Electricity Consumption Analysis Across 3 Zones in Morocco

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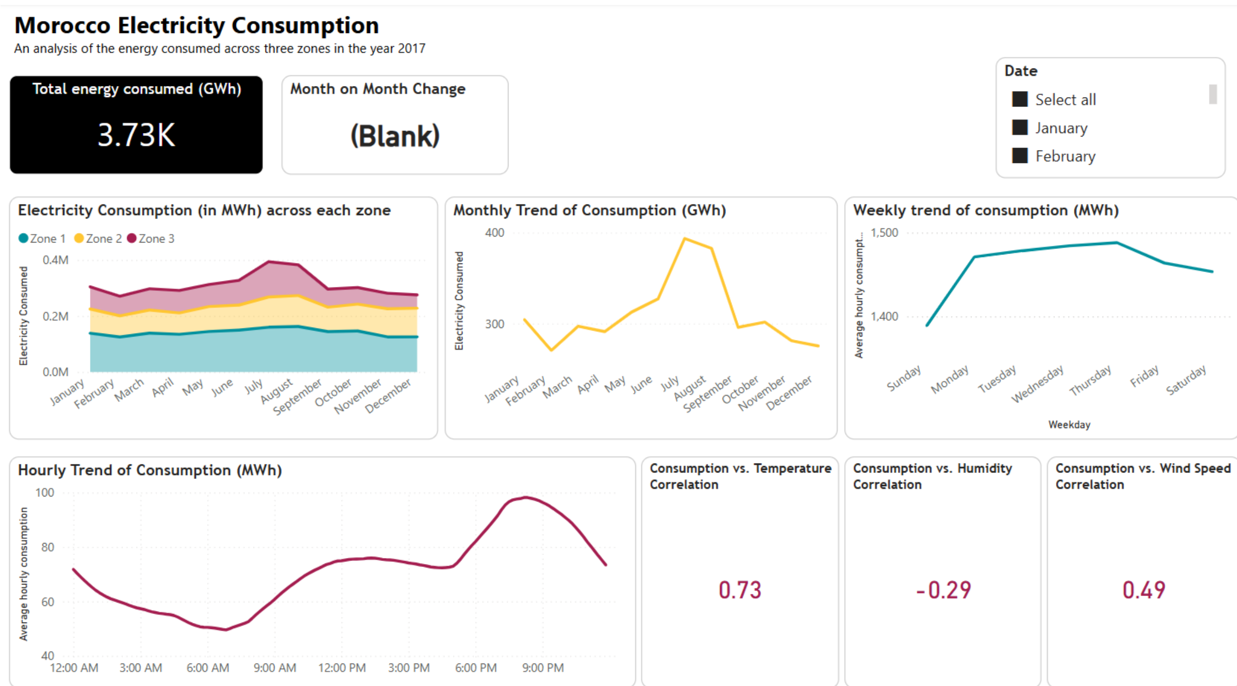
Abstract

This analysis investigates electricity consumption patterns across various temporal granularities (weekly and hourly) and spatial zones, alongside correlations with key meteorological factors. The study reveals distinct consumption trends: weekly data indicate a sharp increase from Sunday to Monday, stabilising mid-week before declining towards the weekend. Hourly consumption demonstrates a consistent daily cycle with a low point around 6:00 AM, a subsequent rise through the morning, and a prominent peak between 8:00 PM and 9:00 PM. Zonal analysis highlights significant variations, with Zone 3 exhibiting the most volatile consumption, characterised by a pronounced summer peak, while Zones 1 and 2 show lower and more stable patterns. Correlation analysis with weather variables identifies a strong positive relationship with temperature (0.73), a moderate positive correlation with wind speed (0.49), and a weak negative correlation with humidity (-0.29). These findings underscore the critical role of temperature in driving consumption and emphasise the necessity for tailored strategies for different zones and periods. The insights gained are crucial for enhancing electricity demand forecasting, optimising grid operations, and developing targeted demand-side management programs to ensure an efficient and reliable energy supply.


Morocco Electricity Consumption
An analysis of the energy consumed across three zones in the year 2017
Total energy consumed (GWh)
3.73K
Month on Month Change
(Blank)
Date
Select all
January
February
Electricity Consumption (in MWh) across each zone
Zone 1
Zone 2
Zone 3
0.4M
0.2M
0.0M
Electricity Consumed
January February March April May June July August September October November December
Monthly Trend of Consumption (GWh)
400
300
Electricity Consumed
January February March April May June July August September October November December
Weekly trend of consumption (MWh)
1,500
1,400
Sunday Monday Tuesday Wednesday Thursday Friday Saturday
Weekday
Hourly Trend of Consumption (MWh)
100
80
60
40
Average hourly consumption
12:00 AM 3:00 AM 6:00 AM 9:00 AM 12:00 PM 3:00 PM 6:00 PM 9:00 PM
Consumption vs. Temperature Correlation
0.73
Consumption vs. Humidity Correlation
-0.29
Consumption vs. Wind Speed Correlation
0.49

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Introduction

This project focuses on analysing electricity consumption patterns across three zones in Morocco using Power BI. The primary objective is to gain actionable insights into how electricity is consumed over time, how consumption varies across different regions, and how external factors such as temperature influence energy demand.

The dataset contains detailed records of electricity consumption at 10-minute intervals, along with associated weather data including temperature, humidity, wind speed, and solar radiation indicators. The analysis aims to identify peak demand periods, understand hourly and daily consumption trends, and explore the correlation between consumption and environmental conditions.

The insights derived from this analysis are intended to support better load balancing strategies, inform energy efficiency initiatives, and contribute to more effective energy management decisions. The use of Power BI enables dynamic visual exploration, allowing stakeholders to interactively examine trends and patterns that can guide operational planning and policy formulation.

The main objective of this analysis is to provide answers to the following questions:

1. What seasonal patterns occur in electricity consumption at the hourly, weekly, and annual levels?

2. Are temperature, wind speed, and humidity correlated with electricity consumption? Which has the strongest relationship?

3. Do different zones exhibit different patterns in electricity consumption?

These questions will require us to determine the total energy consumed across the three zones throughout the year 2017—also, the breakdown of consumption for each zone.

Data source

The dataset used in this analysis contains detailed records of electricity consumption and related environmental conditions across three zones in Morocco. The data was collected at **10-minute intervals**, providing high-resolution insights into energy usage patterns over time. The dataset was collected from the Maven Analytics website.

Each record represents the state of electricity consumption and weather variables at a specific point in time, enabling the study of both temporal trends and external factors influencing consumption.

Field	Description
Datetime	The timestamp indicating the date and exact time (at 10-minute intervals) of the record.
PowerConsumption_zone1	Electricity consumed in Zone 1 (kWh)
PowerConsumption_zone2	Electricity consumed in Zone 2 (kWh)
PowerConsumption_zone3	Electricity consumed in Zone 3 (kWh)
Temperature	Ambient temperature in degrees Celsius (°C)
Humidity	Relative humidity in percentage (%)
WindSpeed	Wind speed measured in kilometres per hour
GeneralDiffuseFlows	The measurement of how much emissions gases diffuse into the broader atmosphere
DiffuseFlows	The measurement of how much emission gases diffuse into the local atmosphere

Methodology

In carrying out the analysis, Power Query and PowerBI were used exclusively. The .csv file was imported into PowerBI, then transformed and analysed. The steps followed during the analysis process are listed below.

1. The datetime column was separated into separate columns, date, and time, to each contain the date and time data in that order.

2. Renamed Columns for better readability.

3. Set the proper data type for each column.

4. Created a new column, weekday, to include the day of the week each data was collected e.g. Monday, Tuesday etc. Another column was created labeled 'weekday num', which stores the numeric value of each day of the week, i.e. 1 for Sunday, 2 for Monday. This was used in sorting the Weekday column.

5. Data analysis expressions (DAX) was written to create some calculated measures needed for analysis. Measures created are:

- Average hourly consumption – to determine the trend of consumption hourly

- Average weekly consumption - to determine the trend of consumption weekly

- mom % growth – to determine the growth or decline rate of consumption across months

- total consumption – to determine the total usage. It can be segmented across months, days etc.

- Correlation factor – 3 different correlation factors were calculated for the 3 different external variables, to determine their relationship with the electricity consumed.

Analysis and Results

This phase of the report presents the results of the analysis process. Analysis reveals that a total of 3.73 thousand GWh was consumed across the 3 zones for the year 2017. The results are presented in a manner to answer the objective questions.

1. What seasonal patterns occur in consumption?

At the annual level, figure 1 gives a description of the trend.

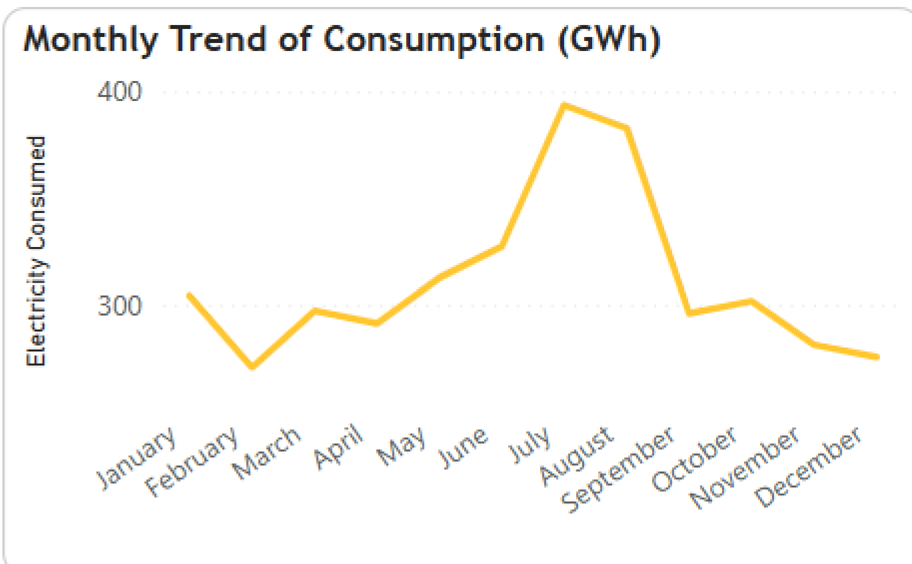

Figure 1: Monthly trend of consumption

There is a noticeable drop in consumption from January to February. Consumption steadily increases month-by-month from February to July, with the sharpest rise occurring between June and July, where it reaches the peak. After peaking in July, consumption decreases sharply through August and September. Afterwards, consumption stabilises at a lower level, with a slight decline as the year ends. The data shows a **mid-year peak** (July) in electricity consumption, possibly driven by seasonal factors such as high temperatures (e.g., cooling loads during summer).

Figure 2 presents the trend at the weekly level.

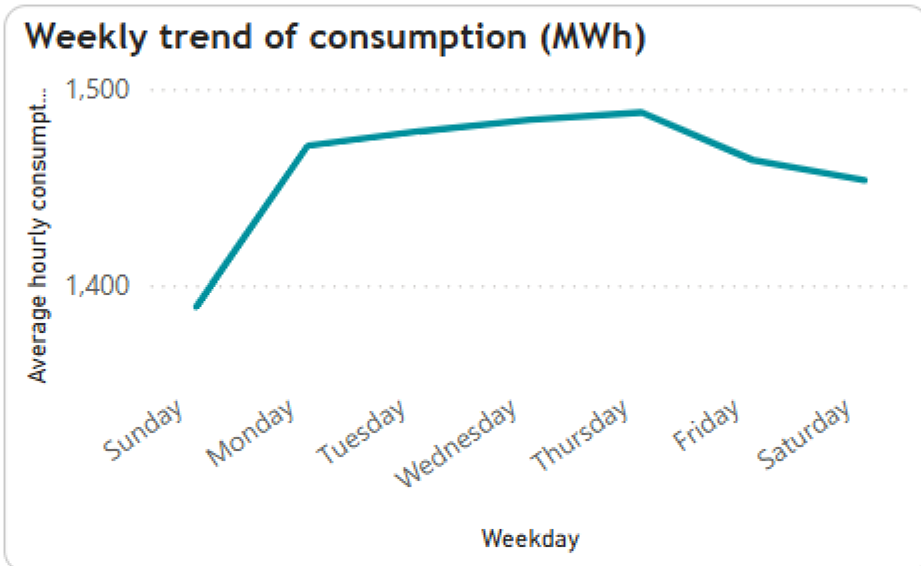

Figure 2: Weekly trend of consumption

Consumption starts at its lowest point on Sunday, just under 1,400 MWh, and then experiences a significant jump to reach a peak on Monday, rising to just over 1,470 MWh. After the sharp rise on Monday, consumption continues to increase, but at a much slower, more gradual rate, reaching its highest on Thursday. It then begins to decline steadily through Friday and Saturday.

In summary, the consumption trend shows a strong start to the week with a large increase from Sunday to Monday, followed by a period of relatively high and stable consumption mid-week (Monday to Thursday), and then a decline towards the weekend.

Hourly consumption:

Figure 3 clearly describes the hourly consumption trend. Consumption starts high, around 72 units at midnight and then steadily decreases, reaching its lowest point of approximately 50 units at 6:50 AM. This suggests a period of minimal activity or demand during the very early hours of the morning.

After hitting its lowest point, consumption begins to rise sharply from 6:50 AM, indicating the start of daily activities. It continues to increase, peaking around 76 units by 1:00 PM.

Following the midday peak, there's a slight dip in consumption between 1:00 PM and approximately 4:00 PM, where it drops to around 72 units. After this dip, consumption starts to rise again as the late afternoon progresses towards evening.

Consumption experiences a significant surge in the evening, starting from around 6:00 PM and reaching its highest peak for the day, just shy of 100 units, between 8:00 PM and 9:00 PM. This likely corresponds to peak evening activities when many people are home.

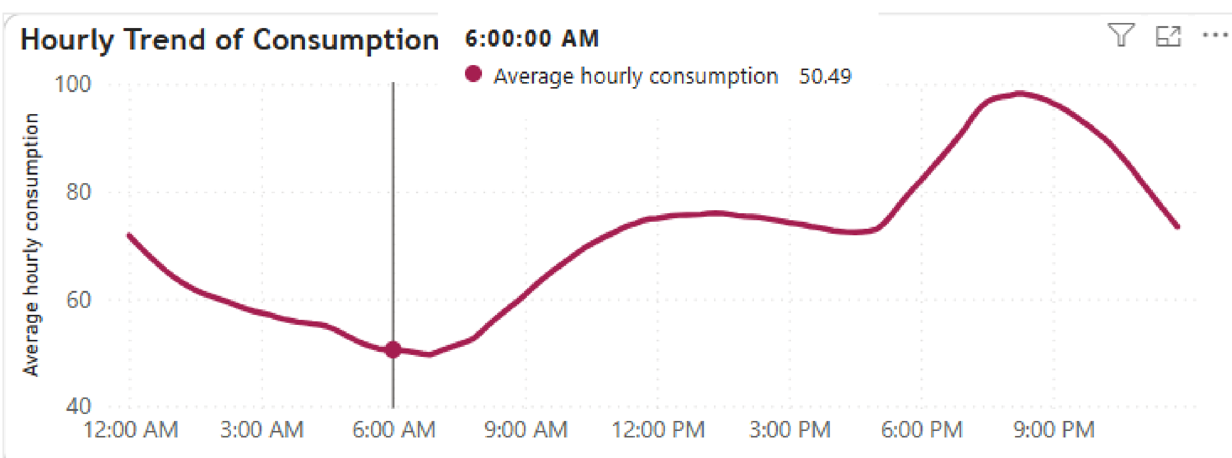

Figure 3: Hourly trend of consumption

2. Variables affecting electricity consumption

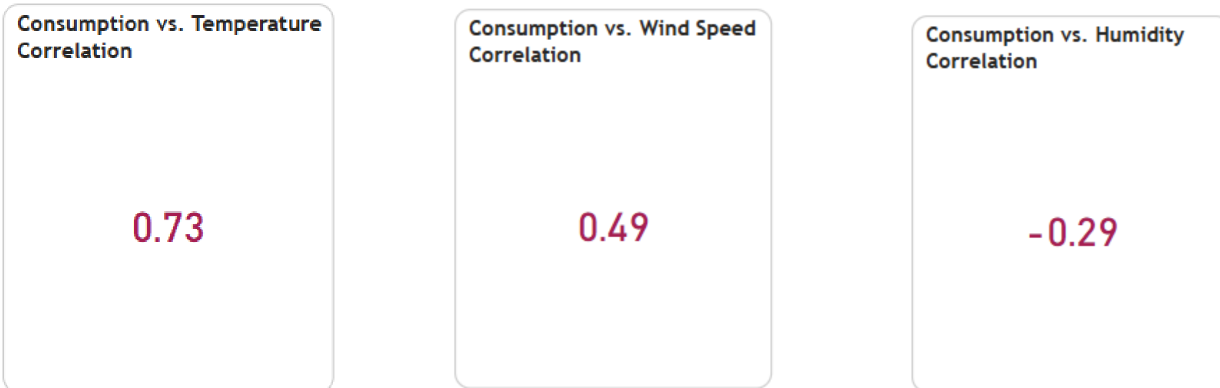

Figure 4: Correlation factors of different variables

Consumption vs. Temperature Correlation: 0.73

- This indicates a **strong overall positive correlation** between consumption and temperature.
- As temperature increases, consumption tends to increase significantly. This is a common pattern, especially in areas where cooling systems (like air conditioning) are used more heavily during hotter weather, leading to higher energy consumption.

Consumption vs. Humidity Correlation: -0.29

- This indicates a **weak negative correlation** between consumption and humidity.
- As humidity increases, consumption tends to slightly decrease, or vice versa. The correlation is weak, meaning humidity is not a major factor in driving consumption changes, but there's a slight inverse relationship. For instance, very high humidity might make a given temperature feel hotter, potentially increasing AC use (as seen when the visual was filtered to show only summer).

Consumption vs. Wind Speed Correlation: 0.49

- This indicates a **moderate positive correlation** between consumption and wind speed.
- As wind speed increases, consumption tends to increase moderately. This might seem counterintuitive at first glance, as wind can have a cooling effect.

Hence, temperature has the strongest relationship with electricity consumption.

3. Do different zones exhibit different patterns in electricity consumption?

While all zones show a tendency for increased consumption during the mid-year months, the **magnitude and distinctness of this peak vary greatly**. Zone 3 is the primary driver of the overall seasonal consumption pattern due to its high and highly variable consumption, especially in summer. Zones 1 and 2, while showing some seasonal variation, maintain much more stable consumption levels throughout the year, with Zone 1 being the most consistent.

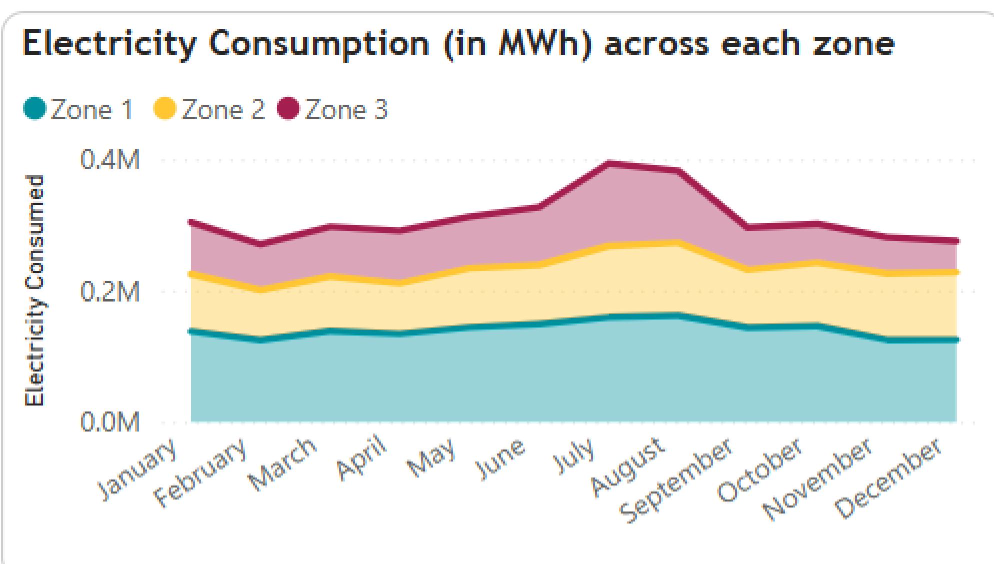

Figure 5: Consumption variation across zones

Recommendations

The following recommendations were made based on insights from the data:

1. Given the strong positive correlation (0.73) between consumption and temperature, prioritise temperature forecasts in electricity demand prediction models.

2. Use the hourly trend data to optimize generation, transmission, and distribution operations.

3. Schedule maintenance activities for early morning hours (e.g., 3:00 AM - 6:00 AM) when average hourly consumption is at its lowest.

Appendix

This contains the DAX used in calculating some measures.

1. Average hourly consumption = AVERAGEX(VALUES(powerconsumption[Hour]), SUMX(powerconsumption, (powerconsumption[Electricity consumed (Zone 1)]+powerconsumption[Electricity consumed (Zone 2)]+powerconsumption[Electricity consumed (Zone 3)])/365000))

2. Average weekly consumption = AVERAGEX(VALUES(powerconsumption[Hour]), SUMX(powerconsumption, (powerconsumption[Electricity consumed (Zone 1)]+powerconsumption[Electricity consumed (Zone 2)]+powerconsumption[Electricity consumed (Zone 3)])/52))

3. MoM % Growth =

```
VAR Current_Month =
   CALCULATE(
      SUM(powerconsumption[Electricity consumed (Zone 1)]) +
      SUM(powerconsumption[Electricity consumed (Zone 2)]) +
      SUM(powerconsumption[Electricity consumed (Zone 3)])
   )


VAR Previous_Month =
   CALCULATE(
```

```
    SUM(powerconsumption[Electricity consumed (Zone 1)]) +
    SUM(powerconsumption[Electricity consumed (Zone 2)]) +
    SUM(powerconsumption[Electricity consumed (Zone 3)]),
    PREVIOUSMONTH(powerconsumption[Date].[Date])
  )

RETURN
DIVIDE(Current_Month - Previous_Month, Previous_Month)
```