HSLU Lucerne University of Applied Sciences and Arts

Technik & Architektur
BSc. Business Engineering | Innovation
Bachelor-Thesis

Leverage electric vehicle batteries for the energy transition, a customer centric approach

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1. Background, Challenge & Objectives

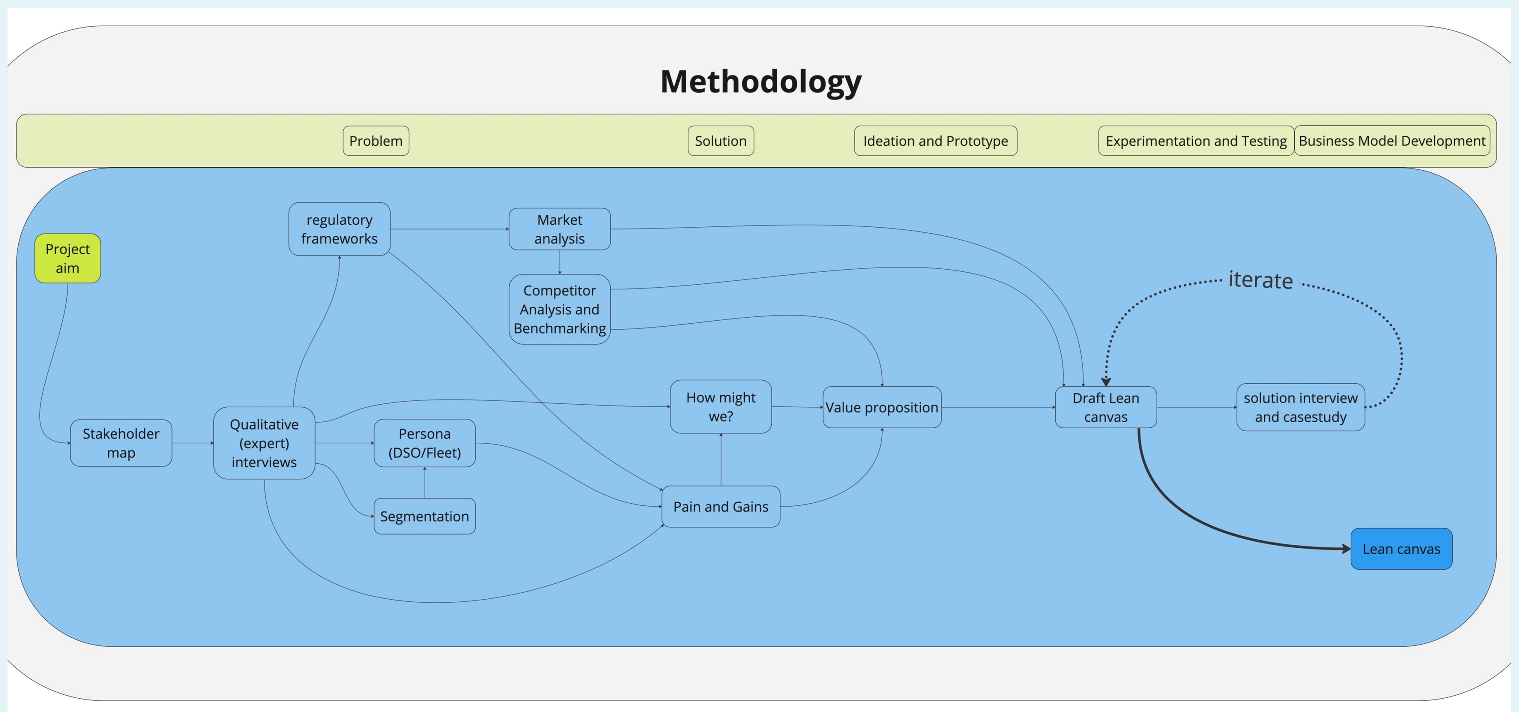
Background / Context
In a world more aware than ever of environmental impacts, integrating EVs and renewable energy into our future energy ecosystem is not just innovative but essential. As companies replace traditional fleets with EVs, integrating these large controllable battery presents challenges and opportunities for infrastructure and management. The Author's passion for this critical integration is fueled by a desire to develop sustainable solutions that propel us towards energy transition while addressing customer needs.

Challenge / Research Questions
Identify customer needs through need finding and later iterative testing to develop a smart EV charging solution that optimises power flows, enhances renewable energy consumption, and maximises financial benefits for EV fleet owners and DSOs

Objectives / Hypotheses
Understanding the Ecosystem and Market Dynamics
Customer Needs and Segmentation
Competitive Landscape Analysis
Ideation and Concept Development
Prototype Development and Testing
Business Model

2. Methodology / Materials

Methodology
The research methodology includes expert interviews, stakeholder analysis and personas, shedding light on the diverse perspectives, objectives, challenges, and benefits perceived by various-sized DSOs and EV fleets at different stages of their EV transition. An in-depth regulatory analysis, market research and competitor analysis explores future opportunities, and a detailed value proposition is translated into a lean canvas which was refined through testing and a solution interview.

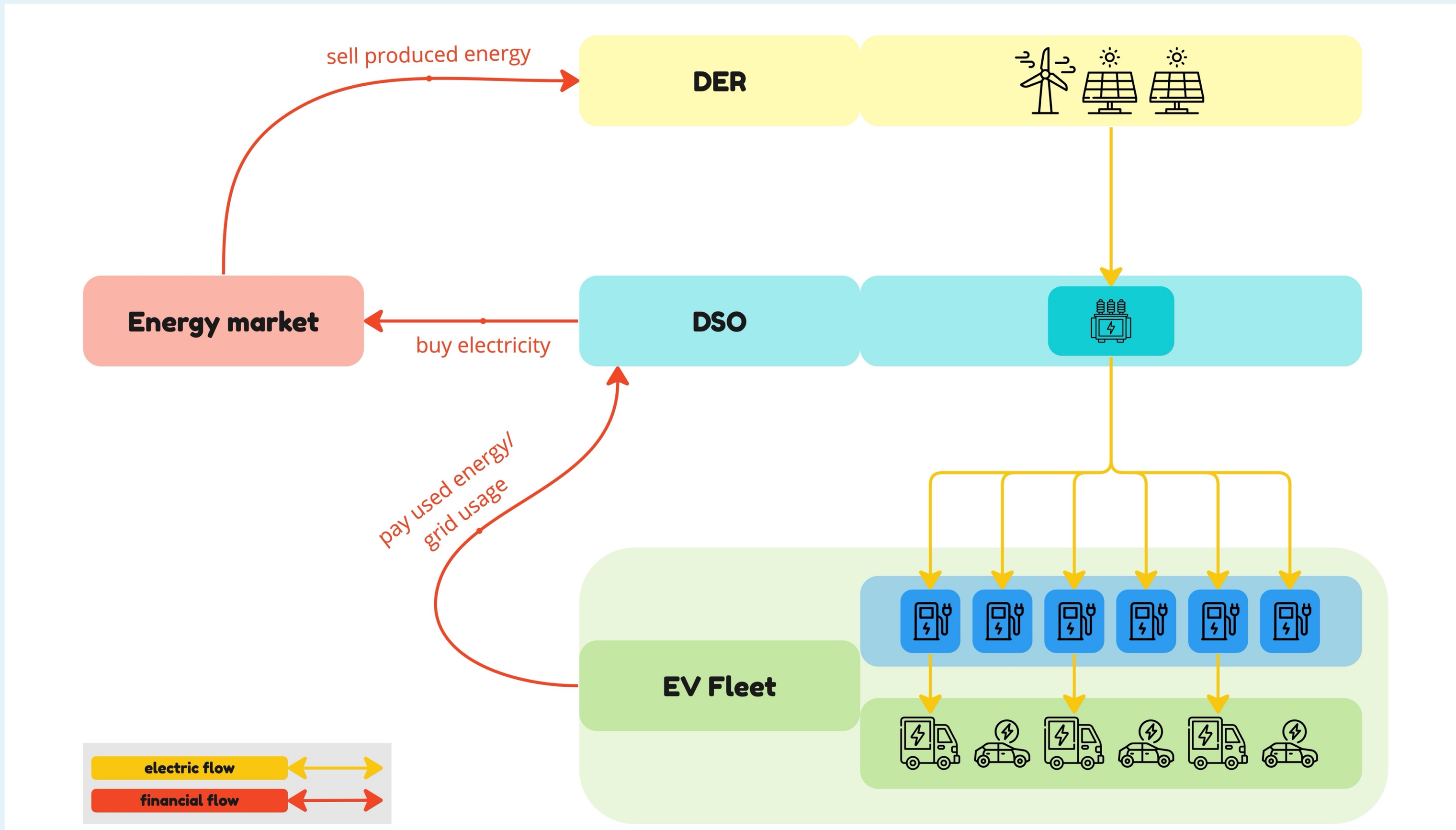


Materials / Data / Tools

- Stakeholder map (Miro board)
- How might we? Questions (design thinking toolbook)
- Value proposition, Lean Canvas (design thinking toolbook, strategyzer)
- Load Curve from charging EVs (interview partner)
- Plot of dynamic price signals from DSO (API and python code)

3. Results / Solution / Recommendations

Overview
An overview over the simplified interactions between renewable energy production, the DSO and the EV fleet is presented. This example shows the normal charging process with no optimisation in place. The results show the potential in alignment of the charging speed either according to the current grid usage, available renewable energy or the market price.



Findings
Companies want to focus on their core business and see e-mobility as a tool for their current business. Changing to EVs creates new hurdles and many different factors to consider, such as route planning, connection capacity of buildings, administrative billing process, backends etc. Taking into account these factors is viable for a seamless transition

Case study and variable tariffs
With the help of data from the interviews, a basic optimisation calculation was possible. The daily operation stays the same for the fleet and charging peaks are reduced with the help of an optimised charging pattern, resulting in possible savings from several thousand CHF a year for at a single location. Optimising along market prices would have reduced costs even further.

4. Discussion, Conclusions & Outlook

Discussion
The solution in the thesis cannot prevent the expansion of the grid, but it can optimise and reduce the impact of electric vehicles. However, the widespread adoption of dynamic pricing by more DSOs in Switzerland is necessary. The motivation of DSOs to reward EV fleets is critical. If they do, it creates a win-win situation for both sides.

Conclusions
The thesis concludes that this solution, which facilitates the integration of EVs and DERs into the grid, optimises power flows and yields financial benefits. This framework can be a foundation for further case studies and developing a minimal viable product (MVP) to validate these findings.

Outlook
Developing algorithms best suited for optimising charging patterns

Literature

- Gschwendtner, C., Knoeri, C., & Stephan, A. (2023). The impact of plug-in behavior on the spatial–temporal flexibility of electric vehicle charging load. Sustainable Cities and Society, 88, 104263. https://doi.org/10.1016/j.scs.2022.104263
- Kapustin, N. O., & Grushevenko, D. A. (2020). Long-term electric vehicles outlook and their potential impact on electric grid. Energy Policy, 137, 111103. https://doi.org/10.1016/j.enpol.2019.111103

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