High-Resolution Smart Meter Load Dataset Collected from Multiple Cities in Morocco

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ARTICLE INFORMATION

Article title

High-Resolution Smart Meter Load Dataset Collected from Multiple Cities in Morocco

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Keywords

Load forecasting; Smart meters; Electricity consumption; Data analysis; Morocco; Distribution transformers; Energy management.

Abstract

Here in this data set, we are offering high-resolution electric consumption data collected via smart meters installed across multiple Moroccan cities with special focus on 22kV distribution transformers. The smart meters employed in this study have the feature of storing electric parameters, and the data has been retrieved from residential and industrial regions in Laayoune, Boujdour, Marrakech, and Foum Eloued. The dataset, accumulated at a 10-minute (30-minute) frequency in Marrakech, constitutes the granular foundation for precise load forecasting models tailored to the idiosyncrasies of each region.Raw and processed versions of the dataset are both available, thereby making it a valuable for energy management, load forecasting, and smart grid optimization experts and researchers. The information can be used to study patterns of consumption, detect anomalies, and develop prediction models for the best power distribution and grid stability. Visual representations of trends in electricity consumption by geographic area and time period are also provided to facilitate ease of interpretation and further research use.

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SPECIFICATIONS TABLE

Subject	Energy.
Specific subject area	Load forecasting using smart meter data.
Type of data	Table.
Data collection	Data were collected using smart meters with a storage capacity of up to 67,000 observations per parameter and a frequency of at least 10 minutes.
Data source location	Laayoune, Boujdour, Marrakech, and Foum Eloued.
Data accessibility	Repository name: High-Resolution Load Dataset from Smart Meters Across Various Cities in Morocco Data identification number: 10.17632/6s9mfp3bd8.2 Direct URL to data: https://zenodo.org/records/16423697 Instructions for accessing these data:
Related research article	The updated data is related to the research article presented in [1]

VALUE OF THE DATA

This data provides high-resolution electricity consumption data, which is important in constructing accurate load forecasting models for individual regions in Morocco. The nature of the dataset, where it captures electricity consumption in 10-minute intervals (30 minutes for Marrakech), enables careful investigation of day-to-day, week-to-week, and seasonal variations in loads, and thus it is an essential tool for energy researchers and practitioners.

The dataset has broad applications in energy management and forecasting. It can be used by researchers to analyze load fluctuations, identify consumption patterns, and optimize energy distribution. The multi-purpose nature of the dataset makes it applicable with a range of predictive models, including time-series forecasting and deep learning-based models. The data can be used to improve grid stability, manage demand response, and support predictive maintenance of power distribution networks.

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One of the best advantages of this dataset is that it can be used for artificial intelligence (AI) and machine learning (ML) applications. As frequency of data collection is high, it can be used to train deep learning prediction models such as Long Short-Term Memory (LSTM) networks, Transformer-based models, and gradient boosting models (e.g., XGBoost, LightGBM). Such models can be used to improve precision in demand forecasting, detect outliers in electricity usage, and facilitate predictive maintenance of utilities. Cluster algorithms can also aid in profiling consumption behavior into distinct user classes, and optimization methods based on reinforcement learning can be explored for refinement of energy management strategies [2].

Apart from its direct applications in forecasting and energy optimization, the dataset offers extensive coverage of various Moroccan cities across both domestic and industrial consumption regions. This enables comparative analysis among different geographical and socio-economic contexts, allowing researchers to draw richer insights into regional patterns of electricity demand.

In Laayoune, Boujdour, and Foum El Oued, the dataset includes data from all 22 kV distribution transformer departures, enabling a complete and representative view of electricity consumption at the city scale.This comprehensive coverage allows researchers to assess city-wide load behaviors at the medium-voltage level, which is rarely accessible in publicly available datasets and adds significant value for regional energy modeling.

Compared to commonly used datasets, this dataset provides unique insight into North African electricity consumption behavior and infrastructure performance. In addition to raw data, the dataset is provided in clean, well-structured CSV format, facilitating immediate integration into data analytics platforms such as Python, R, or MATLAB.

The information is also useful for sustainable energy growth and smart grid research. With its intensive electricity consumption data, it can help efforts to enhance grid resilience, advance renewable integration, and implement smart demand-side management practices. The stakeholders, policymakers, and utilities can use the information to formulate evidence-based solutions to peak-load reduction, energy efficiency upgrade, and transition to a cleaner power system.

BACKGROUND

Accurate load forecasting is an important aspect of energy management and grid optimization, particularly in regions with heterogeneous patterns of electricity consumption [3]. With the ever-increasing demand for energy globally, power utilities are facing growing challenges in predicting load variability, ensuring grid stability, and optimizing power distribution. Traditional forecasting methods using historical aggregate data are generally insufficient to account for the advanced and dynamic characteristics of electricity usage. This is because of the requirement of high-resolution data sets for enabling precise prediction and facilitating the design of intelligent energy management policies.

Smart meters have altered the character of electricity consumption monitoring by providing interval or real-time data, which presents more meaningful insights into consumer behavior, peak demand usage, and seasonal usage [4]. Unlike conventional metering systems that provide cumulative data

on a long-term basis, smart meters collect disaggregated time-series data, which allows for improved analysis and forecasting modeling. By harnessing this technology, utilities are able to shift from reactive to proactive energy management, maximizing supply-demand balance and grid performance as a whole.

This dataset was developed to address the need for accurate, high-resolution electricity consumption data to support the creation of load forecasting models, improve energy distribution planning, and facilitate energy-efficient decision-making. The dataset captures electricity consumption patterns in various Moroccan cities, residential, and industrial zones, providing a rich source of information for researchers, policymakers, and industry professionals. The availability of such a dataset enables a more accurate understanding of consumption habits, enabling the building of predictive analytics and data-driven energy management strategies.

The evaluation of the dataset's high-frequency character allows to monitor electricity consumption on a constant basis with increased productivity in contrast to standard data gathering using monthly or yearly aggregated data. Fine-resolution analysis of consumption enhances load forecasting accuracy using real-time variation and identifying nascent consumption trends. High-resolution data also allow for identifying anomalies and inefficiencies in electricity consumption to assist utilities in identifying power loss, ensuring unauthorized consumption, or extreme variations in demand.

Using structured time-series data, this data set is best utilized in implementing artificial intelligence (AI) and machine learning (ML) techniques in energy prediction [5]. Sophisticated model approaches such as neural networks, gradient boosting models, and time-series models can employ this data set for enhancing prediction accuracy, developing refined load-balancing methods, and optimizing energy efficiency [6]. Also, smart meter data is a critical part of integrating smart grid technologies so that utilities can roll out real-time demand response solutions, dynamic pricing strategies, and advanced grid automation systems.

DATA DESCRIPTION

The data set has precise measures of electricity usage from various cites Foum Eloued, Marrakech, Boujdour, and Laayoune . It is structured to reflect industrial and residential usage patterns, with measures collected at a sampling rate of 10 minutes for most cities and 30 minutes for Marrakech. The data set includes a number of tables showing the usage trend across various cities and zones, providing data on daily variations in demand, seasonality, and peak load periods.

One critical aspect of this data is the variation in the units of measurement used in different cities:

- For Boujdour, Laayoune, and Foum Eloued, consumption of electricity is in terms of amperes (A).
- For Marrakech, electricity is quantified in kilowatts (kW).

This measurement difference exists due to variations in metering equipment and local power distribution patterns. Since amperes measure flow of current and kilowatts measure actual use, scholars who need to compare data across cities will have to normalize the data by transforming the amperes to kilowatts. The general formula for conversion is:

$$P(kW) = V \times I(A) \times Power\ Factor/1000$$

Where:

- P (kW) = Power in kilowatts
- V (Volts) = Voltage level of the local distribution network
- I (A) = Current in amperes
- Power Factor (PF) = A coefficient (typically between 0.8 and 1) that accounts for phase differences in AC power

For researchers analyzing regional energy consumption trends, it is essential to consider voltage levels and power factors when performing cross-city comparisons. If required, data from Laayoune, Boujdour, and Foum Eloued should be converted to kilowatts for consistency.

The dataset is organized into tables and time-series records, each representing electricity consumption over time for different zones. The following table provides an overview of the dataset's structure:

Table 1: Overview of Data Collection from Smart Meters

City	Zone	Type	Frequency	Start DateTime	End DateTime
Laayoune	Zone 1	Domestic	10	14/09/2022 17:10	24/05/2024 00:00
	Zone 2	Domestic	10	14/09/2022 17:10	24/05/2024 00:00
	Zone 3	Domestic	10	14/09/2022 17:10	24/05/2024 00:00
	Zone 4	Domestic	10	14/09/2022 17:10	24/05/2024 00:00
	Zone 5	Domestic	10	14/09/2022 17:10	24/05/2024 00:00
Boujdour	Zone 1	Industrial	10	14/09/2022 17:10	24/05/2024 00:00
	Zone 2	Domestic	10	14/09/2022 17:10	24/05/2024 00:00
	Zone 3	Domestic	10	14/09/2022 17:10	24/05/2024 00:00
Marrakech	Zone 1	Domestic	30	09/01/2023 00:30	08/01/2024 00:00
	Zone 2	Industrial	30	10/01/2023 00:10	09/01/2024 00:00
Foum Loued	Zone 1	Industrial	10	14/09/2022 17:10	24/05/2024 00:00
	Zone 2	Industrial	10	14/09/2022 17:10	24/05/2024 00:00
	Zone 3	Industrial	10	14/09/2022 17:10	24/05/2024 00:00
	Zone 4	Industrial	10	14/09/2022 17:10	24/05/2024 00:00

	Zone 5	Domestic	10	14/09/2022 17:10	26/12/2023 09:10
	Zone 6	Domestic and Industrial	10	14/09/2022 17:10	26/12/2023 09:10
	Zone 7	Domestic and Industrial	10	14/09/2022 17:10	26/12/2023 09:10

To provide a clearer understanding of the dataset's characteristics, we computed basic descriptive statistics for each zone. These include the mean, standard deviation, minimum, maximum, skewness, and kurtosis of the electricity consumption values. This summary offers insights into the variability and distribution patterns across different regions and supports researchers in selecting appropriate preprocessing or modeling techniques.

Table 2: Descriptive statistics of electricity consumption for each zone

City	zone	Mean	Std Dev	Min	Max	Skewness	Kurtosis
Laayoune	zone1	65,53	18,91	0,00	132,67	0,41	-0,17
	zone2	109,90	33,78	0,00	533,02	0,62	2,73
	zone3	151,44	40,74	0,00	715,86	-0,19	0,06
	zone4	113,58	26,15	0,00	255,25	-0,20	1,21
	zone5	120,21	33,88	0,00	326,85	0,00	0,53
Boujdour	zone1	74,13	24,50	0,00	155,13	0,11	-0,32
	zone2	25,69	15,60	0,00	127,02	1,26	0,75
	zone3	45,76	14,10	0,00	145,45	0,59	0,99
Foum Eloued	zone1	66,37	36,54	0,00	224,21	0,68	-0,22
	zone2	77,54	43,05	0,00	245,97	1,10	0,56
	zone3	89,06	41,59	0,00	257,90	0,61	-0,18
	zone4	37,14	21,85	0,00	120,64	1,08	0,39
	zone5	14,22	4,18	0,00	39,63	0,06	-0,39
	zone6	21,55	6,56	0,00	45,77	-0,34	0,39
	zone7	91,13	42,00	0,00	273,23	0,80	0,33
Marrakech	zone1	1203,27	282,71	0,00	2340,00	0,49	0,06
	zone2	121,93	145,79	0,00	433,00	0,81	-1,20

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EXPERIMENTAL DESIGN, MATERIALS AND METHODS

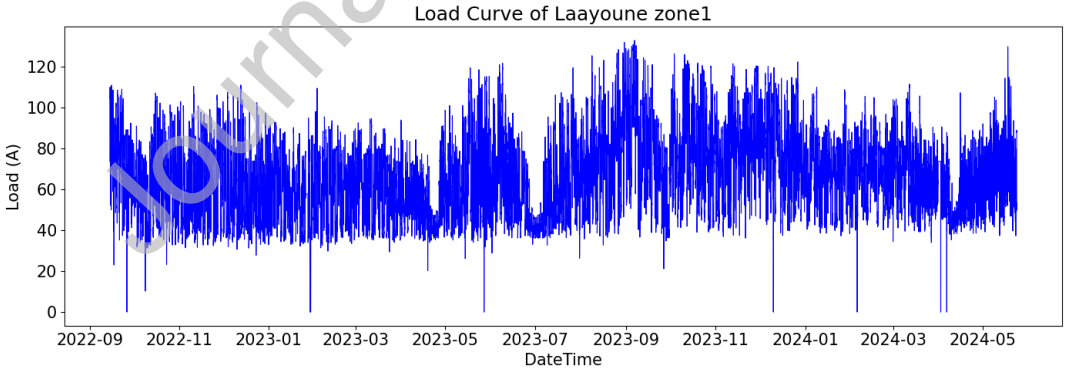
The electricity consumption data were manually retrieved by authorized technicians from ONEE using smart meters deployed in residential and industrial locations zones. These data were subsequently provided to the authors specifically for academic research purposes. This dataset is original and not previously published or sourced from public databases. No questionnaire or survey was used in the creation of this dataset.

Measurements were recorded at a frequency of 10 minutes (30 minutes for Marrakech). The dataset contains 88,891 observations for the other cities and 17,502 for Marrakech. The smart meter has the capacity to store one year of data at a frequency of 10 minutes. Lowering the recording frequency allows the meter to store more data. The process of data collection involved manual extraction of data by operators to guarantee the accuracy and completeness of the dataset.

The smart meters used for data collection were of the type Landis+Gyr E650 or equivalent, installed and managed by ONEE on 22 kV distribution feeders. These meters support interval logging at 10-minute (or 30-minute) frequencies and enable manual data export via USB.

Both urban and residential sectors of Laayoune, Boujdour, Marrakech, and Foum El Oued were covered for data collection purposes, with Marrakech being sampled in kilowatts and the rest of the cities sampled in amperes. Raw data and processed forms are available within the dataset, providing a complete set of material for load forecasting research.

To provide an impression of the process of data gathering, Figures 1-4 present visual representations of the patterns of electricity usage in different zones and cities. These figures depict differences in patterns of consumption between residential and industrial zones and demonstrate the day-of-the-week pattern of demand changes.



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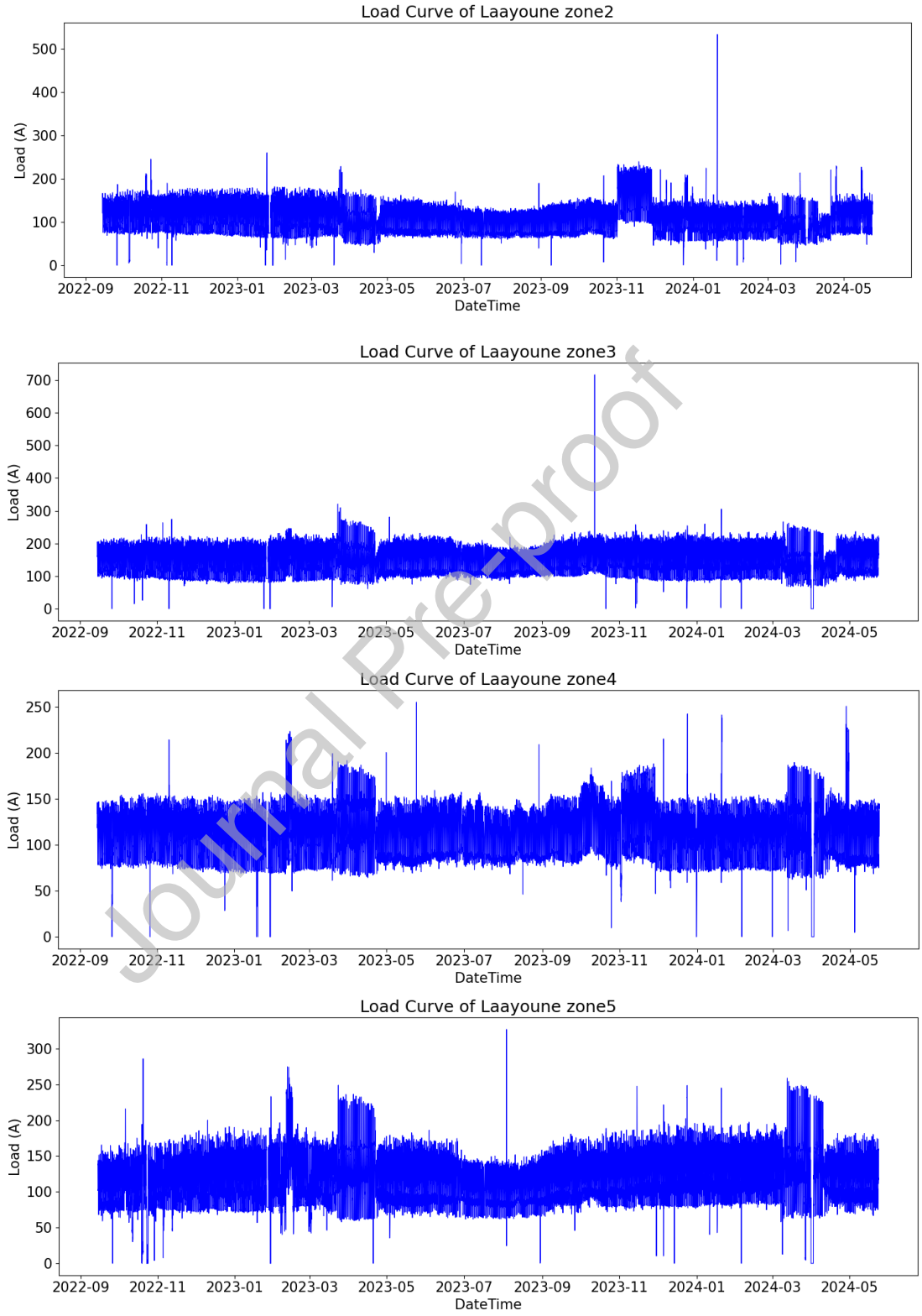

Figure 1: Visualization of Dataset for Zones of Laayoune

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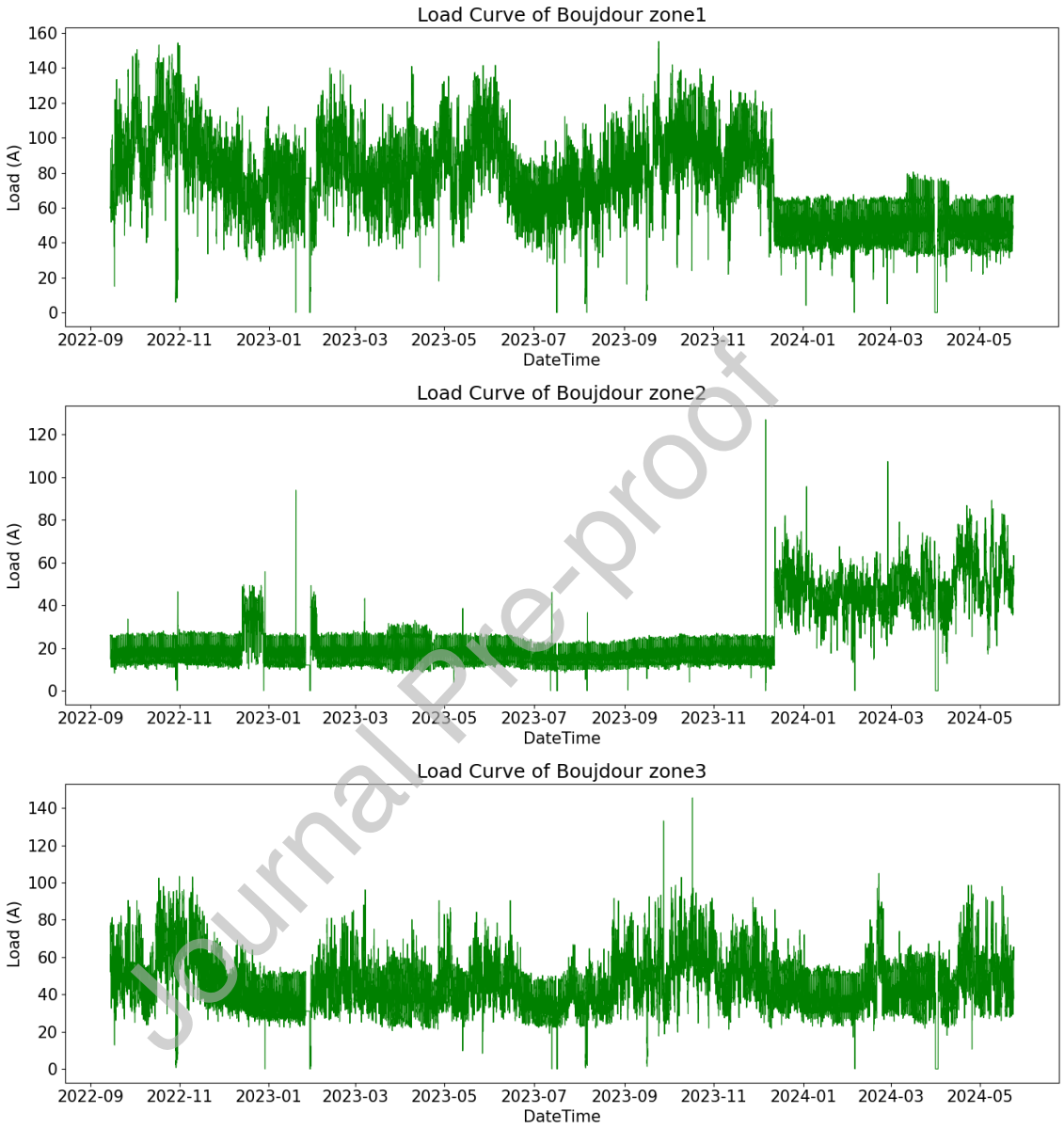

Figure 2: Visualization of Dataset for Zones of Boujdour

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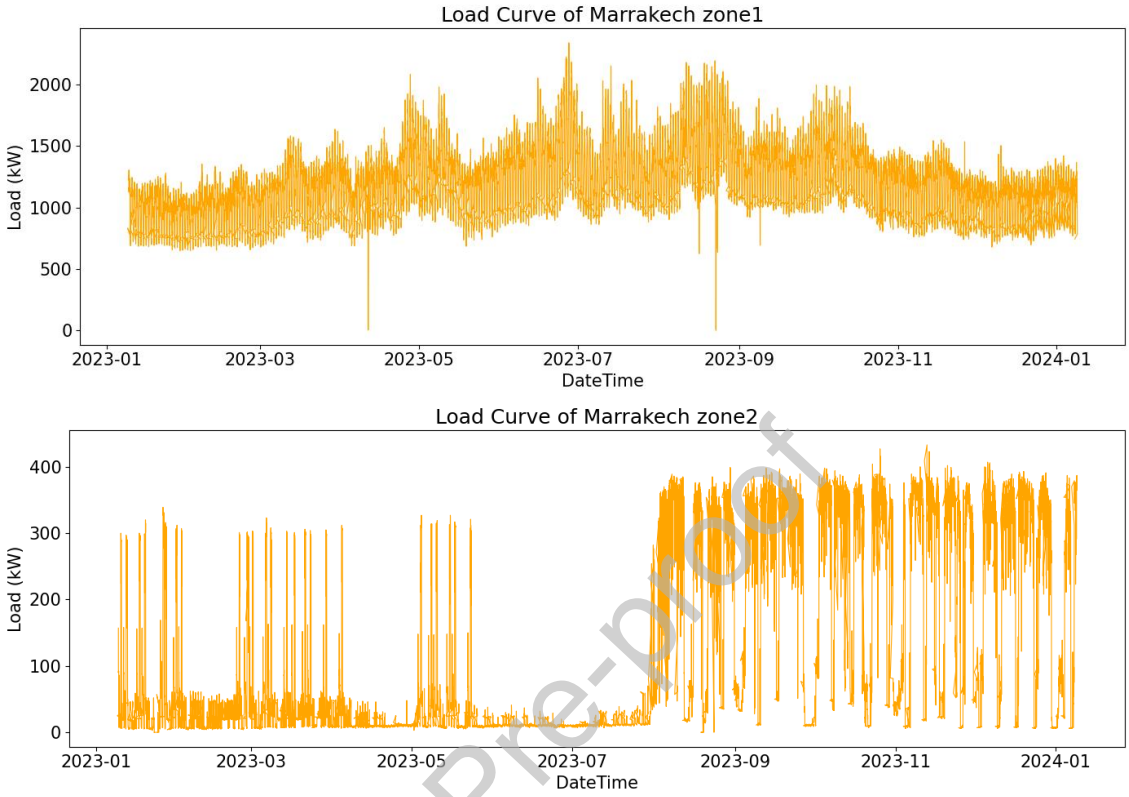
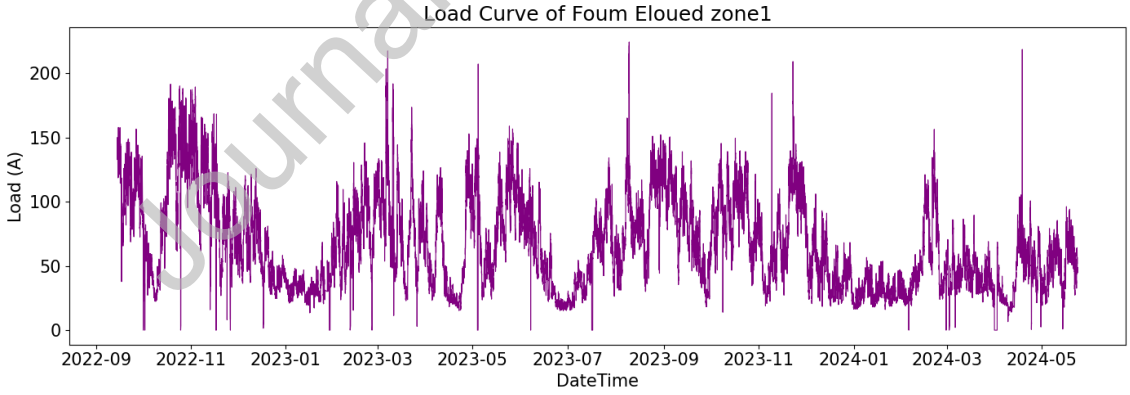


Figure 3: Visualization of Data for Zones of Marrakech



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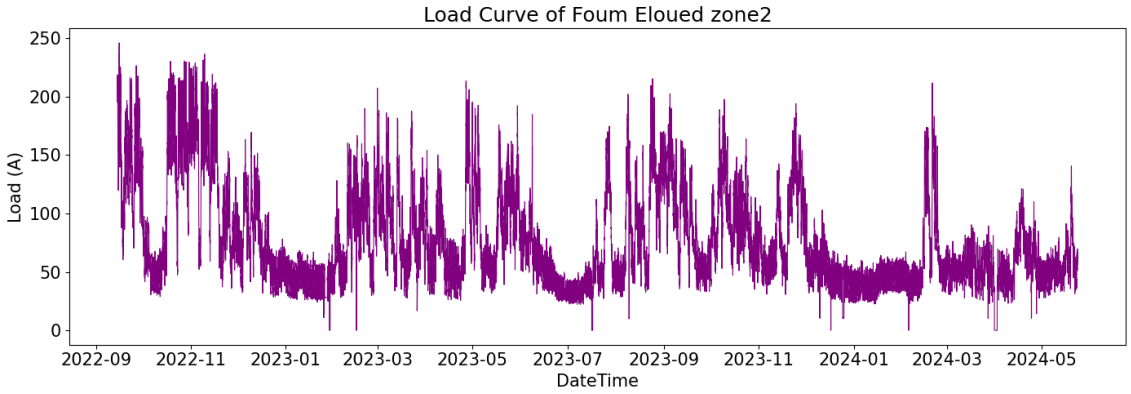

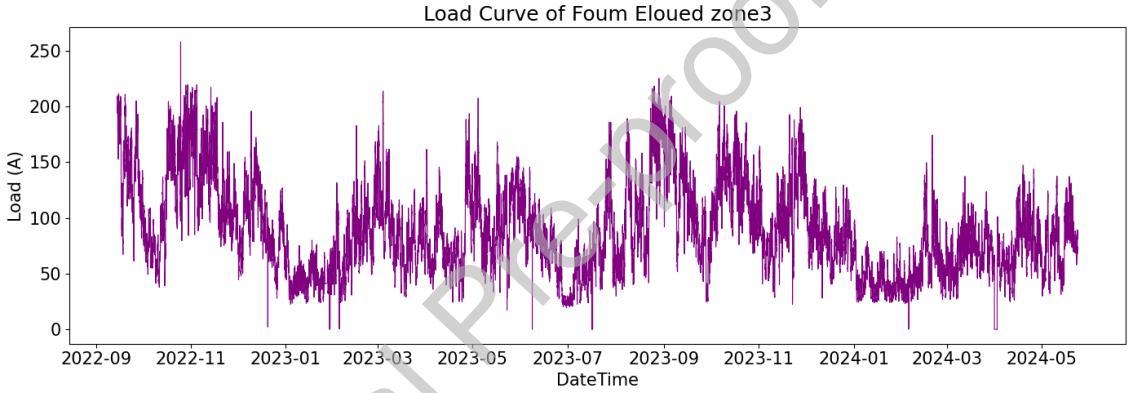

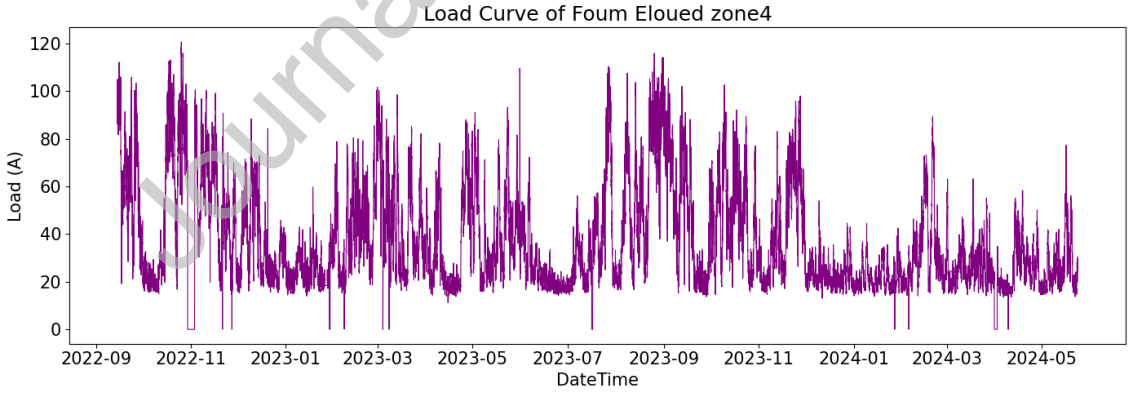

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Figure 4: Visualization of Dataset for Zones of Foum El Oued

These visualizations provide a clear depiction of the electricity consumption trends and highlight the differences in demand between various zones and cities. The figures demonstrate the high-resolution nature of the dataset, making it a valuable resource for detailed load forecasting and energy management studies.

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LIMITATIONS

The primary limitation is the difference in measurement units between cities (kilowatts in Marrakech and amperes in other cities), which may require additional normalization for comparative analysis.

ETHICS STATEMENT

The authors confirm that the current work does not involve human subjects, animal experiments, or any data collected from social media platforms. The authors have read and follow the ethical requirements for publication in Data in Brief.

CRediT AUTHOR STATEMENT

Mouad Bensalah: Conceptualization, Data curation, Writing - Original draft. Abdellatif Hair: Methodology, Supervision, Validation. Reda Rabie: Research, Data review, Validation, Visualization. Hatim Derrouz: Data review, Validation, reviewing.

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DECLARATION OF COMPETING INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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