

# Solar Commander

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## 1. Background, Challenge & Objectives

### Background / Context

In response to rising energy demand, the usability optimization and maximization of the harvested solar energy has been a crucial matter to increase the efficiency and benefit of solar systems especially in OFF-Grid applications.

### Challenge / Research Questions

The project aims to provide a simplified study about how the use of solar management and control devices can increase the usability of solar systems, and to design a concept of the Solar Commander device through performing exploratory research and prototyping. That challenge can be made possible by answering the research question "how to design a solar management and usability control device that excels at the following five attributes: 90% connectivity ability, less complexity, good price, upgrade of old devices, and island focused. Furthermore, proves the feasibility of the attributes with basic experimental setups".

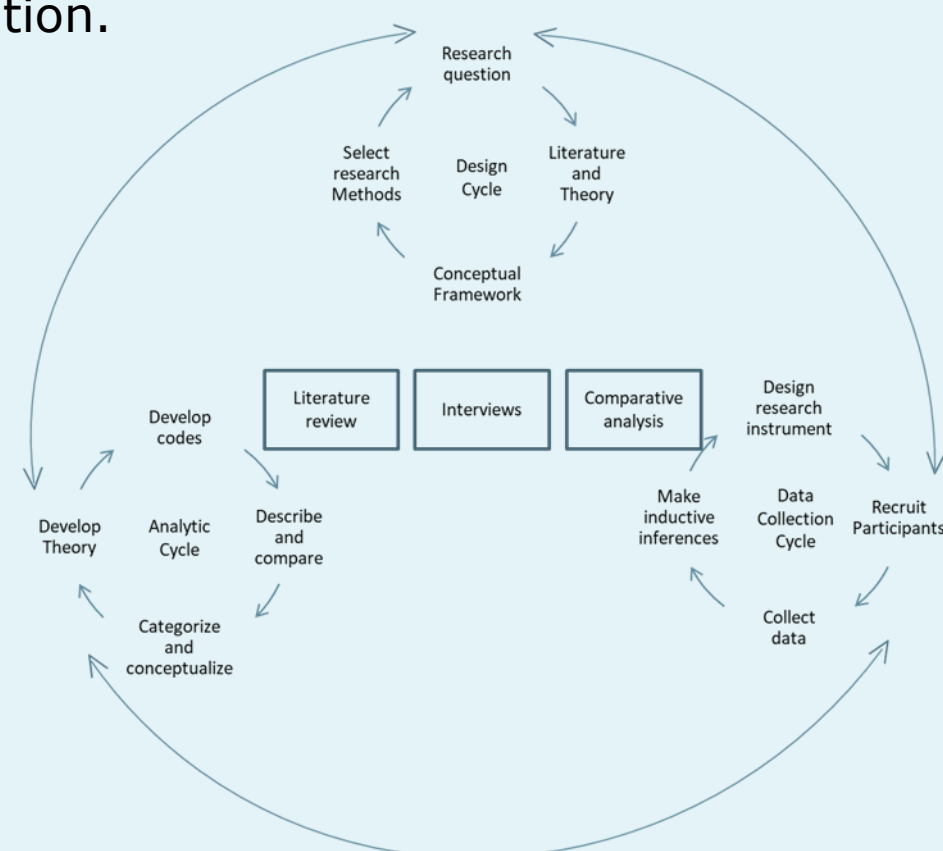
### Objectives / Hypotheses

1. Conducting systematic literature review on the usability effect of solar management and control devices and the conceptualization of such devices based on academia.
2. Providing a framework that helps in understanding the effect of solar management control devices on the usability and efficiency of the PV systems.
3. Provide a concept Idea and initial prototype of the Solar Commander

## 2. Methodology / Materials

### Methodology

The methodology used to conduct this project is qualitative and it consists of five parts, for the theory : integrative literature review, semi-structured interviews, and analysis. For the practical part: design of concept in the form of systematic method, and qualitative experimental testing for validation.



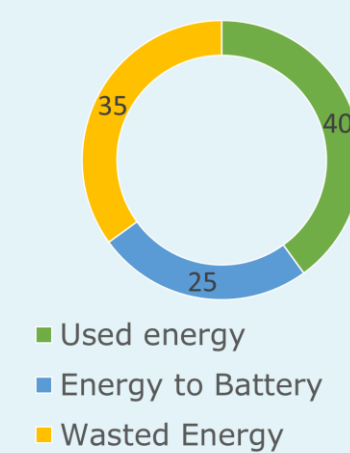
The figure above shows different sub cycles included in the main cycle of qualitative literature review (Monique Hennink 2020)

### Materials / Data / Tools

- Theoretical data from integrative literature reviews and interviews.
- Materials available in the market and relevant to the project.
- Prototype testing for data collection and validation.
- For prototyping tools from the HSLU work shops were used.

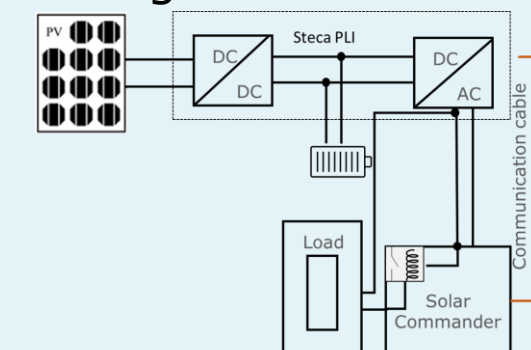
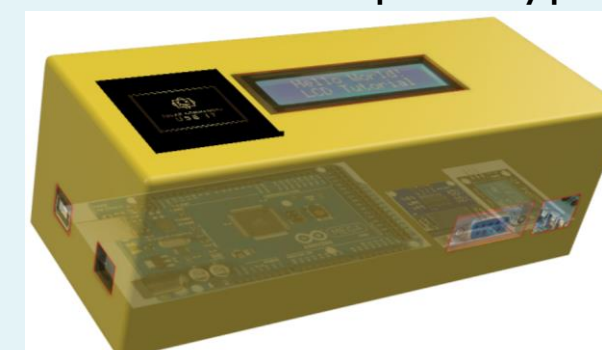
## 3. Results / Solution / Recommendations

Valuable data were discovered after the analysis of the literature that allowed in the estimate positioning of the Solar Commander in the market.



The figures above shows the Usability of Solar energy in Solar systems without the use of Usability optimization device and the predicted positioning of the Solar Commander in the market with respect to other similar devices. (Solar EMpower 2022)

Technological considerations helped supporting the decision about why/which specific parts suits best to implement in the solar commander. Design and implementation assisted in the development of the Solar commander's first prototype and in creating an idea about the costs.



The figures above illustrates the initial prototype of the Solar Commander. Finally testing for validation have shown how to benefit from the Solar commander and how far did the development reached in addition to creating the future recommendations.



The figures above show the Solar Commander's application and the fully functional prototype for validation

## 4. Discussion, Conclusions & Outlook

### Discussion

Discussion is interpreted through the experimental testings. It revealed that the Solar Commander reached the ability to communicate with 74% of the inverter found in the global market as a first step, yet more research should be done to reach the goal of at least 90%.

### Conclusions

It could be concluded that the Solar Commander's project is useful and have proven to excel on the 5 target features : Cost effectiveness, Simplicity, Off-grid focused, upgrading of old consumer devices, and wide range of connectivity.

### Outlook

1. the Solar Commander is new in concept and have the possibility to affect in apparent ways. If the mentioned aspects are researched further, they have the potential to contribute more to a focused and practical oriented research.

## Literature

- Monique Hennink (2020): Qualitative research methods. SAGE publications Ltd.
- 10 Solar PV System Losses – How To Calculate Solar Panel Efficiency (2023). Available online at <https://www.solarempower.com/blog/10-solar-pv-system-losses-their-impact-on-solar-panel-output/>, updated on 5/23/2023, checked on 5/23/2023.