LUT School of Energy Systems
Dep. of Electrical Engineering
LEMPS – Laboratory of Electricity Markets and Power Systems

Data-Driven Model to Estimate Dynamic Energy Demand in Rural Mini-Grids: A Case Study from Kenya

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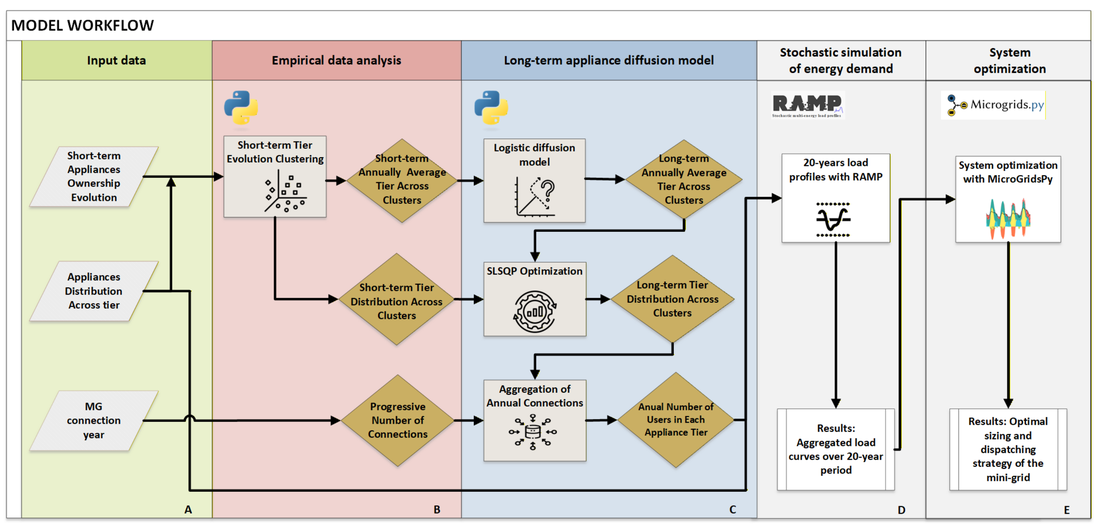
Introduction

- The longer households have access to electricity, the more likely they are to consume more electricity
- Reliable data on energy demand growth is scarce or entirely absent
- Inadequate mini-grid system designs, fail to meet future energy needs, or are unnecessarily oversized
  → **Inefficient and unsustainable solutions.**

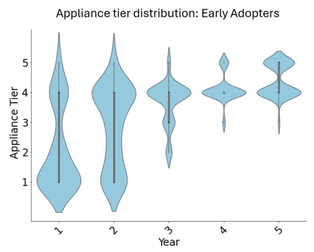
Objectives

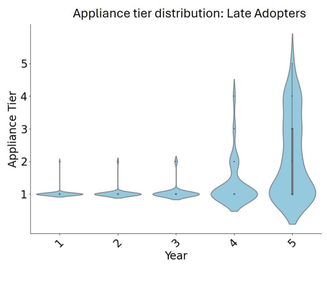
- Formulation of a bottom-up modeling approach for dynamic demand characterization
- Leverage short-term (5-years after electrification) patterns on appliance ownership and usage to estimate long-term electricity demand evolution (20-year)
- Two key drivers of demand growth: (i) the expansion of the consumer base; and (ii) the progressive adoption

Model workflow:



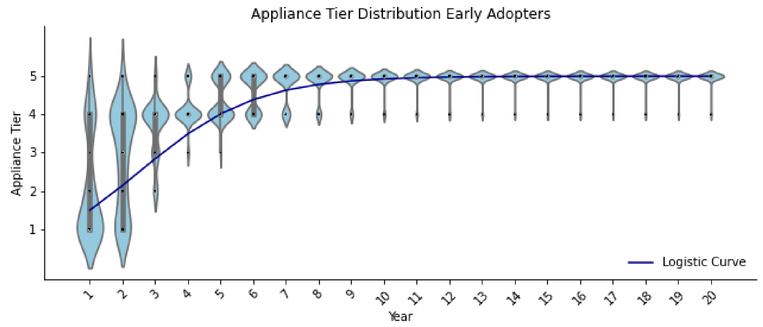
Results

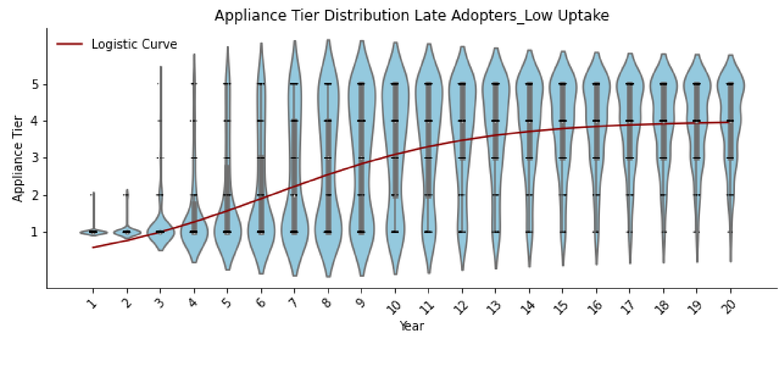




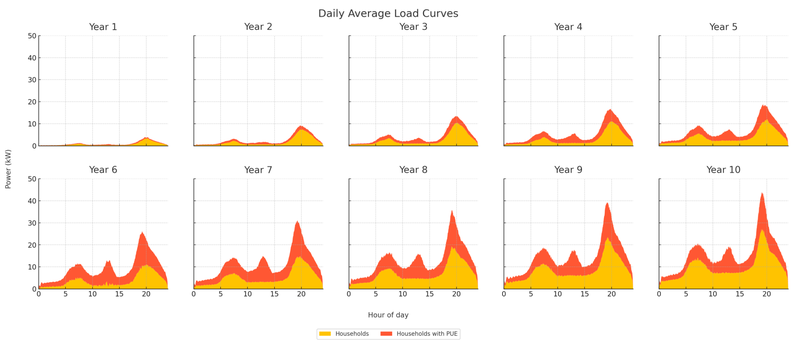
Empirical data: Short-term diffusion

Long-term diffusion





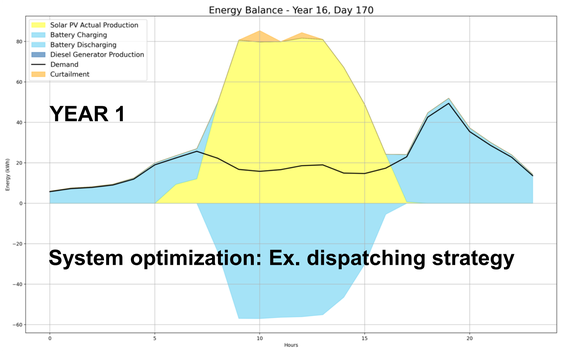
Demand load estimation

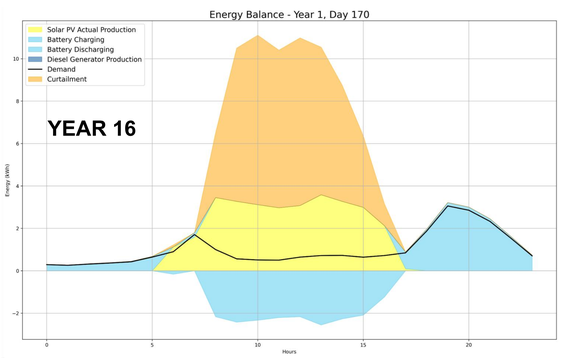


System optimization: Capacity expansion steps Years 1,5 and 10. Hybrid system

Component	Year 1	Year 5	Year 10	Year 15	Year 20
Solar PV (kW)	15	65	117	117	117
Diesel Generator (kW)	10	10	10	10	10
Battery (kWh)	59	244	521	521	521

NPC	349.1 kUSD
LCOE	0.367 USD/kWh
Curtailment	32.10 %





PROGE project has received funding from the Research Council of Finland (decision number: 357187).

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