ELECTRICITY DEMAND ESTIMATION FOR MINI-GRIDS: A COMPARATIVE STUDY BETWEEN A NOVEL GAME-BASED AND TRADITIONAL SURVEY-BASED APPROACH

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The Role of Mini-grid to Reach Universal Access.

- Mini-grids are localized small scale electricity system tied to the local electricity needs.
- They are cost effective
- Mini-grid are expected to provide electricity access 490 million of the 750 million people without electricity.
- 210 mini-grids are required to reach universal access by 2030

Mini-grids Challenges

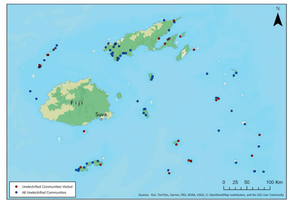
- The face higher upfront cost
  - Inaccuracy in demand estimation which result in oversized or undersized system due to the mismatch between generation and demand
- Regulatory uncertainty project financing
- Low demand
- Revenue collection

Research Questions

- How can we better perform demand estimation to right size the system?
  - Which reflect local needs and community priorities.
  - Reduces electricity generation and demand mismatch.
  - Which lower the cost and improve financial sustainability.
- How can we provide electricity knowledge communities with no or limited past electricity usage experience?

Study Area

- FIJI has complex terrain
- Two major islands have electric grid (over 70% Fijian population)
- 300+ islands
- 110 islands are unelectrified
- Around 40% of Fiji's electricity is generated from diesel.
- Remote islands get electricity from a mix of SHS or diesel powered mini-grids



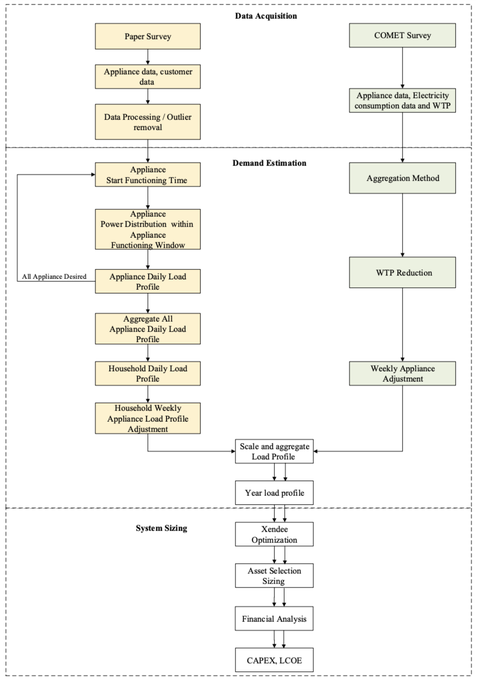
Traditional Survey

- Data was collected at the household level, and community members using paper questionnaires
- Household income sources, current appliance ownership, and anticipated appliance use following the installation of the mini-grid.
- The survey covered 30 communities capture data from 1,000+ households and capturing information on 46 different appliance types
- Community timetables from participating communities to understand daily activity patterns, which helped estimate typical appliance usage windows.

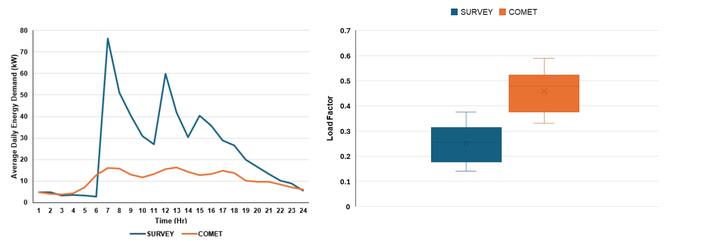
Game Based Approach

- Participant are given tablet with Community Energy Toolkit (COMET) simulation tool, it has and interactive design elements that simulate community electricity usage.
- With intent to capture human behavior which in turn identify customer priorities in addition to their energy demand response to different configuration system and different tariff
- Participants select virtual appliances by purchasing (with in-game money)
- 24-hr simulation is started and participants can turn appliances on and off based on their typical daily routines
- The participants manipulate their appliance usage, they can see in real time how their behavior affects the community energy system through energy consumption meters
- The end of the 24hour simulation, participants are given a monthly energy bill based on their energy consumption
- Participants are learning the cost of energy appliances, how their energy consumption affects their community, and how their energy usage connects to their energy costs

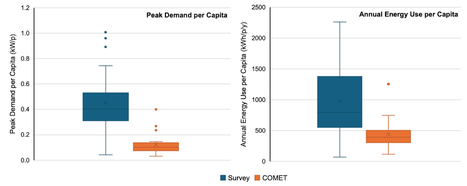
Methodology



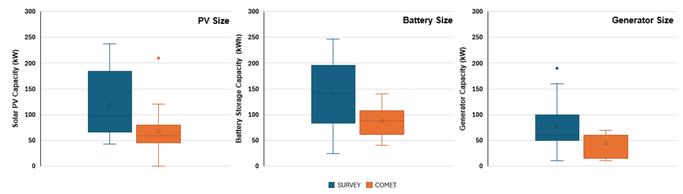
Results

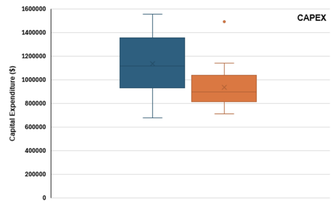


- Gamification method has average higher load factor which represent higher mini-grid's utilization rate.
- The average gamification yield load factor is above 45 % which is above the average current mini-grid 30%



- Survey resulted into higher variability and higher peak per capita
- Higher peak result into bigger system





- On average the survey method had a CAPEX that was 21% greater than the gamified method

Future Work

- Test the accuracy of gamification and traditional survey methods in capturing the community energy demand one systems are installed
- Create a gamification framework that will include best practices for data collection and demand estimation

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