Project 1: Weather and Electricity Consumption

Group C: Benjamin, David, Ezra

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Background

Parliament Q&A | 03 JUL 2023

Written reply to to PQs on electricity demand and grid stress from prolonged heat wave

Questions

Ms Cheryl Chan Wei Ling: To ask the Minister for Trade and Industry with the impending prolonged and intense heat (a) whether demand for cooling needs will overwhelm the power grid; and (b) whether there is a likelihood of this competing demand slowing down the deployment of electric vehicle charging infrastructures across Singapore.

Dr Lim Wee Kiak: To ask the Minister for Trade and Industry (a) whether there has been a significant increase in electricity consumption since the onset of record high temperatures in Singapore; (b) what measures are in place to monitor and assess electricity demand and grid stress; and (c) what contingency plans are in place to address potential challenges in meeting the increased electricity demand during heat waves or prolonged periods of high temperatures and under what circumstances will they be activated.

Mr Murali Pillai: To ask the Minister for Trade and Industry (a) whether the recent heatwave in Singapore has contributed to a spike in electrical consumption in both residential and commercial premises; (b) if so, what is the net increase in usage in terms of percentage and cost; and (c) what steps will be taken to ensure that Singapore's power grid will continue to have capacity to deal with the expected higher demand owing to climatic conditions in the future.

Written Answer by Minister for Trade and Industry Mr Gan Kim Yong

Secondary research concludes:

1. < *20°C*, electricity demand has a **negative** relationship with temperature
2. > *20°C*, elec demand has a **positive** relationship with temperature
3. In richer countries, electricity demand is **more elastic** with temperature

Thus: In Singapore, we can expect that **an increase in temperature will lead to strong increase in electrical demand.**

Problem Statement

Can we accurately **predict the level of electricity consumption** (and thus, plan for electricity generation) **based on climate-related data**?

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1

An enquiry was triggered for our team (in EMA) to do a **exploratory analysis** to gain **insights on Singapore's weather patterns** and its **relation to electricity consumption**. The findings to be presented are targeted at other teams and managers at EMA involved in the **planning of power generation,** and aim to better inform their understanding and hence **aid their decision making in their planning process**.

2

Electricity generation in Singapore is carried out to **fully meet the expected demand** and ensure a **stable supply without any disruptions like brown-outs and black-outs.** This is especially **vital to companies in industries** like **semi-conductors and chemicals manufacturing.**
(ie. Energy generation cannot be too little)

3

With **energy prices increasing** and experiencing unexpected swings, it is imperative that **electricity generation is not carried out in major excess of demand,** which leads to **wastage and higher costs**.
(ie. Energy generation cannot be too much)

4

We will use electricity consumption rates of the residential sector - residential sector is not the largest consumers of electricity but it represents a very **substantial sector** with similar growth patterns to the overall electricity consumption rates.



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Datasets Used

Weather-related datasets from data.gov.sg:

Monthly Total Rainfall	Measure of monthly total rainfall from 1982 to 2023
Monthly Number of Rain Days	Measure of number of rainy days from 1982 to 2023
Monthly Mean Surface Air Temperature	Measure of monthly mean surface air temperature from 1982 to 2023
Monthly Mean Sunshine Duration	Measure of mean sunshine hours 1982 to 2023
Monthly Mean Relative Humidity	Measure of monthly mean relative humidity from 1982 to 2023

From Singapore Energy Statistics by the Energy Market Authority in Singapore :

Mean Monthly Household Electricity Consumption	Measure of monthly household electricity consumption in kWh from 2005 to 2022

Procedure / Methodology

Household Electricity Consumption

Monthly data from **2005 to 2022**

Surface Air Temperature

Monthly data from **1982 to 2023**

Total Rainfall

Monthly data from **1982 to 2023**

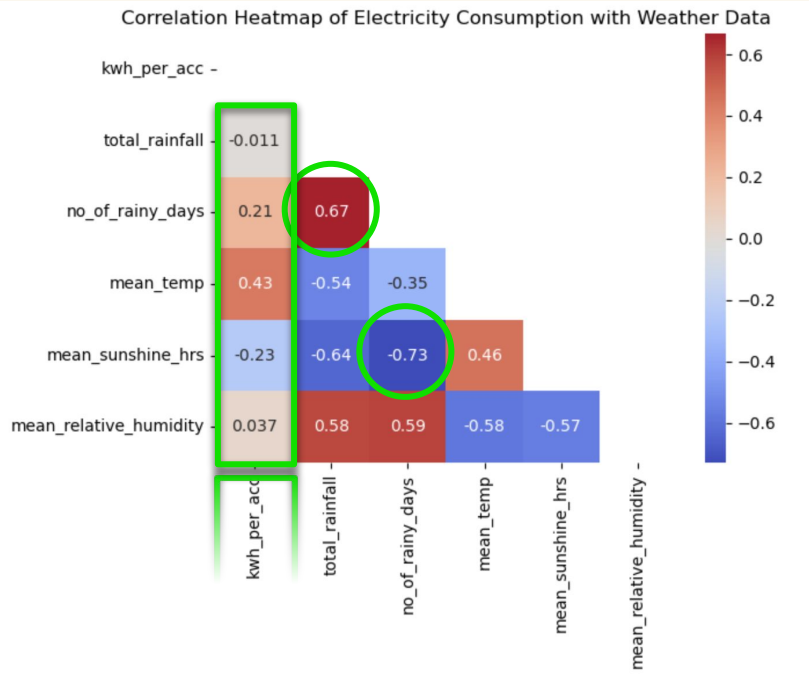
Other Climate Datasets

Monthly data from **1982 to 2023**

Combined Data

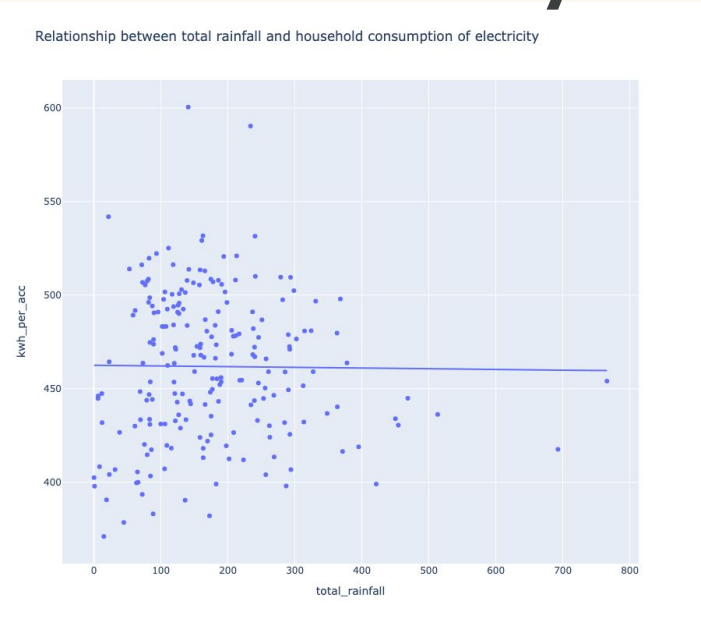
Correlation heatmap

- Highest positive correlation between rainy days and total rainfall.
- Highest negative correlation between rainy days and sunshine hours
- **Weather** & **electricity** consumption correlation **lower correlation**



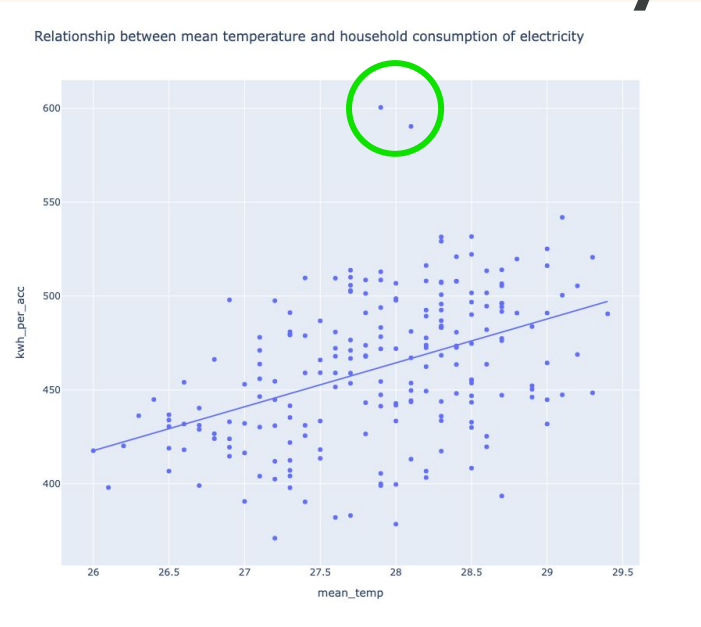
Relationship between total rainfall and household consumption of electricity

- **Lowest correlation** between electricity consumption and any of the weather variables
- **Clustered**
  - Lower total rainfall
  - Average electricity consumption
- **Large extremes** in rainfall and electricity usage



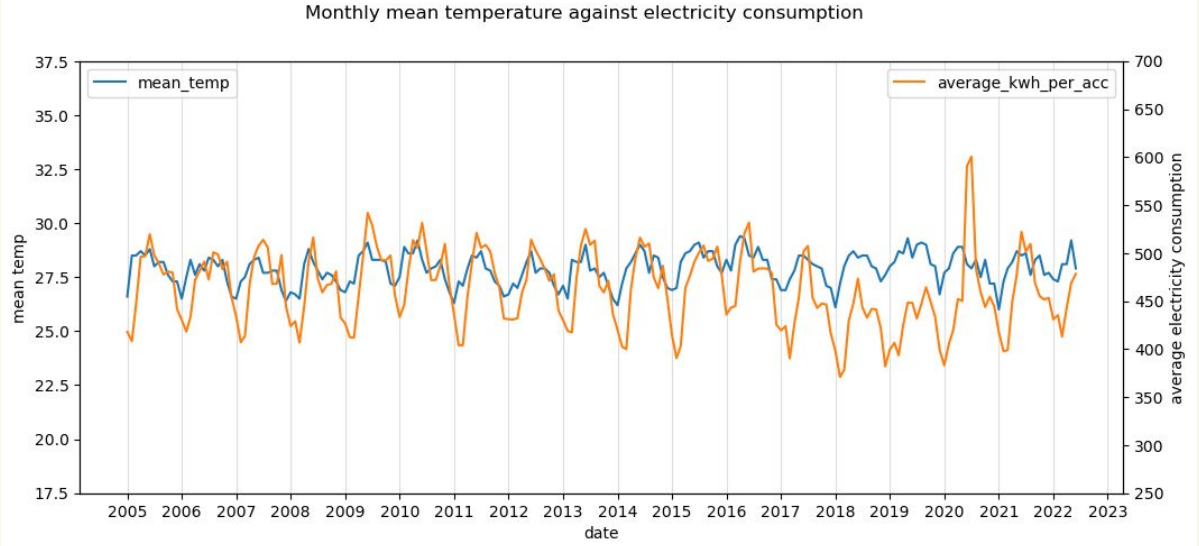
Relationship between mean temperature and household consumption of electricity

- **Highest correlation** between electricity consumption and any of the weather variables
- Some indications of positive linearity
  - Narrower range
- **Some extremes** in electricity consumption



Monthly mean temperature against electricity consumption over time

- **Strong seasonal association**
  - Low year ends
  - High mid years
- Consistent from 2005 - 2017
- Some drift from 2018
- The 2 extremes previously linked to ‘Circuit Breaker’



Conclusions

- Close link between household electricity consumption and mean daily temperature, but not rainfall

- Seasonal pattern, high during mid year, low during year end

Recommendations

- Obtain more granular data at weekly or daily level, with geographic distribution
- Identify key activities driving household electricity consumption
- Develop models to predict consumption patterns

Thank you!