Electric Vehicle home charging - key findings and implications summary report

Lewis Cameron [1] Murray Goulden[2]

[1] School of Social and Political Science, University of Edinburgh, Old College, South Bridge, Edinburgh, EH8 9YL

[2] School of Sociology and Social Policy, University of Nottingham, NG7 2QL

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Overview of summary report

- Research questions & approach
- Headline findings
- Barriers
- Enablers & policy recommendations

Examined barriers, enablers & solutions for:

How to increase the adoption & use of smart electric vehicle chargepoints (SEVC) at home for improved demand-side management (DSM), response & social wellbeing?

How to increase the use of off-peak charging for this?

How to increase the acceptance & use of smart chargepoints' smart functions for this?

Method

A qualitative study of diverse people's perspectives & practices influencing adopting & using SEVCs & DSM behaviours at home.

A whole household (hh), whole family, inclusive approach with maximum variation sampling to better include:

- the diverse domestic contexts shaping behaviours (including energy & mobility),
- differences within & across society & structural influences,
- Missing, diverse forms of citizens, (non-)consumer, (non-)use, needs, implications.

A multi-process approach for same reasons – decision-making, choosing, configuring, using, learning, routine use, routine formation, advanced uses, resistance, disuse, non-use of charger & DSM options, & what influences these. *A* multi-method approach for this.

- Co-produced visual method – design fictions – in 4 sections & a cartoon format with provocations & humour, each section consumed together, followed with related open-ended, semi-structured, conversational questions at their pace.
- Participant observation throughout & informal discussions before, during & after each section further increased data variety & richness.
- Cartoons & discussions in whole family & their living rooms increased inclusive understandings, participation, & data breadth, depth & contextualisation.
- Varied & extensive interactions & participation from all.
- Including from under-researched & hard to reach but influential, vulnerable & affected groups (e.g. children, women, disabled, low income). Sample included:
- No private off-street parking (1/6 hh); Low income (2/6 hhs); disabled (3/6 hhs); renters (1/6 hh); mobility schemes (2/6 hhs); children (all hhs), from 1-18 years & 2-4 children; * Elderly was a cohort we could not access directly, but were key features in the data.

Headline findings

1) **Low uptake of SEVC** - (2/6 households, 4 hhs had EVs, 6 EVs in total).

2) **Low uptake of SEVC-mediated DSM** – (0 hhs).

3) **Low uptake of off-peak charging & tariffs** – (None used off-peak tariffs. All charged at peak times, immediately after returning home for the day. Only 1 hh aware of off-peak EV tariffs, but this did not cause use of it.

4) **Low uptake of PV to EV** – (0 hhs. 2 hhs had EVs & PVs. Having PV & EV insufficient to cause SEVC adoption or PV2EV).

5) **Smart functionality unused -** (None used or wanted the smart functionalities).

6) Car & EV charging performs key roles - fulfilling valued identities, tasks, relationships, care provision & family life. – Smart-mediation undermined this.

7) **Drivers & barriers for uptake are cross-sectoral** – Drivers & barriers map across the diverse stages of decision-making & interaction moments across multiple sectors, governmental & market. Key drivers were high relatability, observability, trialability, comparability, & social validation. Key barriers were gaps in these at any decision-making or interaction moment.

- Gaps in these caused perceptions of distrust, injustice, risk & insufficient gains, further preventing desired behaviours & these key (social) drivers.
- Negative experiences, even in unrelated areas, are strong barriers. e.g. Universal Credit, policy U-turns & perceptions the desired behaviours are not commonly done, understood, validated (rewarded) & more rewarding for others.

8) Multiple barriers & enablers for inclusively increasing desired uptake & behaviours – but enablers contrary to dominant technological, market & policy approaches.

9) Consumer Protections

- All concerned of lock-in to SEVC, products they didn't like & deceptive selling.
- All were concerned about & confused by tariffs, price uncertainty, subscriptions, bundles, fees to leave contracts, hidden costs & low exchangability.
- All found the choice of SEVCs & tariffs overwhelming & incompatible with their busy lives.
- Data security no concern, but 3/6 hhs had significant charger security concerns.
- Decision-making, use & control of charger was unequal & gendered.
- Use of SEVC app, the only interface for 4/4 hhs, was negligible, unequal & gendered.
- Additional & hidden costs & underdeveloped repair, exchange & 2nd hand markets.

Such issues risk undermining *meaningfully* informed choice, accessibility & welfare. Design dominance of apps over shared display increases these risks.

Barriers

1) **Reliance** on smart technologies.
2) Reliance on tariffs.
3) Reliance on apps.
4) Eco-driven behaviours stop at EV purchase, not spurring off-peak charging.
5) **Alienation, distrust & disengagement** - from no choice (SEVC rather than slow charger) & too much choice (number of SEVCs, number of charger manufacturers, over 1000 models & 100 manufacturers in the UK.
6) **Distrust** in smart functions to deliver essential household & mobility needs.
7) Distrust in energy sector to deliver sufficient benefits to justify SEVC & DSM.

8) Alienation, distrust & disengagement from desired behaviours AND their achievement not being sufficiently socially acknowledged, understood & validated.
9) **Social drivers & barriers** - Social mechanisms & constraints most influential to EV charging behaviours, dwarfing influence of 'informed decisions', small price & eco signals - but missed by current approach.
10) **Cost & risk avoidance** – upfront cost of SEVC still too high & unfair for most.
    Gains too uncertain & distant.
11) **Symbolism** – car means autonomy, identities & family helper – undermined by generic smart narrative, smart default settings & misinformation & choice profusion that obscures independent & meaningful choice.
12) **Resistance** - Collective & interwoven routines & their constructs resist change - Hhs perceive their energy, domestic & mobility behaviours as relatively inflexible & crucial for the whole household, supporting accomplishing key tasks, roles, identities, care, family maintenance, wellbeing, & coping with emergencies. Without reassuring these & their continued production, change is resisted.
13) **Behavioural lock-in** – charging routines are locked-in to returning home from work & completing the last job for the day. Ai & off-peak charging delays or reduces this perceived achievement whilst lacking physical & symbolic coupling with a key routine.
14) Alienation, distrust & disengagement increased by perceptions the sectors doesn't understand the social, individual & family functions & constraints of charging, & their uniqueness within & across society.
15) Alienation, distrust & disengagement further increased by perceptions these social & practical aspects will be undermined & not supported.
16) Negative experiences – at every stage, from researching tariffs & chargers, to installation's & repairs hidden costs, to long-term disinterest in the smart functions & promised benefits & rewards.
17) Promises made & changes required not being socially perceived & valued.
18) These not being perceived equally – gendered, class, disability & age differences.

Enablers – Policy recommendations

1) Clearly cost-reflective

- Make the desired behaviours of householders conspicuously cost-reflective for all householders. Privatising the costs of & shifting household behaviours for SEVCs & DSM requires perceptibly clearer & fairer household benefits & distribution of benefits & costs. Benefits of SEVC & DSR currently principally system-level. Risks & costs high at household level. Especially at early stage of transition. All participants perceive this balance of gains & risk as unfair & insufficient for them.
- Requires whole-system, cross-sector approach for perceived fairness & transparency.
- Greater rewards for households to normalise SEVC DSM. If tariff-based, needs a "Massive" tariff or price benefit. Once normalised, rewards can level off.
- Reduce upfront costs as much as possible (paying anything for SEVC deemed unjust & unaffordable for 2/6 hhs).
- Remove all additional costs, especially for vulnerable & excluded groups e.g. fusebox upgrade when required provided for free & in initial visit with no extra organisational or time requirements for citizen, no penalties for overriding smart charging & such intervention always & easily possible for all, all assured long-term through trusted guarantees, warranties, rewards, redress & protections.
- Greater cost-reflectivity even more important now to build trust & acceptance as new default off-peak charge setting further erodes essential trust & acceptance.

2) Guarantee key utility

- Householders need greater assurance of key utility
- Provide & promote minimum charge they set & can change anytime easily with no penalties, ability to do this on charger, not just app, all assured long-term through trusted guarantees, outcome-based guarantees, warranties & rewards.

3) Guarantee full control by human(s)

- Giving up agency requires reassuring this process was perceived as fair, trusted & through householders autonomy & control, & can be reclaimed instantly, effortlessly, in householders terms. *All participants would use SEVCs & smart functions if this was provided more. For this they required:*
    - Easy for all to set minimum charge they want for whenever they want.
    - This ability to not be confined to an app.
    - Provide on-charger manual interface & voice-based interface.
    - No default or automated settings that limit this control.
    - collective & participatory design & policy-making,
    - peer-to-peer or community-based support.
- Regulate against defaults & interfaces being unclear to household as this limits trust, uptake & protections - Default settings will only be accepted if required trust, sense of autonomy & meaningful consent is generated = throughout our findings, & Citizens Advice (2021); Consumer Futures (2014).

* From July 2022, UK policy will breach this fundamental social requirement by mandating SEVCs pre-configured to avoid peak charging.

4) Simplify product options & presented benefits & rewards

- Provide all key information on a single platform.
- Build trust in this by the provider having no commercial interest, requiring government funding, & longer-term. Recommended also by EVET (2021).
- Key information to include only suggested or stated benefits & outcomes that are conspicuously & consistently achieved with desired behaviour.
- Provide independent choice/product comparisons.
- Ensure alternatives, negatives & risks of SEVCs are not omitted.
- Present relatable costs & benefits of options. Not long-term minor savings.
- Make metrics consistent & socially meaningful & emotive.
  e.g. 'EV miles' may be more relatable for most people than kWh, but its power to drive behaviours requires making this metric standardised: consistent, clear, comparable. Currently calculation & definition varies & not transparent.

e.g. Community & household metrics e.g. who is the best driver or SEVC user in the family, household & community.

- Address normative influences, practicalities & cognitive biases.
  e.g. 1) behaviours more risk avoiding than profit-seeking, so provide long-term guarantee against losses e.g. how long will off-peak charging be that price & offered for that many hours in 24 hours?
  2) Provide upfront benefits in short to mid-term to compensate for costs, risks & uncertainties, until norms reassure these.
  3) Illustrate % of society & my peers or community is doing desired behaviours & why; How exactly society & my peers or community has experienced it; How long it might take to install, learn to use & adjust when needed; what common experiences this is akin to (e.g. installing & learning to use apps on your phone &/or refuelling your car when the petrol/diesel prices are lowest), what is the guaranteed pay-back time for this inconvenience & any financial cost).

"There's so many tariffs, that's a minefield for a lot of people, there needs to be more transparency in what product you are getting & what that looks like". Mum, H2.

"How long it takes to pay for itself would be key for me." mum, H4 "A combination of this, if there's a warranty, what the warranty is on it, will it save you money, the likelihood of it lasting long enough to pay for itself. It's relatively new technology, is it actually going to pay for itself." Dad, H4.

5) Build public trust & consumer protections across sectors & government

- Trust & protections essential as smart products & flexibility makes products & market more complex, increasing consumer risks & uncertainties.
- Trust gives legitimacy to points 1-3 & a key barrier & enabler.
- Challenging due to cross-sector nature of trust.

- Build trust by methods 1-15. social mechanisms & consistent, simple, reliable policy & products perceived as fair with promises matching experiences. *Emphasised repeatedly by all participants.*
- More protections needed than updated in latest regulation – especially accessibility & equity impacts & commensurate safeguards - & across sectors.
- Provide this in a single, independent point of contact to simplify the complex consumer journey & any redress.
- Ensure protections & redress apply proactively & swiftly across the multiple & high diversity of actors, some relatively unregulated & new, with differing roles, responsibilities, market boundaries & market stage - increases the chance of consumer challenges, bad experiences & these not being redressed.
- For this, Ofgem will need to enforce their powers more, more quickly & redress more swiftly, requiring additional enforcement resources (Citizens Advice, 2022) & regulating over complex actor interdependencies & boundaries (energy, charging & AI providers, aggregators, third party intermediaries, installers, vehicle services)
- Avoid experiences that undermine trust & consumer welfare. Including negatives & risks of SEVCs omitted from official sources, misinformation, energy providers hiking direct debits, incorrect billing, slow reimbursement to consumers, faulty or limited perceived benefits of smart meters, market instability, Energy Price Cap U-turns, sustainability, decarbonisation & social support U-turns, electricity, petrol & diesel price volatility, high profits for producers, driveway requirements, EVs perceived as unaffordable for poorest. *Mentioned by all parents in study.*
- See recommendation 15.
- Update Consumer standards from the 2008 regulations to meet this complexity, without being too prescriptive to stifle innovation.
- Updated regulations should build upon The Electric Vehicle Consumer Code for Home Chargepoints (EVCC), the forthcoming Future Energy Retail Market Review (Ofgem), reports from Consumer Advice & ongoing consumer research.

- Enforcement should focus on customer experience rules (billing, service, debt, misinformation) over technical matters that only indirectly affect consumers.
- Protect against unwanted defaults & interfaces, address lack of research on their impact. Impacts suggested by our study include: unequal & low usability, uptake, secondary peaks.
- Provide parameters for how defaults are provided & update these parameters with ongoing customer experience & outcome-based research – which most effectively shifts EV charging whilst minimising distrust, inequalities & harms.
- Responsive parameters to ongoing consumer & outcome-based research will support effective default designs & desired outcomes without being prescriptive, which limits realising most effective designs, & without having insufficient parameters, resulting in markets making their own interpretations, resulting in default options of varying ease & suitability, causing accessibility limitations, & consumer learning on one system not being transferable. The EVET also recommends this (EVET, 2021).
- Positive experiences here will be crucial in influencing long-term consumer perceptions & behaviours to smart products.

6) Harness Routine & Social drivers of behaviours

- **Couple routines** – link desired charging & DSM with a key routine & symbolic attribute currently driving peak charging: returning home, feeling empowered & charging successfully, achieving self, family & social validation & roles.

- **Observability** - increase visibility of desired behaviours & achieved rewards: i.e. a display facing the public on the charger or car & another in the most lived-in room in the home, showing collectively when car will be charged by, if off-peak or best times for community, what proportion of their charging or V2G is at these best times, what benefits this provided to household & community & country.

- Provide community reviews, forums, referrals & ratings for peer-based feed-back & experiential & normative information - experiences & peer-based sources were more influential than information or rewards from non-peers (*e.g. no participant mentioned official or independent sources of information or reward, only 2 knew which tariff they were on or looked at pricing or official information. All participants emphasised personal, family & peers' experiences & opinions of them as key*).

- **Relatability** - Make desired behaviours contextualised to households & communities as much as possible, e.g. above methods & community events & household-level, interactive communication, e.g. voice-based & shared messages & interfaces displaying how much your charging is costing or earning per mile, & cost-saved & benefits for the community & family.
- **Comparability** - display how this compares with the hh, community, & respected peers to drive social competition, gamification, reinforcement, governance.
- Ensure inclusivity of online & offline platforms & events for all groups & sub-communities, not dominated by certain groups, e.g. men or more able & technical.
- Include other trusted & influential persons & media that people already consult, e.g. Martin Lewis, peers, social media, multi-media (especially short videos).
- **Ownership** – Eco, thrifty or techie identities did not drive desired behaviours & willingness. But other identities would: self-created, displaying skills, agency, taste, culture, contributions & achievements.
- Provide these normative, experiential & social mechanisms before individual or rational signals such as prices, standardised information or speculative & non-contextualised information such as savings & ease-of-use.

7) Harness social nature of rewards & achievements

- Monetary & eco metrics & rewards did not drive desired behaviours. Instead, signal desired behaviours as *observable achievements*, gaining

social performance, influence, recognition, acknowledgement, competition, validation, & conformity.

- Display desired behaviours as achievements to whole household & locality, spurring competition within hhs, communities & between communities via on-charger, voice-based & community-level displays of charging/V2G/DSM progress, rankings, comparisons & rewards displayed live with daily & weekly summaries.
- Replace perceived loss of agency, skill, creativity, identities & achievements further by supporting continuous inputs into policy, products & technologies.
- Further promote this by platforming all rewards, reviews & recommendations, enabling all citizens to add, rank & vote upon them, & clearly see impact of this on policies & products. Reward best contributions in socially visible way e.g. on engagement platform.

e.g. Better Reykjavik - online platform for all citizens to recommend, review & vote on policies, budgeting & ideas in real-time, has received input from 60% of the city's population across all neighbourhoods, with 600 of the ideas becoming city policy & projects by 2017, & the platform ongoing & being implemented in 42 countries as a result of its impacts (Citizens.IS, 2022).

- Remove narratives, marketing & designs & design practices that convey or label the desired behaviours as universally easy, non-achievements, individual, or external (e.g. achieved by technology & technocrats).
- Instead, allow engagement platform & citizen-led product & policymaking to develop inclusive, internalised narratives & products they relate to.

8) Experiential drivers of behaviours

- Experiences & social drivers & rewards from peers unanimously influenced EV, charging & DSR behaviours. Increase these further via increasing trialability & observability, e.g. **A) directly via free trials** of different chargers, tariffs & EVs, available to all & on mobility schemes, with no hidden costs or hassle; via on-charger manual interface & visual display of type of charging; **B)** indirectly via citizen-led ranking of products & referral schemes. **C)** Avoid & remove barriers to these, such as external gatekeepers, exclusive membership, lengthy contracts & restrictions. **D)**

Ensure, insofar as possible, experiences are consistently positive for all. e.g. remove hidden costs, hidden defaults, hassles, exclusions, difficulties to choose & use & realise benefits, deception that SEVC is only option & easy for all. Regulate against selling or misinforming about higher-cost replacements or SEVC over lower-cost options. **E)** Reduce prominence of non-experiential & non-social mechanisms such as standardised information, apps & monetary tariffs.

9) Increase inclusivity & perceptions of fairness

- Builds on importance of cost-reflectiveness & trust. Exclusions from interfaces, schemes, products, benefits & perceived compatibility with their lives, identities & family prevented desired uptake & behaviours directly, & indirectly via perceptions of distrust & unsuitability within & beyond the study households - even when other members of hh were pro SEVC & off-peak charging.
- Particular concerns for elderly, disabled, those without private driveway & low income, with young children (to charge at home & off-peak, to use apps & all the options, to choose & switch between tariffs & chargers most beneficial for them, affordability of upfront costs, depreciation of ICE car & associated "petrol head" identities, insufficient 2nd hand EV market, to benefit as others can).
- Build inclusivity across these & other excluded groups by addressing capability requirements through points 1, 4, 10, 12 & 14 in range of contexts, including those of the groups highlighted above & all vulnerable & resistant groups.
- Address barriers for all groups to meaningfully participate, requires ongoing research & neighbourhood & participatory trials & design of SEVCs & products.
- Match off-peak charging tariffs & rewards for residential street & home.

10) Capability requirements & bundles

Not all can or will use apps. Not all have time, ability or money to organise additional requirements. These differences are socially stratified, likely to

reinforce existing social inequalities unless additional intervention. (Also found by Powells & Fell 2019).

- Reduce capability barriers by reducing hassles, hidden costs, reliance on apps & bundling all requirements. e.g. Bundle all required steps in one household visit for free with trusted local actor (e.g. fusebox upgrade by local dealership or electrician used before). Same actor provides any further support where necessary.
- Reduce upfront costs for certain groups, means based.
- Provide additional support & training for those who need in relatable format, e.g. whenever needed & via established & trusted locals, providers, peers, friends, family.
- Consider giving an upfront incentive to whole household to boost uptake by sharing rewards & acknowledgement of the effort required for most households.
- Provide alternative interfaces, designed with diverse publics & vulnerable groups.
- These, including bundles & products, only effective if trusted, social & socialised – use established sources of influence, e.g., testable offerings, visible community reviews, ratings, forums, referral schemes, recommendations, local providers.
  e.g., instead of free miles or smart home tech (invisible, hard to compare & so confusing) offer free MOTs or car service from local, preferred garage (parents, H6).

11) More participatory approaches

Some mechanisms under current approach have opposite impacts, e.g. very low uptake of off-peak tariffs, charging, SEVCs & smart functions.

- Modify focus on smart tech, convenience & tariffs to social mechanisms.

Increased local support from latest policy (HM Government, 2022) responds to some barriers highlighted in this study, Ricardo (2000); & CMA (2021), but beyond the need for more on-street SEVCs, & resources local authorities (LA) need for this, key barriers, differing needs & low uptake of SEVC's smart functions (our study) are unaddressed.

Participatory approaches - inclusion in tech & policy design & appraisals - aid this & many key constraints & requirements found in this study:

a) Product design & support to account for low & stratified uptake, affordability & accessibility, excluded & vulnerable groups & gendered differences.
b) Limitations Local Authorities have shown providing accessible on-street charging.
c) Need to increase trust, legitimacy & willingness to uptake SEVCs & DSM services.
d) Need to feel sense of agency, autonomy, role fulfilment, value & skill – participation can reassure citizens that the key roles their car or EV charging performs will be maintained, even if in other ways.
e) Lack of visibility & acknowledgement of desired behaviours & its achievement.
f) Need for preventing monopolies, lock-ins, & provision & usability gaps.
g) Need for alternative design & delivery mechanisms & business models.
h) Need for sharing key learnings, resources & behaviours.
i) Need to better distribute & share societal capabilities to adopt & benefit.
j) Need for ongoing evaluations by ordinary users in diverse contexts.
k) Need for engagement beyond point of sale & perception getting an EV is enough, "we did our bit".
l) Support groups to self-identify rather than label them as 'smart users' or anything else they don't relate to.

Citizen inclusion in these enhances the objectives of latest policy, e.g. the Local EV Infrastructure Fund & increases resources, capacities, innovation & expertise, supporting LAs to address low & varied on-street SEVC provision, & supporting desired behaviours.

12) SEVC & DSR as social assets & social benefits

- Promote EV & SEVC as *their household's asset* (No participant made any link to these as asset for anything, including PV to EV & getting paid to charge & discharge).

- Make these wider benefits more observable, comparable, validated & testable via social mechanisms above at key levels influencing behaviour (home, family, peers, community, region/nation).
- Links to perceived cost-reflectiveness, trust, agency, ownership, relatability, legitimacy, inclusivity & fairness.

13) A consumer advisory, engagement & interaction platform

- Provide platform that supports & aggregates methods that influenced all participants (social, interactive, normative, behavioural, experiential, trusted).
- All participants would use such a platform if integrates these mechanisms & the methods they already use: social networks, local & peer-to-peer, already commonly trusted & consulted public figures, multi-media, especially short videos, *e.g. Norwegian SEVC company Easee releases compelling 1-2 minute videos, some receive 50k views in 2 months, e*.g. Reykjavik's online platform.
- No participants used other advisory sources (e.g. EST, Citizens Advice).
- A platform that combines these increasingly valuable as complexity of consumer journey increases (e.g. more smart products, actors, services & flexibility).

  e.g. comparison sites popular (4/6 hhs) but most don't include EV or smart tariffs, nor include the whole market, or what their comparisons are based on.
- Platform could integrate recommendations of this study.
- Requires independent organisation with longer-term funding.
- Requires long-term platform, not closing as government change, e.g. Reykjavik's platform 12 years & counting, vs. UK's 'Simple Energy Advice' site now closed.
- Requires a single point of contact to simplify consumer journey, record & share experiences & provide arbitration & redress.
- Make partnerships & resource sharing to avoid waste & confusion via replication.
- Should include real-time information of charging/discharging patterns, norms & values of for them & their local, regional & national network.

- Platform should give more space to these than less trusted & relatable content (e.g. rational, individualised, speculative, external, non-contextualised).
- Provide this across all decision-making & interaction junctures - car manufacturer, dealership, energy supplier, chargepoint operator, before sale, point of sale & aftersales & repairs & replacement - in same platform.
- Provide a nation-wide hub with sections for every region & social group to identify with, create, add, develop, share, rank & vote upon. Hub can spur wider participatory governance & design, & replication by other departments & countries, as per Iceland's platform, now in 42 countries (Citizens.IS, 2022).

For any questions and further information contact: ***horizon@nottingham.ac.uk***