‘Making the Invisible Count’

A Design Science Research Approach to Predictive Modelling of Electric Vehicle Workplace Charging Loads

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

June 04th, 2025 | DESRIST Conference

Marcel Seger | Supervised by Prof C. Wilson, Prof C. Brand
Co-authors: Dr Christoph Clement, Dr Marc-Fabian Körner

DPhil (PhD) Candidate
School of Geography & the Environment (SoGE)
University of Oxford

My educational background blends entrepreneurship w/ operations research

Study Background & DPhil Research Group

Marcel Seger

PhD Student (3rd year)

Environmental *Change* Institute

iDODDLE

Research Project

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) 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

Funding

This research was supported by European Research Council ERC Consolidator Grant, #101003083 (2021 – 2025)

Funded by the European Union

European Research Council
Established by the European Commission

iDODDLE
The Impacts of Digitalised Daily Life on Climate Change

Agenda

Overview

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

Regulatory environment & real-world problem motivation

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

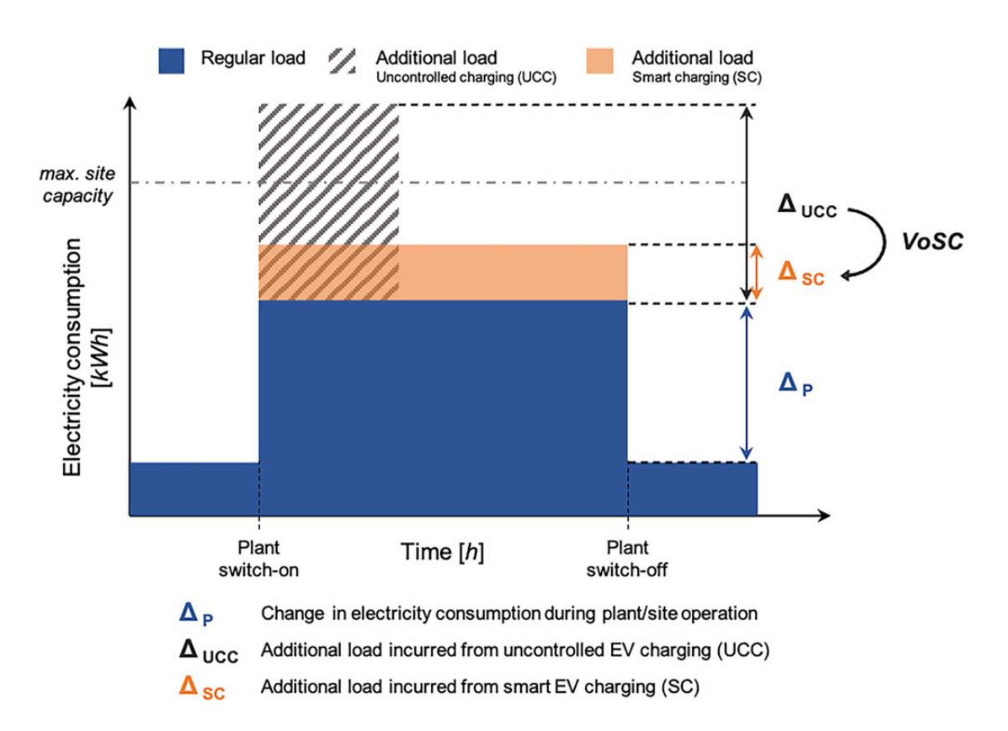


Fig. 1 | Schematic electricity consumption profile of industrial site.

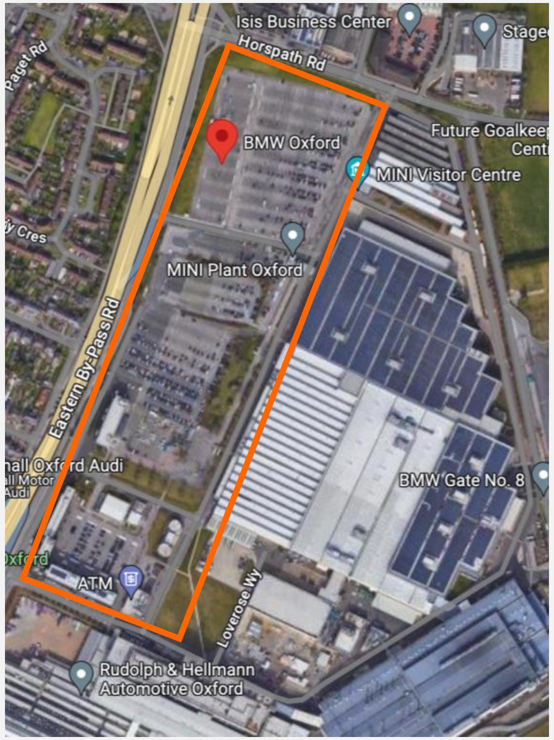


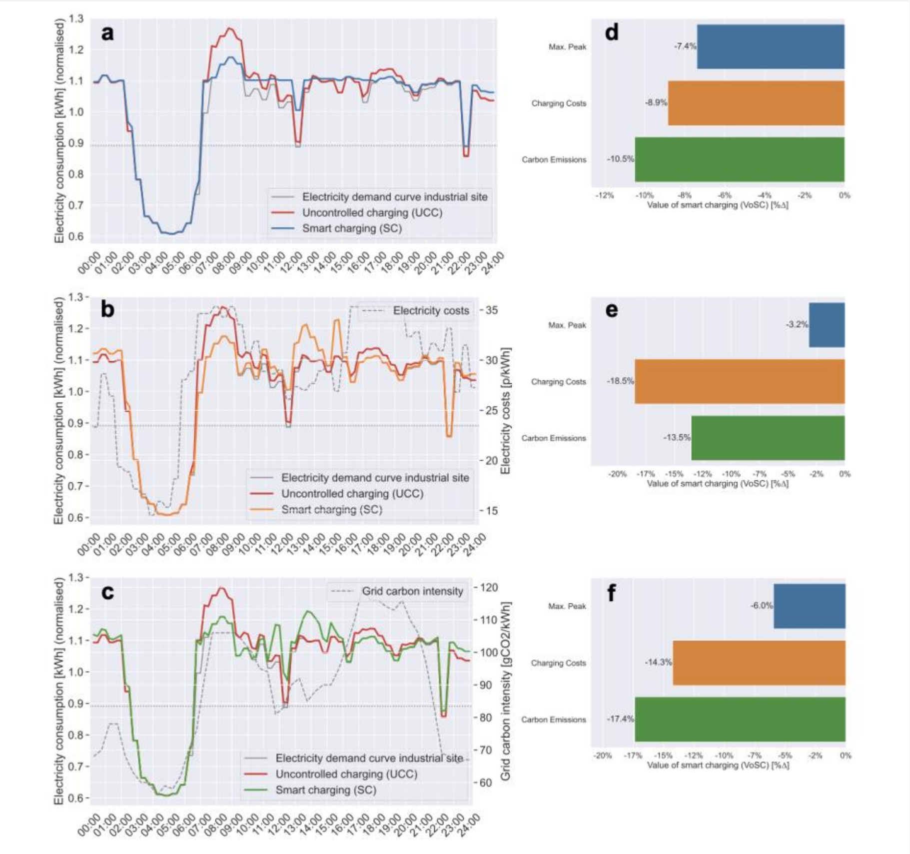
Fig. 2 | Aerial image of employee car park.

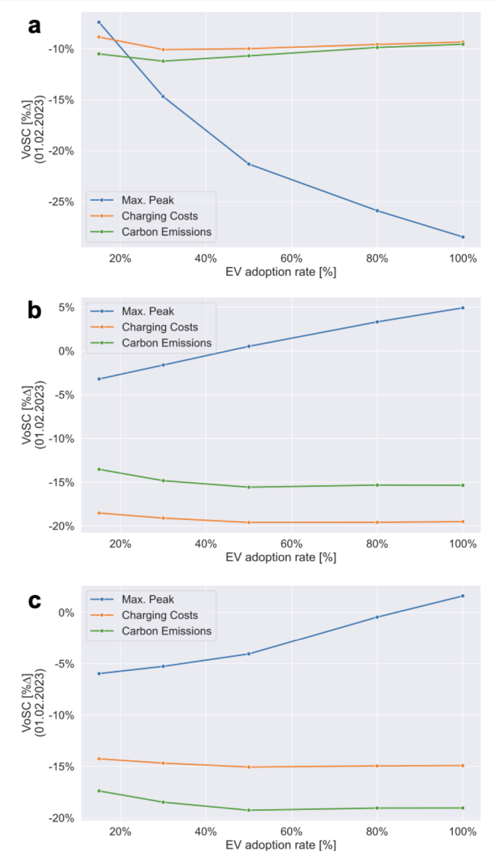
Motivation: regulatory context

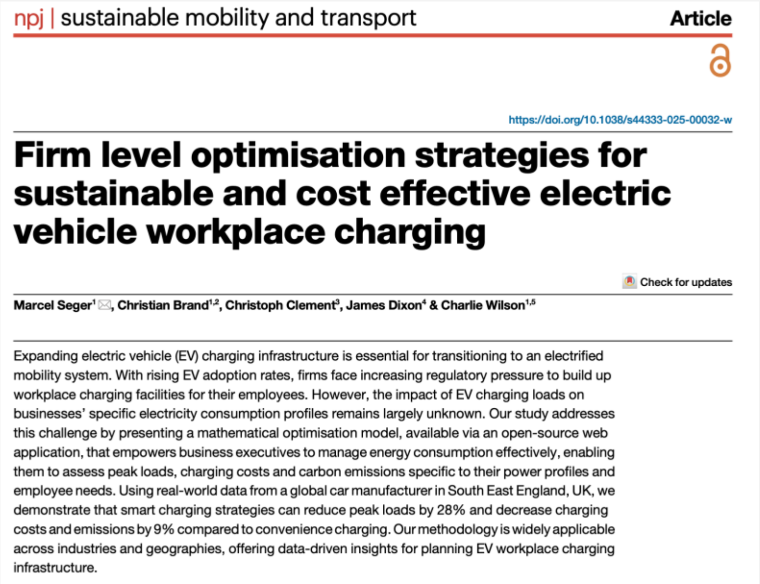
- Enforcement of recent EU laws add regulatory pressure for firms
  - Corporate Sustainability Reporting Directive (CSRD): more stringent reporting of Scope 3 emissions, including employees' commute practices to the workplace
  - Energy performance of buildings (EPBD): legal requirement to provide min.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

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

Prior work (PhD Paper 1): Overview of key results







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

Fig. 3 | Charging profiles differentiated by model type and different EV adoption rates [**1**]

Firm-specific decision support for predictive modelling of EV charging loads

Overview of prior research

IS for low-carbon energy and mobility systems

- '**Green IS**': addressing challenges of sustainability and efficiency in energy and mobility systems [**2, 3**]
- Prominent examples of 'Green IS' research
  - Sustainable supply chain management [**4**]
  - Digital carbon accounting systems [**5**]
  - Energy-aware business process management [**6**]
  - Organisational digital decarbonisation approaches for environmental sustainability [**7**]
- '**Energy Informatics**': emphasises the role of digital technology systems in optimising energy generation, distribution, and consumption
- Prominent topics:
  - Smart grid management [**8**], decentralised energy systems [**9**], demand-side energy management [**10**]

'Research Gap'

- Most studies have taken on the viewpoint of either network operators or electricity market agents [**22-25**], or electricity market agents [**26-29**]
- In practice, the decision for building + operating EV workplace infrastructure lies within responsibility of private firms
- **Lack of adequate methods, data, and tools for workplace operators**

Sustainable transformation of mobility systems

- 'Green IS' + 'Energy Informatics' contribute significantly to the development of EV charging infrastructure
- Recent scholarly work:
  - Optimised load balancing and the integration of renewable energy into charging networks [**11, 12**]
  - enabling vehicle-to-grid and sustainable charging approaches [**13**]
  - user-oriented systems have been analysed to improve the EV charging experience, including intelligent navigation to available charging stations, real-time availability updates, and dynamic pricing [**14-17**]

Smart EV charging

- 'Smart charging' – a concept referring to managing electricity loads from EV charging cycles according to pre-defined objectives [**18**]
  - Review of common objective functions [**19**]
  - Joint optimisation of the decision on the number of EV chargers to be deployed and the operational decision of charging spot assignments [**20, 21**]

Developing a digital artefact as decision support tool for practitioners

Design science research process: General overview

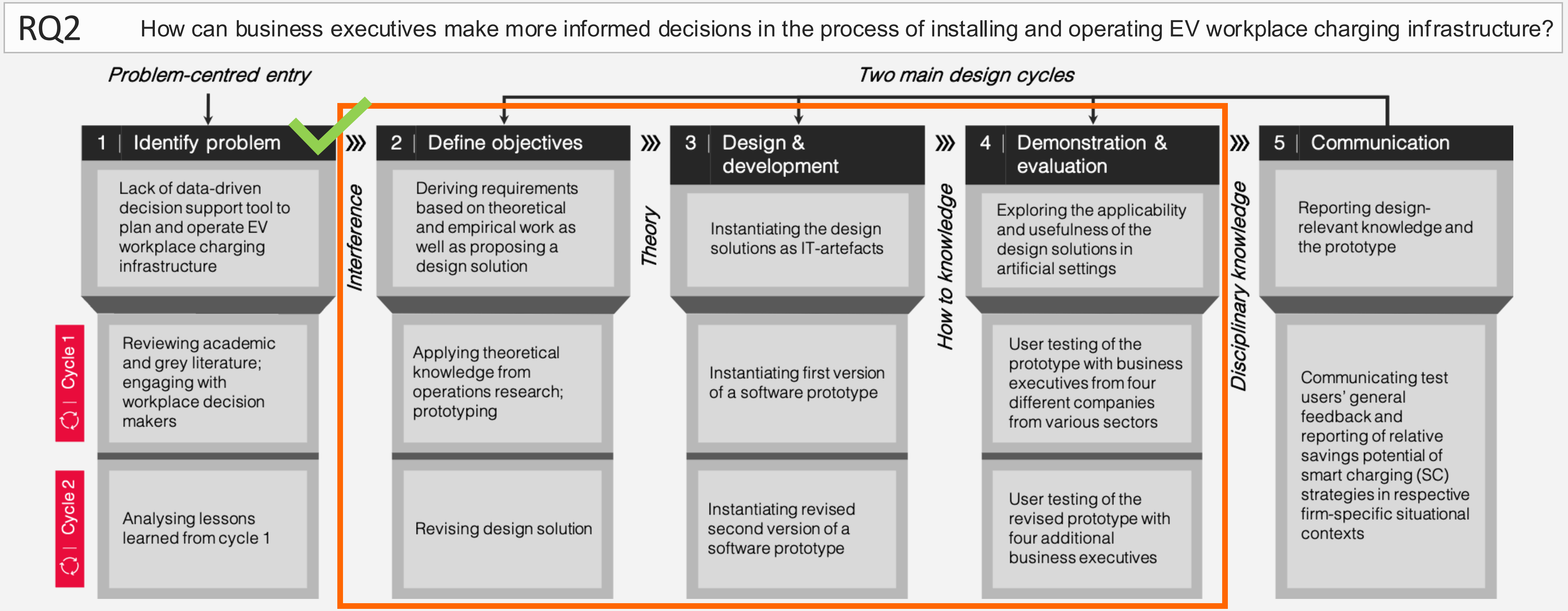


Fig. 4 | Visual overview of the adopted DSR process. (Adapted from [**30**] and [**31**])

Definition of objectives are informed from operations research

Design science research process: Step 2

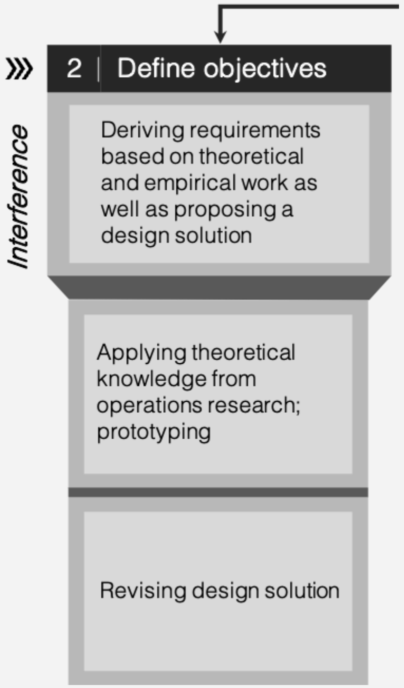


Fig. 5 | DSR step 2

Definition of optimisation objectives

Peak min. & valley filling (PM-VF):

$$min \quad z_{PM-VF} = \sum_{t \in T} (P_t + y_t - C)^2$$

Charging cost min. (CCM):

$$min \quad z_{CCM} = \sum_{t \in T} y_t * \lambda_t$$

Carbon emission min. (CEM):

$$min \quad z_{CEM} = \sum_{t \in T} y_t * \gamma_t$$

(Adapted from [19] and [30])

Proposition of (first) design solution using Figma

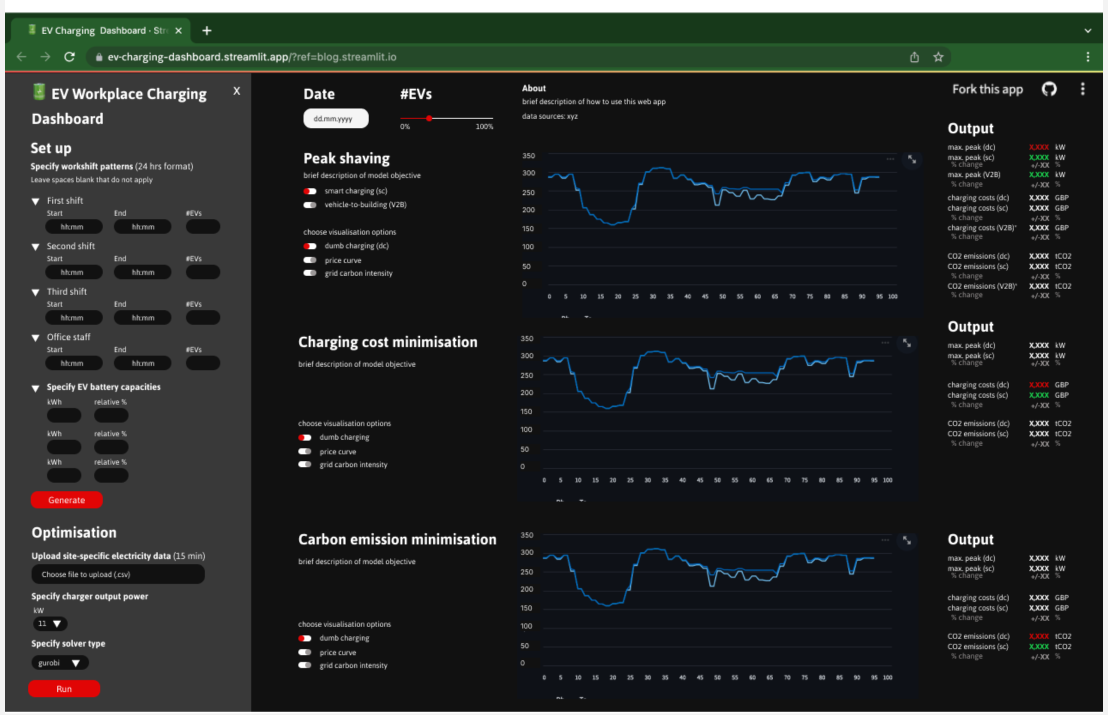


Fig. 6 | Figma design prototype

We used mixed-methods research with a total of eight case study partners

Sampling & data collection

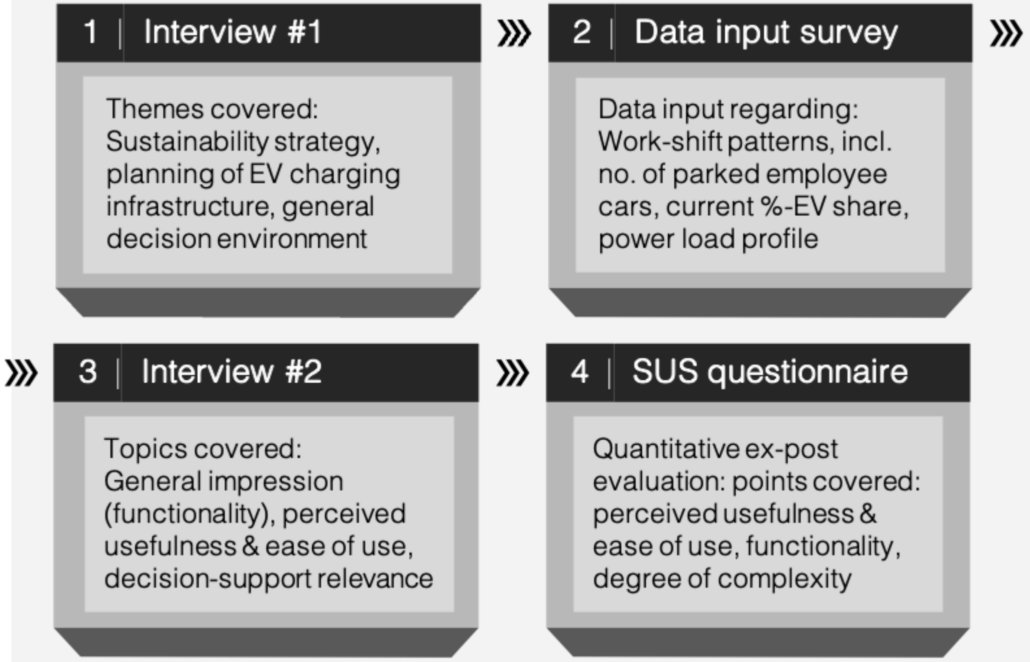


Fig. 7 | Four step data collection procedure for each case study partner

DC	ID	Sector	Electricity consumpt. (p.a.)	Main demand source
1	1	Media & publishing	20,000 MWh	Printing machinery
1	2	Office supplies	232 MWh	Office buildings
1	3	Healthcare	6,137 MWh	Hospital operations
1	4	Pharma	6,000 MWh	Drug manufacturing
2	5	Paper production	197,290 MWh	Production machinery
2	6	Manufacturing	4,000 MWh	Compressed air generation
2	7	Building materials	2,000 MWh	Office buildings, HVAC
2	8	Energy infrastructure	1,724 MWh	Production machinery

Tab.1 | Overview of multi case study sample spanning multiple industries

We conducted two semi-structured interviews with each case study partner

Sampling & data collection

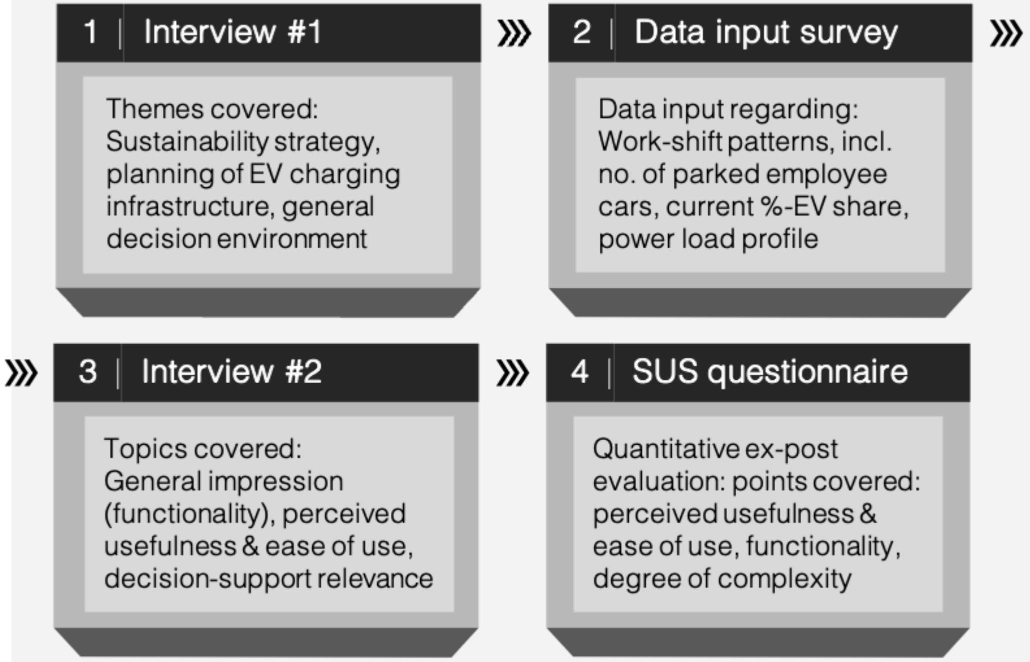


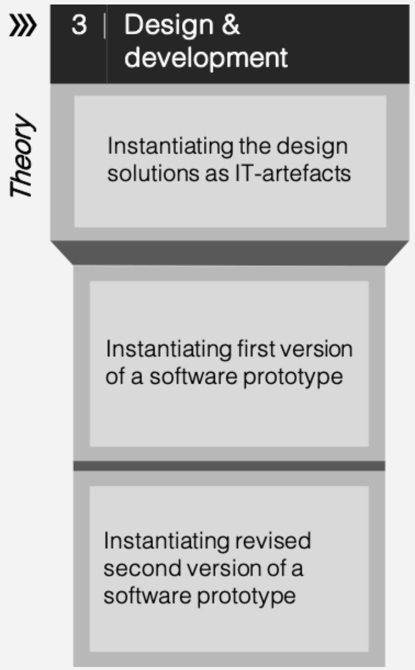
Fig. 7 | Four step data collection procedure for each case study partner

Design cycle (DC)	ID	Role of interview partner(s)	Date of interviews: Interview 1 Duration (mm:ss)	Date of interviews: Interview 2 Duration (mm:ss)
1	1	a: Corporate sustainability b: Finance/energy procurement	26.11.2024 (45:39)	04.12.2024 (49:54)
1	2	a: Head of facility management	10.12.2024 (28:29)	14.01.2025 (42:33)
1	3	a: Strategic purchasing b: Fleet management	28.11.2024 (31:01)	17.01.2025 (39:06)
1	4	a: Energy provisioning (engineering) b: Head of corporate responsibility	22.01.2025 (36:22)	21.02.2025 (46:39)
2	5	a: Executive assistant CEO b: Energy portfolio manager	05.03.2025 (36:41)	30.04.2025 (49:07)
2	6	a: Sustainability manager b: Project manager (engineering) c: Team lead maintenance	05.03.2025 (38:17)	06.05.2025 (40:39)
2	7	a: Sustainability manager	11.04.2025 (47:05)	28.04.2025 (29:11)
2	8	a: Engineer sustainability manager	30.04.2025 (18:55)	07.05.2025 (36:13)

Tab. 2 | Detailed overview of interviewees' roles within the company

The artefact is built in a modular manner using streamlit for visualisation

DSR step 3 (Design cycle 1)



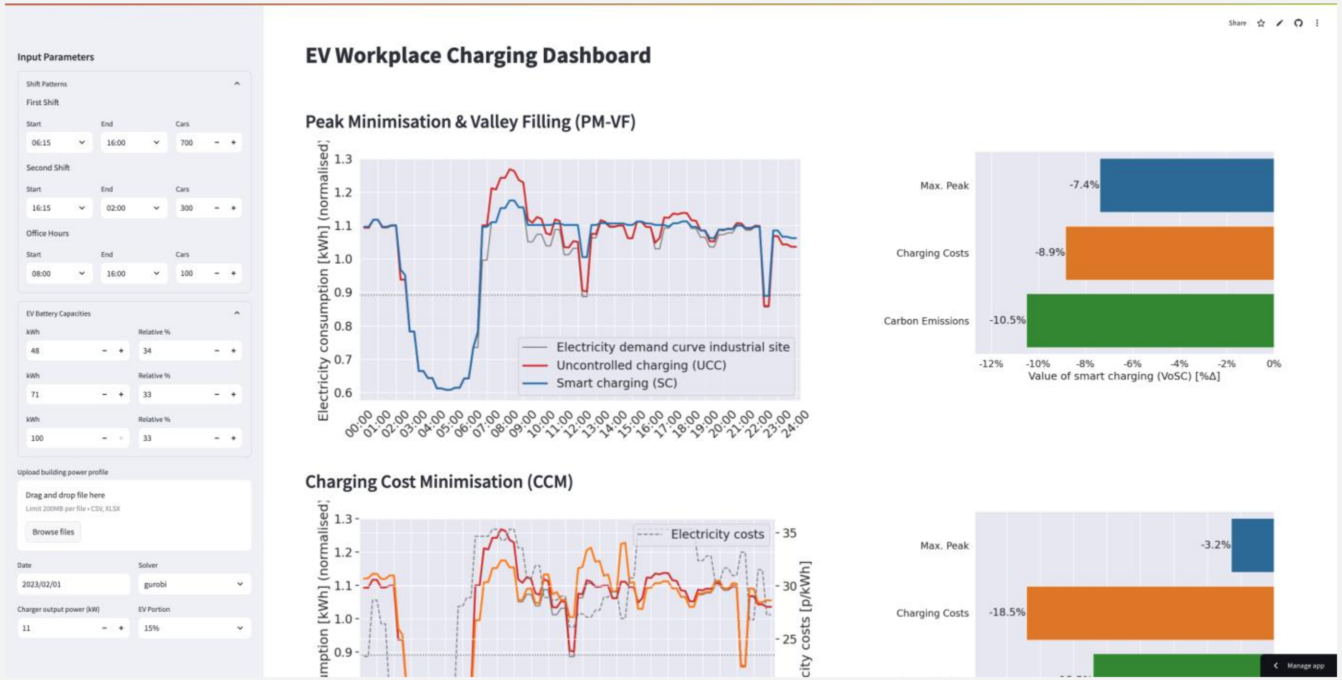


Fig. 8 | First functional prototype (**Design cycle 1**)

Coding languages & tools

python
Data pipeline

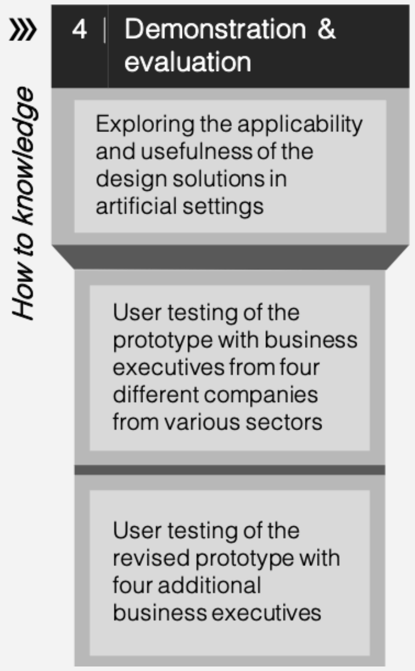
PYOMO
Model formulation

GUROBI OPTIMIZATION
Optimisation

Streamlit
Visualisation

We tested the artefact based on real-world firm-specific data

DSR step 4: Demonstration

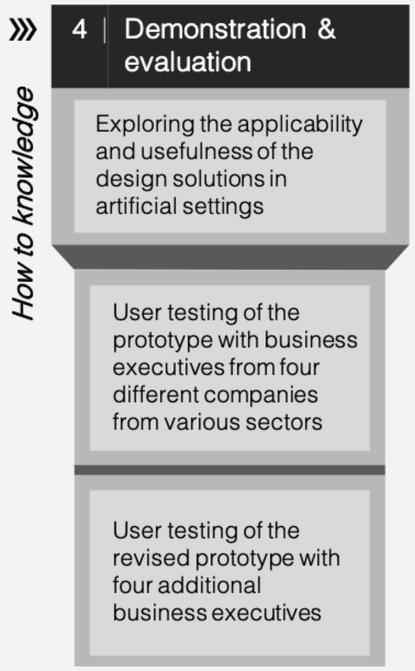


DC	ID	Sector	Electricity consumption (p.a.)	Main demand source	Work shifts	# Cars	EV rate (status quo)	Type of analysis
1	1	Media & publishing	20,000 MWh	Printing machinery	AM (06:00–14:00)	90	5%	Firm-specific data
					PM (14:00–22:00)	80		
					Night (22:00–06:00)	60		
1	2	Office supplies	232 MWh	Office buildings	Office staff (08:00–16:00)	50	25%	Firm-specific data
1	3	Healthcare	6,137 MWh	Hospital operations	Fleet (16:00–07:30)	50	10%	Firm-specific data
1	4	Pharma	6,000 MWh	Drug manufacturing	AM (06:00–14:00)	100	10%	Firm-specific data
					PM (14:00–22:00)	150		
					Night (22:00–06:00)	80		
					Office staff (08:00–16:00)	300		
2	5	Paper production	197,290 MWh	Production machinery	AM (06:00–14:00)	250	5%	Firm-specific data
					PM (14:00–22:00)	175		
					Night (22:00–06:00)	80		
					Office staff (08:00–16:00)	60		
2	6	Manufacturing	4,000 MWh	Compressed air generation	AM (06:00–14:00)	100	30%	Firm-specific data
					PM (14:00–22:00)	70		
					Office staff (08:00–16:00)	100		
2	7	Building materials	2,000 MWh	Office buildings, HVAC	Office staff (07:30–17:00)	500	12%	Default load profile
2	8	Energy infrastructure	1,724 MWh	Production machinery	AM (06:00–14:00)	170	3%	Firm-specific data
					PM (14:00–22:00)	30		
					Office staff (07:00–16:00)	140		

Tab. 3 | Firm-specific inputs from case study partners

We received eight highly relevant design & feature improvements

DSR step 4: Evaluation (Design cycle 1)

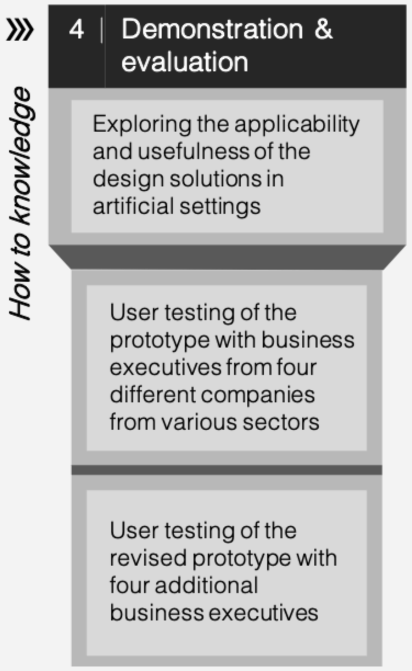


DC	ID	Quote from interviews (round 2)	Timing (mm:ss)	Qualitative code(s)	Prio.
1	1b	*"Something I might even wish for more is this: You've now (...) taken the load profile of a single day at our site and analysed it. As a complement or extension, one could perhaps create some kind of average."*	16:07	Aggregated analytics	High
1	1b	*"In Germany, we also have (...) a dynamic tariff. (...) You can basically take the numbers themselves and, in the end, go back to all time periods, even into the past. (...) [Then], of course, you can also retrieve the German prices from the website."*	18:10	Germany-specific market price data integration (entso-e)	High
1	1b	*"And regarding CO_2 – specifically grid carbon intensity – I'm not sure if there are actually data available for download to display them properly here. But there is something called the Electricity Map. Do you happen to know it? (...) And there, of course, you can also specifically check for Germany what the electricity mix is on a given day."*	21:01	Germany-specific grid carbon intensity data integration (electricity maps)	High
1	2a	*"And what I would actually find really interesting: is that also dependent on the seasons, depending on what kind of strategy I might want to pursue at the time? And to actually simulate something like that?"*	23:02	Seasonal effects / aggregated analytics	High

Tab. 4 | Qualitative codes from second round of interviews (excerpt)

We received eight highly relevant design & feature improvements

DSR step 4: Qualitative evaluation (Design cycle 1)

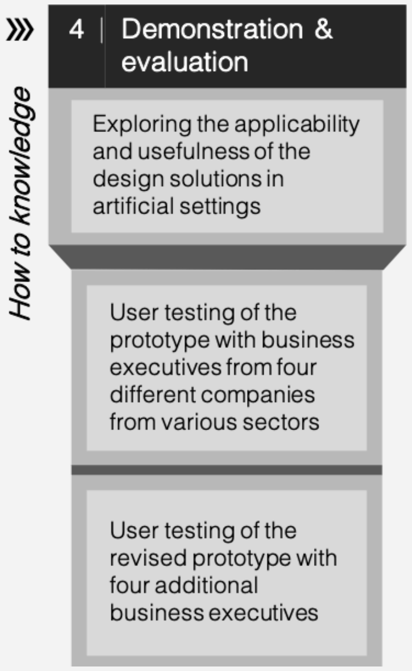


1	2a	*"What would actually be interesting for me personally as a user would be to have a document to understand what the system is doing with the value I'm changing—just to have a sense of security. I don't like blindly trusting technical systems 100%, and even if they've proven themselves many times, I just like to know: what exactly is changing here? Maybe also what assumptions are being made when I change something—and does that also affect the validity of my result?"*	26:43	User guide	High
1	2a	*"What I always find quite practical is having an export function for the respective charts. (...) Maybe a CSV file, and possibly also an export version in high resolution that I can use in presentations or similar [outputs]. I also always like to look at the numbers in a CSV—just to get a feel for it myself."*	34:11	Export function of data/graphs	High
1	3a/b	*"As a next step, it might have been interesting, for example with the costs or other metrics, if the unit were simultaneously scaled up—what does that mean? For instance, with CO_2 emissions, if you want to use that for sustainability reports. What also would have been interesting is the absolute amount and what the reduction actually is."* [3a] *"To say: this is a fact, this is what we actually achieved."* [3b]	24:54	Quantification of absolute savings	High

Tab. 5 | Qualitative codes from second round of interviews (excerpt)

SUS score of 87% after DC 1 indicates high acceptability

DSR step 4: Quantitative evaluation (Design cycle 1)



No.	System Usability Scale (SUS)	Response Distribution 'strongly disagree' (score: 1) to 'strongly agree' (score: 5)
1	I think that I would like to use this system frequently.	1 2 3 4 5
2	I found the system unnecessarily complex.	1 2 3 4 5
3	I thought the system was easy to use.	1 2 3 4 5
4	I think that I would need the support of a technical person to be able to use this system.	1 2 3 4 5
5	I found the various functions in this system were well integrated.	1 2 3 4 5
6	I thought there was too much inconsistency in this system.	1 2 3 4 5
7	I would imagine that most people would learn to use this system very quickly.	1 2 3 4 5
8	I found the system very cumbersome to use.	1 2 3 4 5
9	I felt very confident using the system.	1 2 3 4 5
10	I needed to learn a lot of things before I could get going with this system.	1 2 3 4 5

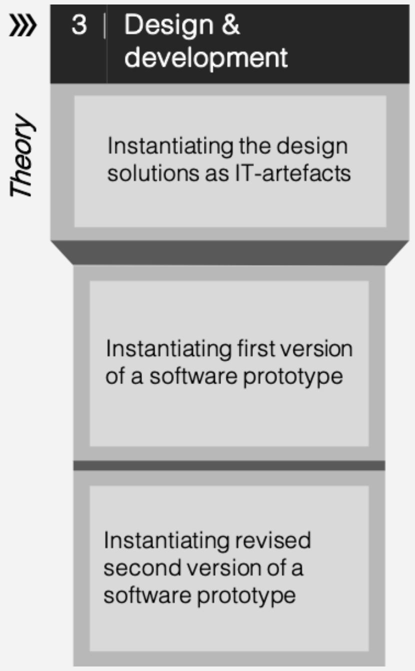
Tab. 6 | Quantitative evaluation using the System Usability Scale (n = 4) (DC 1)

Total Score
87%

'Excellent'
> acceptable

Enhanced artefact incorporating feedback from design cycle 1

DSR step 3 (Design cycle 2)



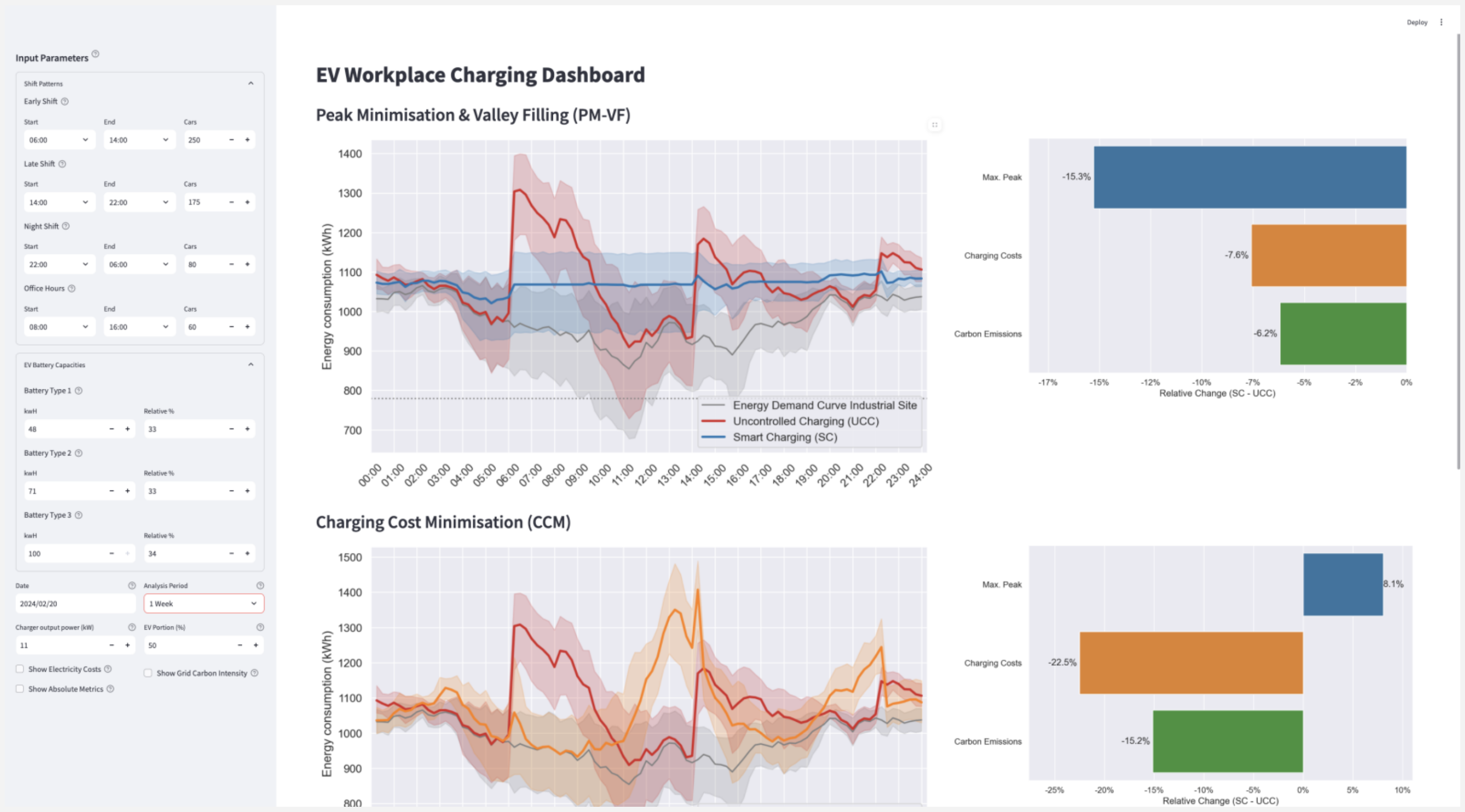


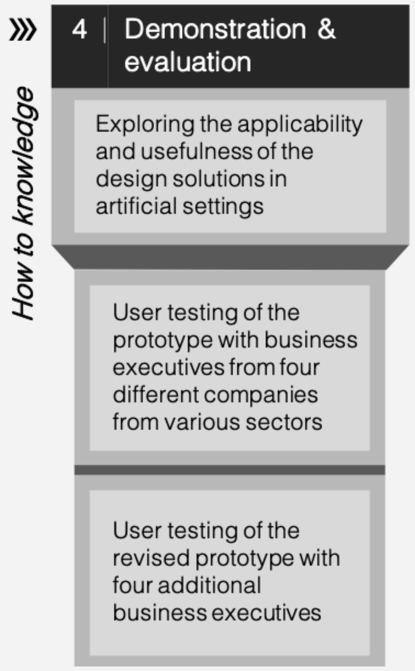
Fig. 8 | Improved prototype (**Design cycle 2**)

Live Demo

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

Final SUS score indicates high acceptability among prospective users

DSR step 4: Quantitative evaluation (Design cycle 2)



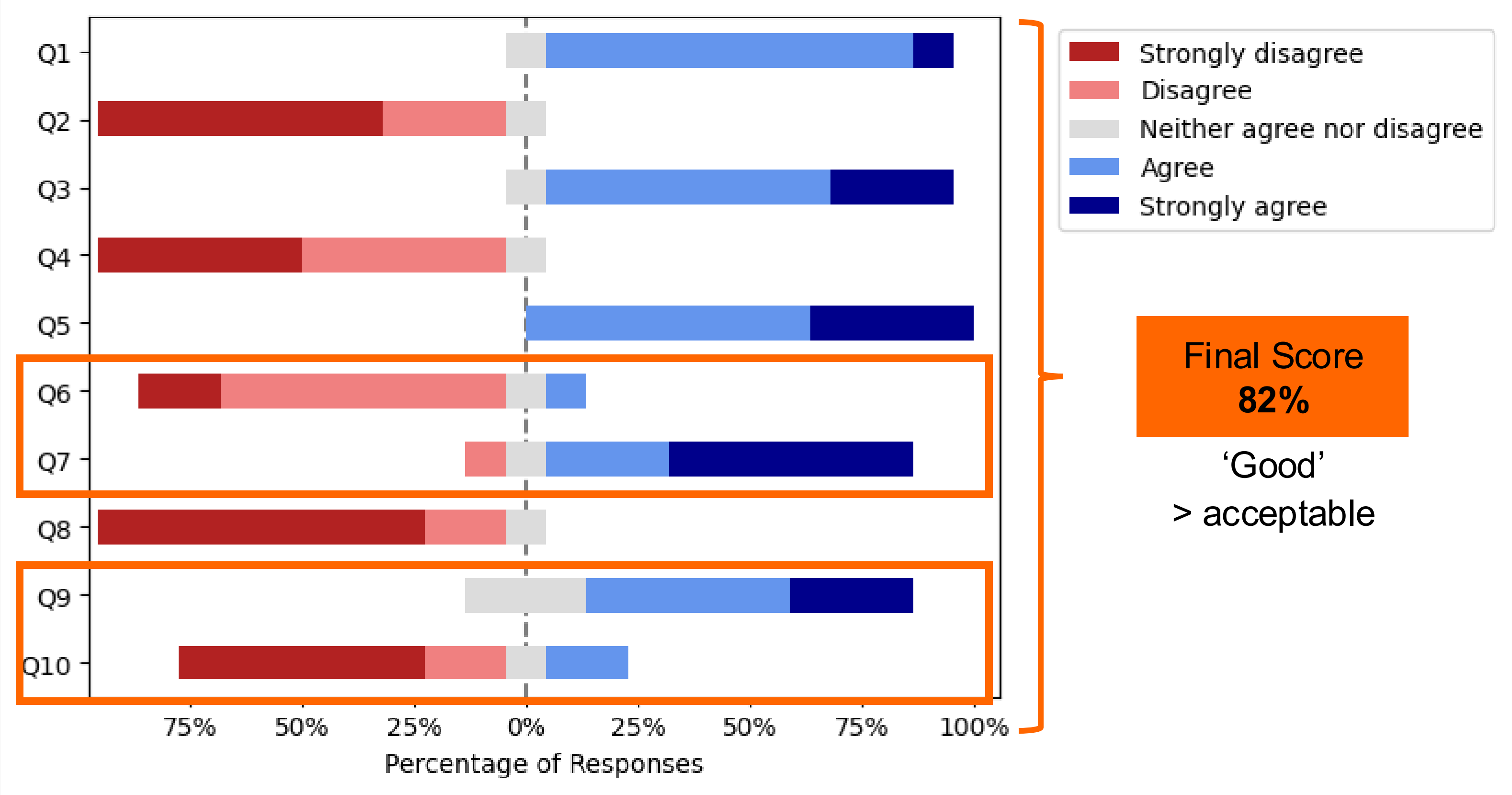


Fig. 9 | Quantitative evaluation using the System Usability Scale (n = 11) (DC 2)

Our research contributes to DSR through ‘exaptation’

Main take-aways

Summary

- We build a **digital artefact** using Streamlit to assists workplace decision makers to more accurately predict the impact of EV workplace charging
- We designed, built, and evaluated the prototype through **two rigour design & evaluation cycles**, collecting qual. + quant. data from eight case study partners (medium- to large-sized firms in Germany)
- With a total SUS score of 82%, we deemed the prototype as acceptable.
- Going forward, we will open-source the web application to the public.

Contribution to theory

- Decision type: ‘**Decision support system**’
  - Guiding workplace decision makers with building and operating EV workplace charging infrastructure
- Core contribution through ‘**exaptation**’, i.e. repurposing existing optimisation algorithms for dedicated applications in workplace charging decision contexts

Selected quotes: perceived usefulness

*"I actually find this **really useful**. Because I think a lot of companies still have no real idea of the challenges that come with electrification in general, and with reducing CO_2 emissions. And just getting an overview of what’s basically out there and how things can be optimised is, I think, a huge help for any company.”*

Case study ID: **4a** [Pharma]

*"But it’s just nice to be able to argue using valid data, and **I think data will become increasingly relevant** in the future anyway. And of course, all this information is something I’d otherwise have to gather myself with a lot of effort. Having it all from a single source—just entering my own values, which I already have—**that’s a great solution**.”*

Case study ID: **2a** [Office supply manufacturer]

Q&A

*…and a special ‘**thank you**’ to*
*my collaborators **Christoph** and **Marc-Fabian***
*and my supervisors **Charlie** and **Christian***

Thank you for your attention!

Any Questions?

Marcel Seger
DPhil in Geography and the Environment
marcel.seger@eci.ox.ac.uk

Please **reach out** to discuss
potential further collaboration

Environmental Change Institute

University of Oxford
3 S Parks Rd
Oxford, OX1 3QY, UK

Semi-structured interview guide

Overview

Interview 1 (excerpt)

Introduction

- Decision Context and Scope
- Criteria Identification
- Stakeholder Involvement
- Information Gathering and Evaluation
- Decision-Making Challenges

Closing Questions

Interview 2 (excerpt)

Introduction

- First impressions of web application
- Ease of use
- Information visualisation
- Real-world applicability
- Decision support
- Improvement and feedback

Closing Questions

We benchmark each model type against uncontrolled charging (UCC) [%Δ]

Approach: Outlining four-step structure

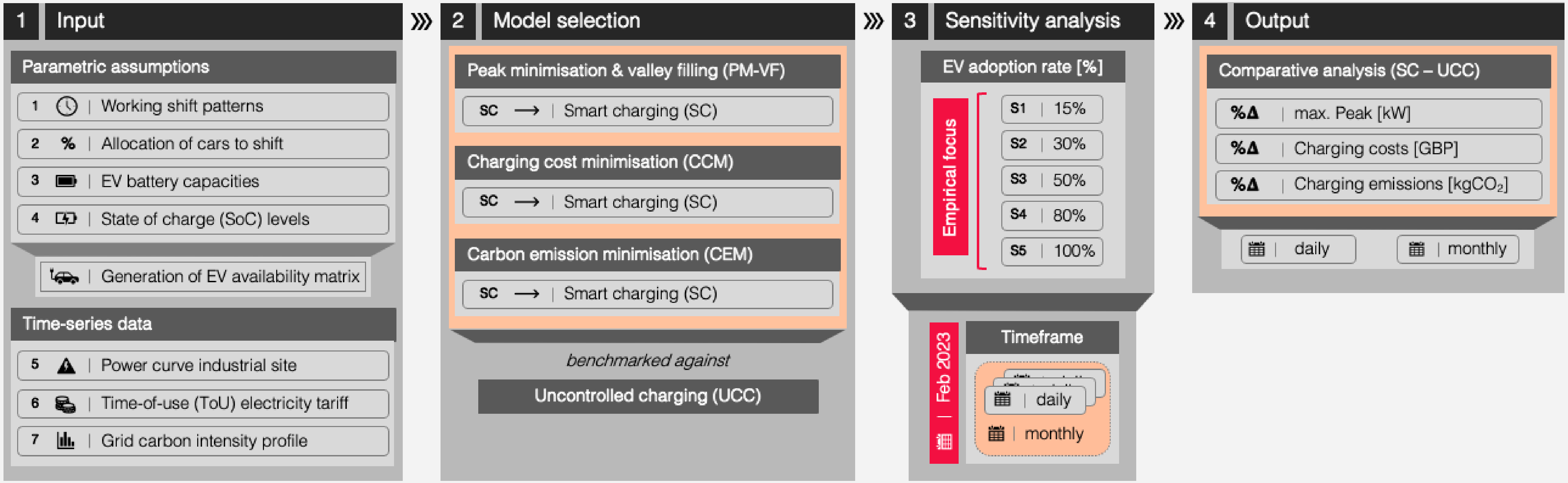


Fig. A1 | Schematic overview of our modelling framework. Step 1: Specification of input parameters. **Step 2:** Selection of model, assessing (i) peak minimisation & valley filling (PM-VF), (ii) charging cost minimisation (CCM), or carbon emission minimisation (CEM). **Step 3:** Sensitivity analysis with varying EV adoption rates [%] and temporal scale. **Step 4:** Computation of model results for each objective function in relative terms (%Δ).

Each model pursues a different optimisation goal, yet w/ identical constraints

Methods: Drawing from operations research (OR)

Peak min. & valley filling (PM-VF):

$$min \;\; z_{PM-VF} = \sum_{t \in T} (P_t + y_t - C)^2$$

Charging cost min. (CCM):

$$min \;\; z_{CCM} = \sum_{t \in T} y_t * \lambda_t$$

Carbon emission min. (CEM):

$$min \;\; z_{CEM} = \sum_{t \in T} y_t * \gamma_t$$

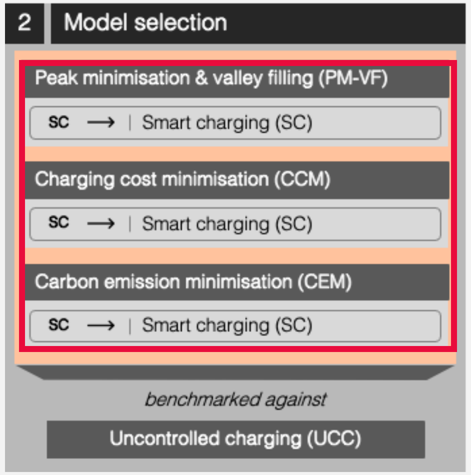
[1]	$s.t. \;\; y_t = \sum_{m \in M} x_{mt} f_{mt}$	$\forall\, t \in T$	Total charging load
[2]	$-p_{max} \leq x_{mt} \leq p_{max}$	$\forall\, t \in T;\; m \in M$	Charging power restrictions
[3]	$0 \leq E_m^{ini} + \sum_{k \in T \mid k \leq t} x_{mt} f_{mt} \leq E_m^{cap}$	$\forall\, t \in T;\; m \in M$	Battery capacity restrictions
[4]	$E_m^{fin} = E_m^{ini} + \sum_{k \in T \mid k \leq t} x_{mt} f_{mt} \geq E_{T+1}$	$\forall\, t \in T;\; m \in M$	Minimum state-of-charge (SoC) requirement
[5]	$0 = x_{mt}(1 - f_{mt})$	$\forall\, t \in T;\; m \in M$	Logical operator ensuring car availability

$$C = \frac{max(P_t) + min(P_t)}{2}$$

Constant C

$$f_{mt} = \begin{cases} \mathbf{1}, if \;\; EV \; m \in M \; is \; parked \; at \; workplace \; at \; time \; t \in T, \\ \mathbf{0}, \quad otherwise \end{cases}$$

Definition of car availability matrix



C	Average of peak and minimum power consumption of building
E_{T+1}	Energy needed for next trip
E_m^{cap}	Battery capacity of EV m
E_m^{fin}	Final battery energy of EV m
E_m^{ini}	Initial battery energy of EV m
F	EV presence matrix
M	Set of EVs
N	Set of time intervals
P_{ui}	Power consumption of building in interval i
$Q^{(i)}$	Set of intervals prior to interval i
T_m	Charging/discharging period of EV m
m	Electric vehicle (EV)
p_{max}	Maximum charging or discharging power
t_m^{arr}	Arrival time of EV m
t_m^{dep}	Departure time of EV m
x_{mi}	Charging/discharging power of EV m in interval i
y_i	Total load for charging/discharging the available EVs in interval i
i	Time interval

For further references, see [**19, 30**].

Each model pursues a different optimisation goal, yet w/ identical constraints

Methods: Drawing from operations research (OR)

Peak min. & valley filling (PM-VF):

$$\min \ z_{PM-VF} = \sum_{t \in T} (P_t + y_t - C)^2$$

Charging cost min. (CCM):

$$\min \ z_{CCM} = \sum_{t \in T} y_t * \lambda_t$$

Carbon emission min. (CEM):

$$\min \ z_{CEM} = \sum_{t \in T} y_t * \gamma_t$$

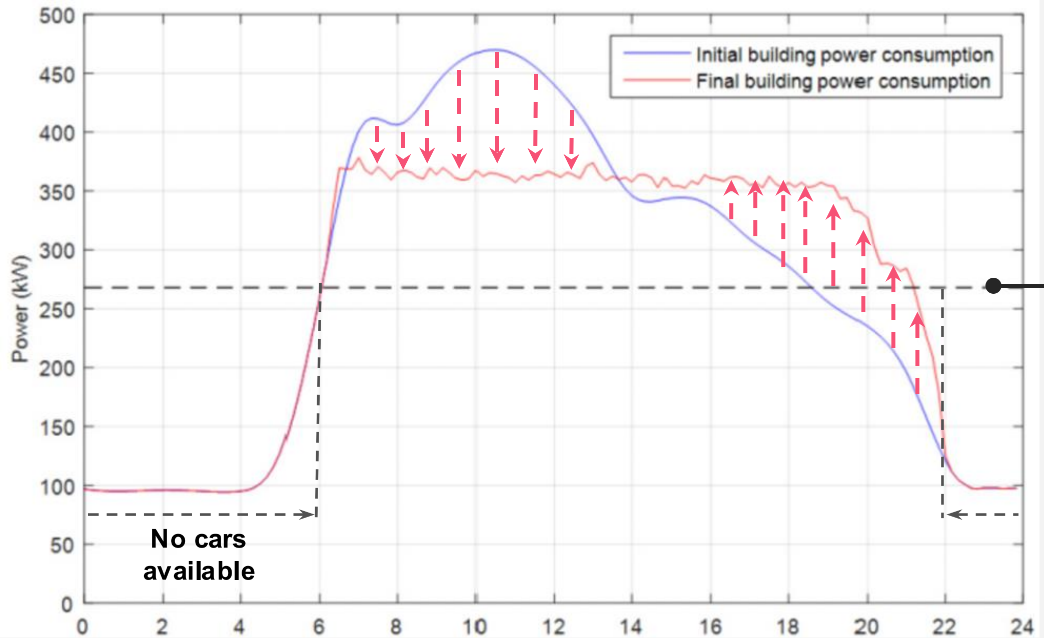


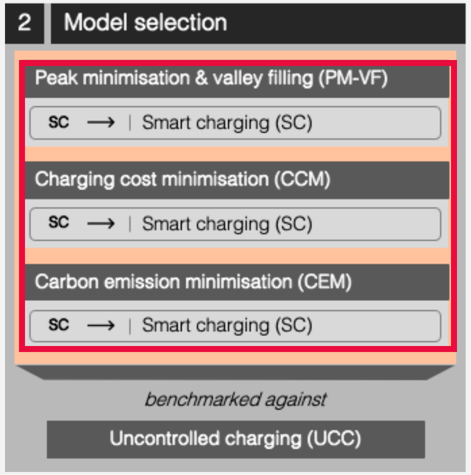
Fig. A2 | Schematic power curve. Figure taken from [5].

$$C = \frac{max(P_t) + min(P_t)}{2}$$

Mathematical Objective Function

Minimising the least square difference:

$$\min \ z_{PM-VF} = \sum_{t \in T} (P_t + y_t - C)^2$$



References

Overview

[1] Seger, M., Brand, C., Clement, C. et al. Firm level optimisation strategies for sustainable and cost effective electric vehicle workplace charging. npj. Sustain. Mobil. Transp. 2, 11 (2025). https://doi.org/10.1038/s44333-025-00032-w

[2] J. vom Brocke, R. T. Watson, C. Dwyer, S. Elliot, N. Melville, Green Information Systems: Directives for the IS Discipline, Communications of the Association for Information Systems 33 (2013).

[3] W. Ketter, K. Schroer, K. Valogianni, Information Systems Research for Smart Sustainable Mobility: A Framework and Call for Action, Information Systems Research 34 (3) (2022) 1045–1065.

[4] P. Heeß, J. Rockstuhl, M.-F. K¨orner, J. Str¨uker, Enhancing trust in global supply chains: Conceptualizing Digital Product Passports for a low-carbon hydrogen market, Electronic Markets 34 (10) (2024).

[5] D. E. Rush, N. P. Melville, C. M. Fuller, Market value and environmental performance of carbon management systems: An international investigation, Information & Management 61 (6) (2024) 103997.

[6] S. Seidel, J. Recker, J. vom Brocke, Green Business Process Management, Springer, Berlin, Heidelberg, 2012, pp. 3–13.

[7] F. Muller, P. Hofmann, J. Struker, C. Leinauer, M.-F. Korner, Digital Decarbonization: Design Principles for an Enterprise-wide Emissions Data Architecture, Proceedings of the 56th Hawaii International Conference on System Sciences (2023).

[8] W. Ketter, J. Collins, M. Saar-Tsechansky, O. Marom, Information Systems for a Smart Electricity Grid: Emerging Challenges and Opportunities, ACM Transactions on Management Information Systems 9 (3) (2018) 1–22.

[9] B. Richter, P. Staudt, C. Weinhardt, Designing Local Energy Market Applications, Scandinavian Journal of Information Systems 34 (2) (2022).

References

Overview

[10] G. Fridgen, L. H¨afner, C. K¨onig, T. Sachs, Providing Utility to Utilities: The Value of Information Systems Enabled Flexibility in Electricity Consumption, Journal of the Association for Information Systems 17 (8) (2016) 537–563.

[11] F. Baumgarte, L. Dombetzki, C. Kecht, L. Wolf, R. Keller, AI-based Decision Support for Sustainable Operation of Electric Vehicle Charging Parks, Proceedings of the 54th Hawaii International Conference on System Sciences (2021).

[12] R. Ahadi, K. Schroer, W. Ketter, Managing Electric Vehicle Charging Hubs Through Dynamic Capacity-Based Pricing, ECIS Proceedings (2024).

[13] H. T. Nguyen, D.-H. Choi, Distributionally Robust Model Predictive Control for Smart Electric Vehicle Charging Station With V2G/V2V Capability, IEEE Transactions on Smart Grid 14 (6) (2023) 4621–4633.

[14] M. Bilousova, M. Frank, Understanding Vehicle-to-Grid User Engagement Using Self-Determination Theory, ECIS Proceedings (2024).

[15] J. Priefer, L. Steiger, Designing a GIS-AHP-Based Spatial Decision Support System for Discovering and Visualizing Suitable Locations for Electric Vehicle Charging Stations, Wirtschaftsinformatik Proceedings (2022).

[16] K. Schroer, R. Ahadi, T. Y. Lee, W. Ketter, Preference-aware Planning and Operations of Electric Vehicle Charging Clusters: A Data-Driven Prescriptive Framework, Pre-ICIS Workshop Proceedings (2021).

[17] C. Crozier, T. Morstyn, M. McCulloch, Capturing diversity in electric vehicle charging behaviour for network capacity estimation, Transportation Research Part D: Transport and Environment 93 (2021) 102762.

[18] J. Huber, E. Schaule, D. Jung, C. Weinhardt, Quo Vadis Smart Charging? A Literature Review and Expert Survey on Technical Potentials and User Acceptance of Smart Charging Systems, World Electric Vehicle Journal 10 (4) (2019) 85.

[19] Y. Zheng, S. Niu, Y. Shang, Z. Shao, L. Jian, Integrating plug-in electric vehicles into power grids: A comprehensive review on power interaction mode, scheduling methodology and mathematical foundation, Renewable and Sustainable Energy Reviews 112 (2019) 424–439.

References

Overview

[20] S. Li, F. Xie, Y. Huang, Z. Lin, C. Liu, Optimizing workplace charging facility deployment and smart charging strategies, Transportation Research Part D: Transport and Environment 87 (2020) 102481.

[21] B. Ferguson, V. Nagaraj, E. C. Kara, M. Alizadeh, Optimal Planning of Workplace Electric Vehicle Charging Infrastructure with Smart Charging Opportunities, in: 21st International Conference on Intelligent Transportation Systems (ITSC), IEEE, Maui, HI, 2018, pp. 1149–1154.

[22] G. Chandra Mouli, P. Bauer, M. Zeman, System design for a solar powered electric vehicle charging station for workplaces, Applied Energy 168 (2016) 434–443.

[23] M. Noori, Y. Zhao, N. C. Onat, S. Gardner, O. Tatari, Light-duty electric vehicles to improve the integrity of the electricity grid through vehicle-to-grid technology: Analysis of regional net revenue and emissions savings, Applied Energy 168 (2016) 146–158.

[24] S.-A. Amamra, J. Marco, Vehicle-to-grid aggregator to support power grid and reduce electric vehicle charging cost, IEEE Access 7 (2019) 178 528–178538.

[25] X. Lei, Y. Shang, Z. Shao, Y. Jia, L. Jian, Grid integration of electric vehicles for optimal marginal revenue of distribution system operator in spot market, Energy Reports 8 (2022) 1061–1068.

[26] L. Calearo, M. Marinelli, Profitability of frequency regulation by electric vehicles in denmark and japan considering battery degradation costs, World Electric Vehicle Journal 11 (3) (2020) 48.

[27] J. D. Bishop, C. J. Axon, D. Bonilla, D. Banister, Estimating the grid payments necessary to compensate additional costs to prospective electric vehicle owners who provide vehicle-to-grid ancillary services, Energy 94 (2016) 715–727.

[28] S. S. Ravi, M. Aziz, Utilization of electric vehicles for vehicle-to-grid services: Progress and perspectives, Energies 15 (2) (2022) 589.

References

Overview

[29] D. Huber, Q. De Clerck, C. De Cauwer, N. Sapountzoglou, T. Coosemans, M. Messagie, Vehicle to grid impacts on the total cost of ownership for electric vehicle drivers, World Electric Vehicle Journal 12 (4) (2021) 236.

[30] K. Peffers, T. Tuunanen, M. A. Rothenberger, S. Chatterjee, A Design Science Research Methodology for Information Systems Research, Journal of Management Information Systems 24 (3) (2007) 45–77.

[31] T. Schoormann, M. Stadtländer, R. Knackstedt, Designing business model development tools for sustainability—a design science study, Electronic Markets 32 (2) (2022) 645–667.

[32] C. S. Ioakimidis, D. Thomas, P. Rycerski, K. N. Genikomsakis, Peak shaving and valley filling of power consumption profile in non-residential buildings using an electric vehicle parking lot, Energy 148 (2018) 148–158.