in this EV managed charging programme?

- ◯ Yes
- ◯ No

Wen, C., Steadman, S., Rafaq, M.S., Vatougiou, P., Deakin, M., 2025. Can reduction of local carbon emissions motivate participation in demand-side flexibility programs? Evidence from the United Kingdom. Applied Energy 388, 125610. https://doi.org/10.1016/j.apenergy.2025.125610

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Overview

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