

Fapote Mini-Grid Load Assessment & LDC Simulation Using Odyssey

Executive Overview

his technical summary provides a comprehensive analysis of the validated electricity demand data for the FAPOTE Mini-Grid project. The assessment covers 255 customer connections with an average daily energy demand of 1,803.09 kWh and a peak demand of 112.29 kW.

The report presents detailed customer segmentation, load profile characteristics, and demand distribution analysis. The findings support strategic decision-making for infrastructure planning, capacity sizing, and operational optimization of the mini-grid system.

System Overview and Key Metrics

The FAPOTE mini-grid serves 255 customer connections with an average daily energy demand of 1,803.09 kWh (monthly: 54,886.07 kWh). Peak demand reaches 112.29 kW at hour 18 (evening), with a system load factor of approximately 67%.

The system demonstrates a balanced mini-grid profile anchored by a TransCom productive-use facility, with established residential, commercial, and productive-use patterns. The ~67% load factor, boosted by the daytime-weighted anchor load, indicates efficient utilization throughout the day.

Metric	Value
Average Daily Load	1,803.09 kWh
Average Monthly Load	54,886.07 kWh
Total Customer Connections	255
Peak Demand	112.29 kW (at hour 18)
System Load Factor	~67%

Load Profile and Peak Demand

The FAPOTE mini-grid system exhibits a distinctive load profile characterized by a peak demand of 112.29 kW occurring at hour 18, corresponding to the evening period when energy consumption reaches its maximum intensity across all customer segments. This evening peak represents the convergence of multiple consumption patterns: residential households transitioning into evening activities such as cooking, lighting, and entertainment; commercial establishments completing their daily operations; and productive users finalizing their workday processes. The magnitude of this peak establishes critical design parameters for the mini-grid, particularly regarding generation capacity, energy storage requirements, and network infrastructure dimensioning.

The temporal evolution of the load profile reveals a progressive rise from low early-morning demand levels, representing minimal base load from essential services and early-starting productive activities. As the day advances, consumption increases steadily through the morning and afternoon hours, driven by the TransCom anchor facility's agro-processing operations, commercial activity, and productive users. Crucially, the anchor load is deliberately weighted toward the daytime solar window, providing important revenue-generating consumption during periods when solar generation would be at its peak and creating favorable supply–demand dynamics for a hybrid renewable mini-grid.

The evening peak at hour 18 carries significant implications for system design and operational planning. First, generation capacity must be sized to reliably meet this peak with appropriate reserve margins to ensure service quality and accommodate demand growth. Second, the timing of the peak suggests that energy storage can play a valuable role in load shifting and peak shaving, particularly given a solar-hybrid generation profile. Third, the concentrated evening demand pattern indicates opportunities for demand-side management interventions, such as time-of-use tariffs or load-control programs, to moderate peak demand and improve overall system economics. The load profile subsequently declines following the evening peak as commercial activities cease and residential consumption tapers through the late evening and night hours, returning to baseline levels sustained primarily by essential lighting, security systems, and refrigeration.

Load

Download Time Series

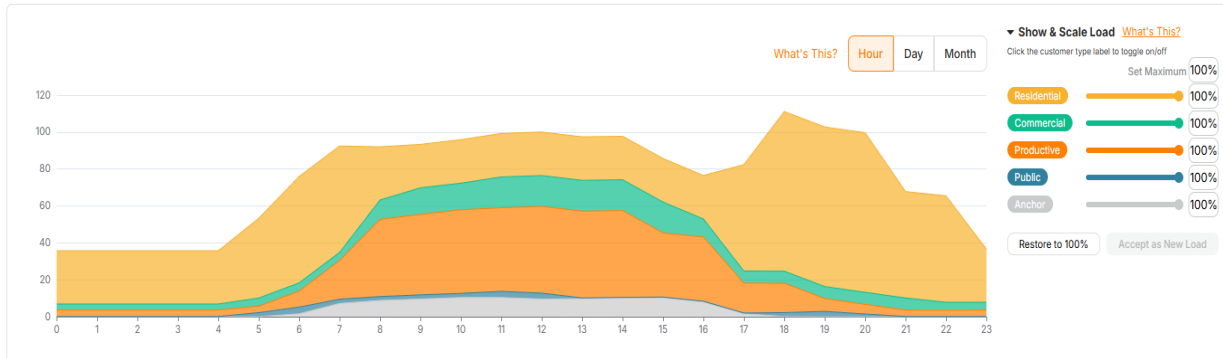
Avg. Daily Load
1,803.09 kWh/dAvg. Monthly Load
54,886.07 kWh/moCustomer Connections
255Peak kW
112.29 kWPeak Hour
18

Figure 1: Fapote Community Validated Load Duration Curve using Odyssey

Customer Segmentation Overview

The 255 connections distribute across five categories: residential (89.8%), commercial (5.1%), productive (2.0%), public (2.0%), and anchor (1.2%). As is typical for productive-use anchored mini-grids, residential dominance by count contrasts sharply with the demand distribution, where the commercial, productive, and anchor segments together contribute ~45.6% of consumption despite only ~10% of connections.

Segment	Customers	Percentage
R1 (Residential Tier 1)	74	29.0%
R2 (Residential Tier 2)	94	36.9%
R3 (Residential Tier 3)	61	23.9%
Commercial (C1)	13	5.1%
Productive Use (P1)	5	2.0%
Public Institutions (PuB)	5	2.0%
Anchor (A1)	2	0.8%
Anchor (TransCom)	1	0.4%
Total	255	100.0%

Customer Types

Expand AllAdd Customer Type

Customer Type ^	Category ⚙	Customers ⚙	Avg Daily Load/Cust. (Wh) ⚙	Avg Daily Load/Type (Wh) ⚙	Scaling Factor ⚙
▶ TRANSCOM	Anchor	1	378,000.0	378,000.0	100% ...
▶ PuB	Public	5	6,022.7	30,113.7	100% ...
▶ P1	Productive	5	22,775.3	113,876.7	100% ...
▶ A1	Anchor	2	48,808.0	97,616.0	100% ...
▶ R3	Residential	61	10,650.0	649,650.0	100% ...
▶ R2	Residential	94	3,150.0	296,100.0	100% ...
▶ R1	Residential	74	472.5	34,965.0	100% ...
▶ C1	Commercial	13	15,597.6	202,768.8	100% ...

Figure 2: Fapote Customer Segmentation from Odyssey Simulation.

Segment	Customers	Avg kWh/Day	Total kWh/Day	% Demand
Residential (R1)	74	0.47	34.97	1.9%
Residential (R2)	94	3.15	296.10	16.4%
Residential (R3)	61	10.65	649.65	36.0%
Commercial (C1)	13	15.60	202.77	11.2%
Productive (P1)	5	22.78	113.88	6.3%
Public (PuB)	5	6.02	30.11	1.7%
Anchor (A1)	2	48.81	97.62	5.4%
Anchor (TransCom)	1	378.00	378.00	21.0%
Total	255		1,803.09	100.0%

Segment Roles and Strategic Significance

Residential customers provide base volume and social inclusion through a three-tier structure accommodating varying affordability levels. Commercial establishments deliver consistent daytime demand with typical 08:00–20:00 operations, improving load factors. Productive users contribute high-intensity consumption via workshops and processing facilities.

Public institutions offer stable, predictable demand through schools, health centers, and administrative offices. Anchor customers provide critical baseload and concentrated revenue: despite representing just over 1% of connections, the two anchor categories

(TransCom + A1) together contribute ~26.4% of total demand, delivering financial stability and enhanced system utilization.

TransCom Anchor Load

The TransCom productive-use facility is the single largest load on the system at 378 kWh/day (~21% of total demand), sized to be a solid anchor without overwhelming existing peak capacity. Its daily consumption reflects standard agricultural Productive Use of Energy (PUE) equipment:

- **Agro-processing (milling, grating, pressing):** two ~15 kW electric mills plus a ~5 kW press at ~50% load factor over 6–8 hours, consuming 130–180 kWh/day.
- **Cold storage & logistics:** a 5-ton walk-in cold room drawing 3–5 kW on a standard compressor duty cycle, consuming 40–60 kWh/day.
- **Irrigation & WASH pumping:** a 5 kW pumping system over ~5 hours, consuming 25–40 kWh/day.
- **Enterprise & digital hub:** lighting, admin computers, internet routing, and small tools, consuming ~20–30 kWh/day.

The TransCom usage profile is intentionally weighted into the daytime solar window, roughly 60% of its daily energy is consumed between 09:00 and 14:00, to optimize the Levelized Cost of Energy (LCOE) and minimize heavy battery cycling by aligning high-draw agro-processing with peak solar production.

Demand Distribution Analysis

Total daily demand of 1,803.09 kWh is distributed across customer segments as follows. Residential consumption accounts for ~54.3% of total demand, subdivided into R1 (1.9%), R2 (16.4%), and R3 (36.0%). Non-residential consumption comprises ~45.6%, distributed among Commercial (11.2%), Productive (6.3%), Public (1.7%), and Anchor (26.4%, of which TransCom is 21.0% and A1 is 5.4%).

FAPOTE Daily Energy Distribution by Customer Segment

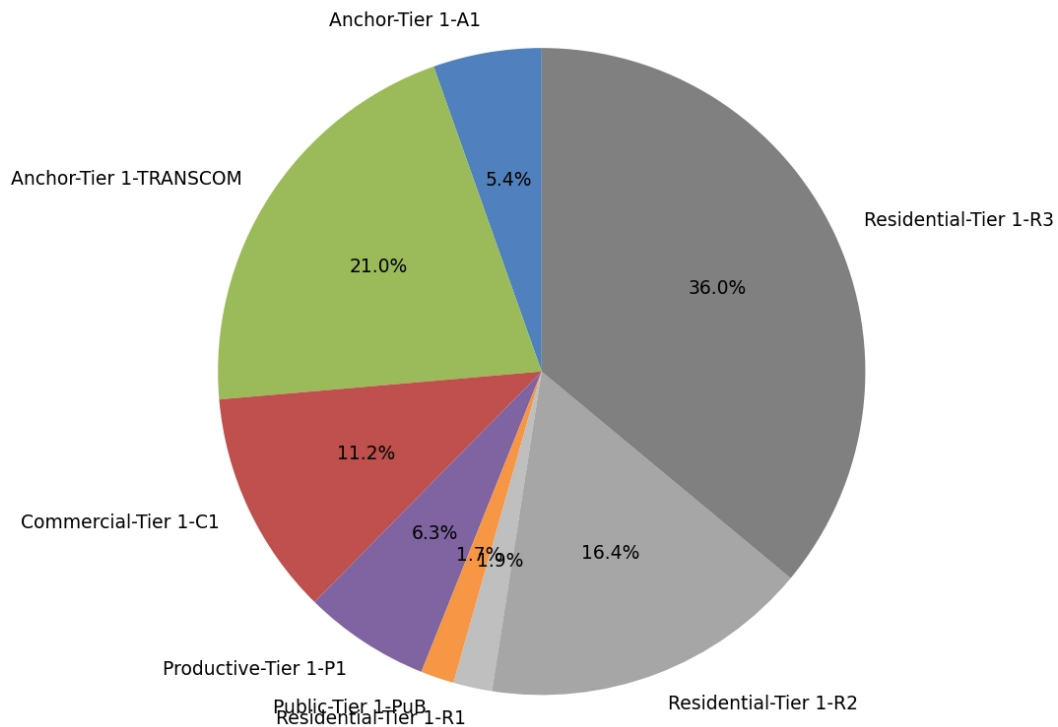


Figure 3: Daily Energy Distribution By Customer Segment.

Residential customers, representing ~90% of connections, consume ~54% of total energy. In contrast, non-residential customers account for only ~10% of connections yet consume ~46% of energy, indicating a healthy productive-use-anchored demand structure. Per-customer consumption varies dramatically across segments, spanning an ~800:1 range from R1 (0.47 kWh/day) to the TransCom anchor (378 kWh/day), underscoring the central role of the anchor load in underpinning the project's commercial viability.