

Modeling Household Energy Behavior in Rural Communities from Developing Countries: A Case Study in Raqaypampa, Bolivia

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Introduction

Efforts to achieve universal access to clean and affordable energy face challenges despite progress, with intensified efforts needed by 2030 due to regional complexities and systemic issues. Scientific focus on energy planning highlights challenges such as spatiotemporal variability and **demand-side considerations**, particularly in rural areas. Given the complexity of **energy consumption, particularly influenced by personal, contextual, sociocultural, and economic factors**, addressing these intricacies is pivotal for effective energy planning. Frameworks like the **Energy Cultures** model provide valuable insights into behavior dynamics, highlighting the necessity of interdisciplinary approaches.

This study aims to devise a modelling approach to investigate the interconnections among self-declared energy practices, actual electricity consumption and external factors that influence residents' lifestyle and energy behaviour in remote communities from developing countries.



Fig. 1: Fieldwork for data collection carried out in Raqaypampa.

Methodological approach

- Monitoring campaign of a rural electrification initiative in Raqaypampa, Bolivia (100 Solar Home Systems)
- Dataloggers and questionnaires used to collect **electricity consumption, demographic, and energy practices data** over a six months period (As this work is still ongoing, emphasis has been placed on a single household within the study area.)
- Analysis included generating **daily load profiles** and comparing **self-reported behaviors** with actual equipment usage.
- Stakeholder interviews provided insights into relevant standards and perceptions.

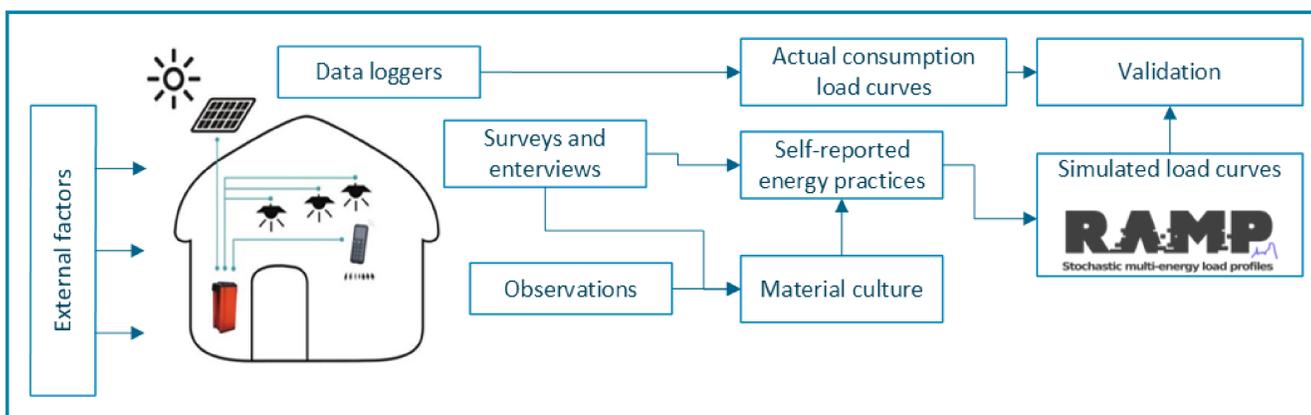


Fig. 2: Flowchart of the proposed methodological approach

Case Study



Fig. 3: Typical household in Raqaypampa

Preliminary results and conclusions

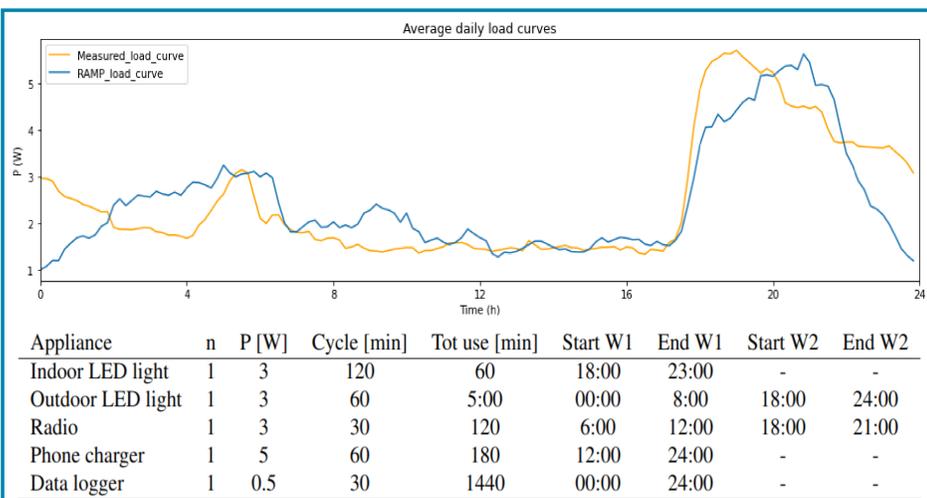


Fig. 4: Comparison of the average measured load curve and the RAMP generated load curve

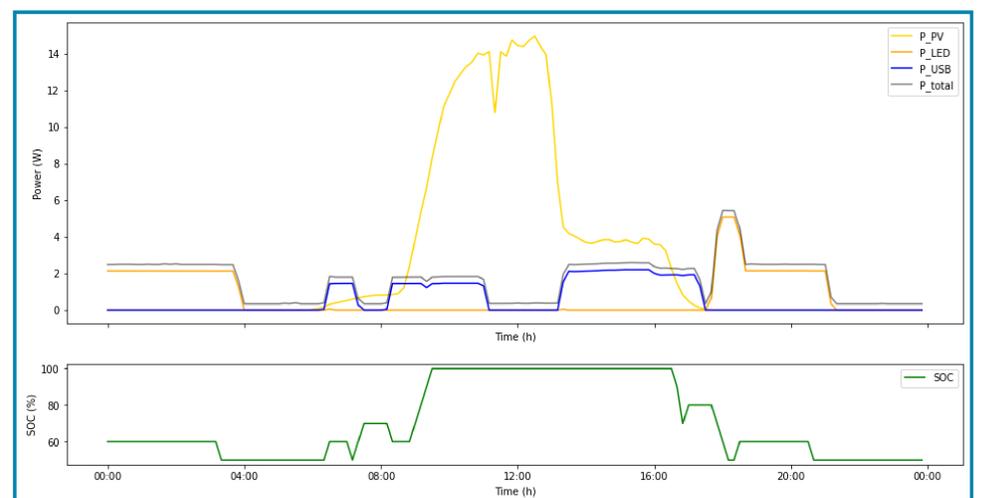


Fig. 5: Actual electricity consumption measured with dataloggers.

- Self-reported energy practices revealed heavy reliance on natural light and agricultural cycles, with lighting crucial for women's weaving activities and children's schooling.
- The measured energy consumption showed **alignment with reported behaviors, with the RAMP model accurately simulating daily load curves**. However, disparities observed during periods at the start and end of the day indicate potential limitations.
- The **system capacity in the studied household is being underutilized**, with usage reported to be below 50%.
- Understanding these dynamics informs tailored electrification initiatives, necessitating **consideration of seasonal variations and daily routines for optimal energy planning**.

What's next?

- Future research will entail **sustained monitoring over a year to extend findings to all households**, enabling broader applicability of the proposed stochastic demand model in energy planning for remote communities.
- Significant emphasis will be placed on qualitative data concerning the **socio-cultural dynamics of energy use**.



Fig. 6: Spatial distribution of one part of the households with SHS in Raqaypampa.

Recent advancements using RAMP, regarding this and other studies, are available in a GitHub repository (see QR)

References

Modeling Household Energy Behavior in Rural Communities from Developing Countries: A Case Study in Raqaypampa, Bolivia. Claudia Sanchez-Solis, Sergio Balderrama, Jaime Zambrana, Sylvain Quoilin. (Submitted Conference paper under review)

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