



Building A Robust Workforce in Electric Power Engineering Albuquerque, NM March 16-17, 2023



Navajo Technical University and Seattle University

Battery Banks

Data Analytics

Energy Access

Off-Grid Systems

Solar Energy

Research Description

More than 10,000 homes on the Navajo Nation do not have access to the power grid. The Navajo Tribal Utility Authority (NTUA) has installed 3.8 kW solar systems on some of these homes. This work analyzes the electrical energy usage characteristics of 127 of these homes. Inverter data was collected over a two-year period. Several statistical analyses were conducted on the data. This project is a unique authentic collaboration between Tribal (Navajo Technical University) and non-tribal (Seattle University) universities in partnership with NTUA.

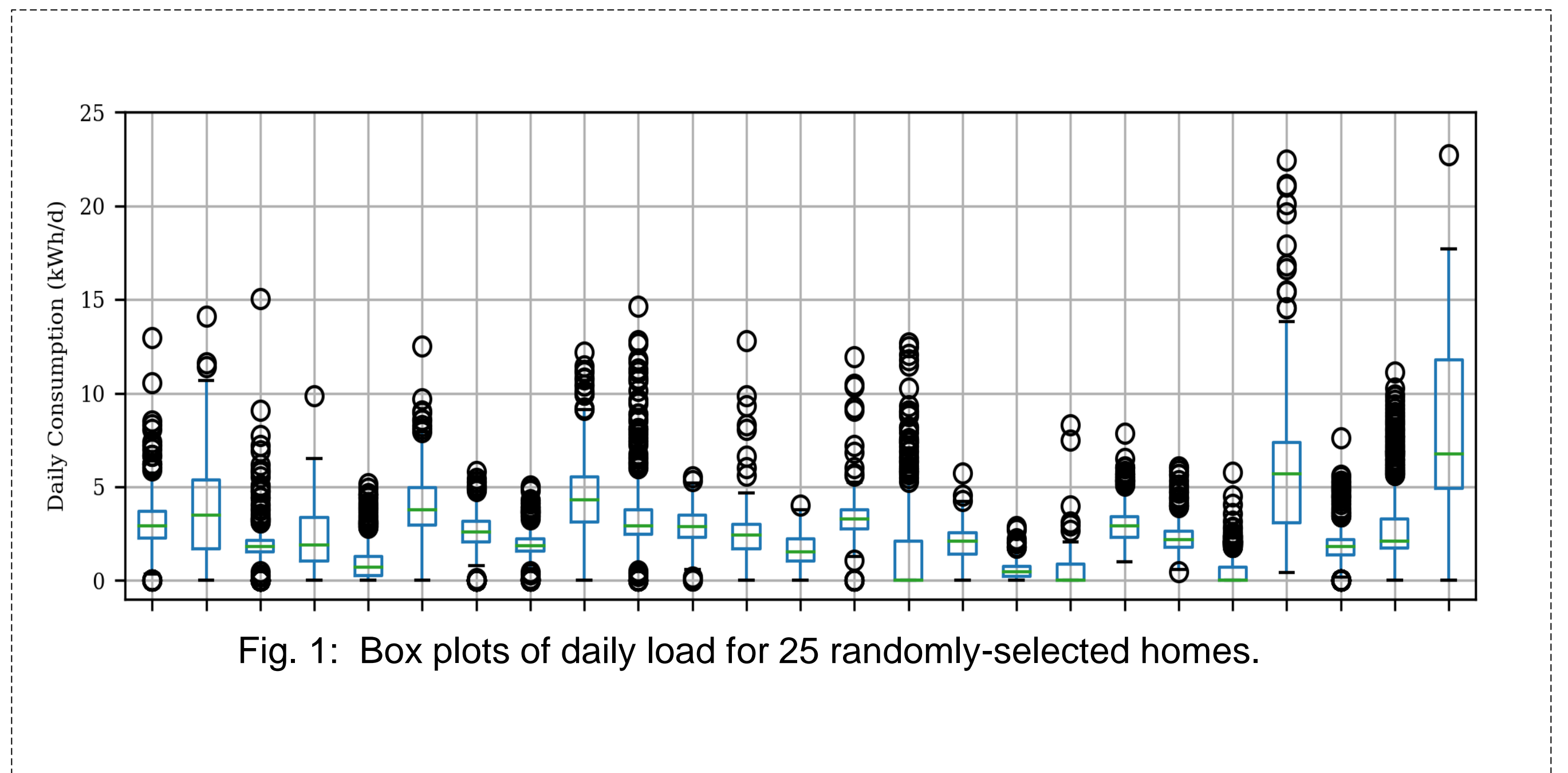


Fig. 1: Box plots of daily load for 25 randomly-selected homes.

Power and Energy Focus

This work focuses on off-grid electrical system design and residential energy consumption characteristics. Over 100 million data points were analyzed from off-grid systems to characterize the daily energy consumption from 127 homes. Then, the solar array and battery bank sizing were re-designed based on the actual load to inform future deployments of the systems. In general, the solar array size could be reduced while still meeting the demand of most homes.



Fig. 2: An off-grid solar system with 3.8 kW bi-facial array, 35.1 kWh gel battery bank and 8 kW inverter.



Fig 3: Collaborative research team featuring students, faculty, and staff from Navajo Technical University, Seattle University, and NTUA. [Not pictured: Dr. Stanley Atcity, Sandia National Laboratories]

SOLAR ARRAY SIZING

Statistic	DC Load (kWh/day)	Required PV Capacity (kW)
Maximum	11.93	4.60
Q(0.975)	9.34	3.60
Q(0.95)	7.20	2.77
Q(0.90)	6.33	2.44
Mean	4.22	1.63
Q(0.50)	3.88	1.50
Q(0.10)	2.28	0.88
Q(0.05)	2.09	0.81
Minimum	1.79	0.69

DISTRIBUTION OF CONSUMPTION

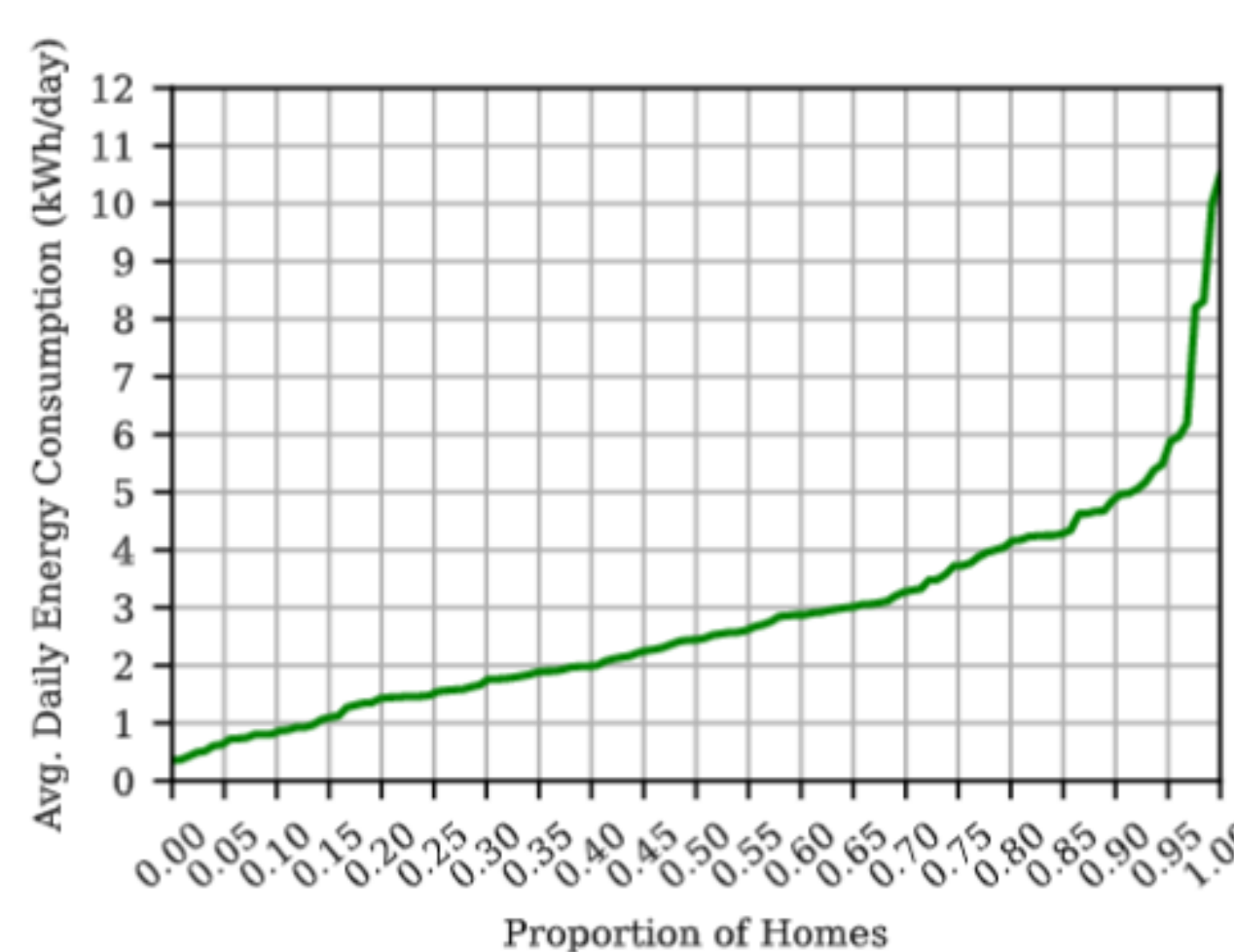


Fig. 4: Empirical inverse CDF of average daily energy use on the AC side of the inverter. Average daily consumption is 2.78 kWh. Median consumption is 2.44 kWh.

This poster is based upon work supported by the National Science Foundation under Grant #2137027/2132028.

BATTERY SIZING

Statistic	DC Load (kWh/day)	Required Battery Cap. for 3 DoA (kWh)
Maximum	11.93	73.5
Q(0.975)	9.34	57.5
Q(0.95)	7.20	44.4
Q(0.90)	6.33	39.0
Q(0.75)	5.17	31.8
Mean	4.22	26.0
Q(0.50)	3.88	23.9
Q(0.10)	2.28	14.1
Q(0.05)	2.09	12.9
Minimum	1.79	11.1