



ROAD TO CLEAN AND RENEW: SOUTHEAST ASIA'S PATH TOWARD SUSTAINABLE ENERGY

SD23039 CHUA EN HUAN

02G

SD23063 MUHAMMAD DANIAL BIN ISSHAM

02G

SD23048 YIP YOONG ENG

02G

SD23023 TION JIA LE

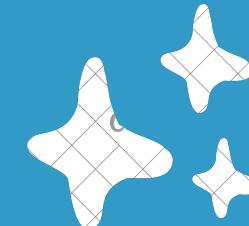
02G

SD23042 SOH HONG YANG

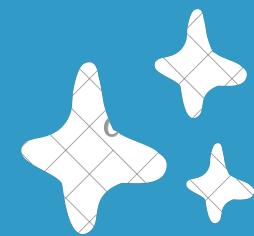
01G



PROJECT DESCRIPTION

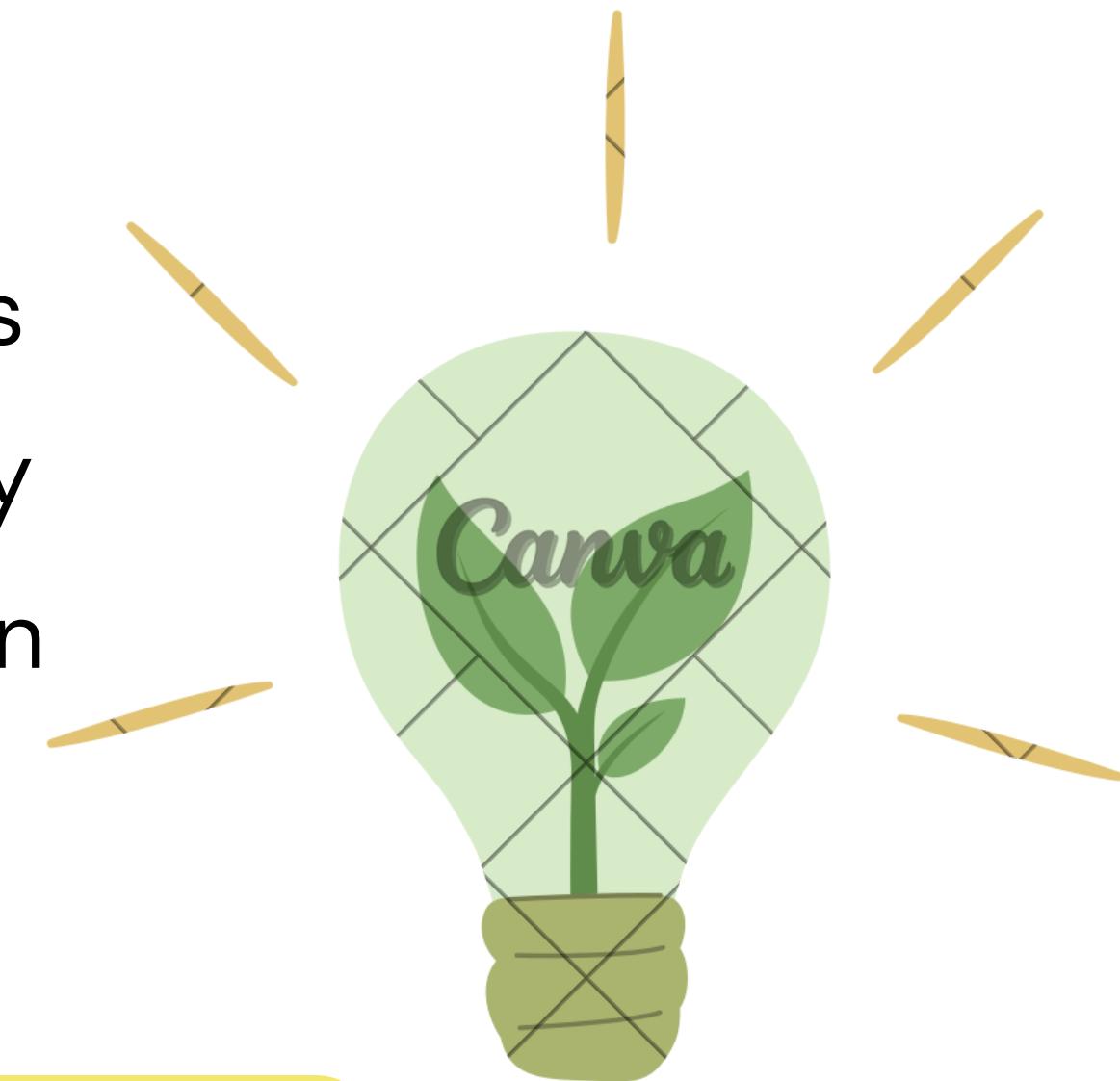


- Renewable energy considered as future major energy source.
- It is used by humans as early as 200 BC.
- ASEAN aims to increase renewable energy proportion to 23%.
- Malaysia target to increase to 31%.



PROBLEM STATEMENT

- ASEAN countries still heavily relies on fossil fuels
- Challenging to do transition to renewable energy
- Linkage between renewable energy adoption and reduction in CO₂ emissions is unclear



PROJECT QUESTIONS & OBJECTIVES

How does access to electricity and clean fuels vary among Southeast Asian countries over time?

To analyze the trends of access to electricity and clean fuels among Southeast Asian countries over time.

What is the relationship between renewable energy development and CO2 emissions in Southeast Asia?

To investigate the relationship between renewable energy development and CO2 emissions in Southeast Asia.

How do economic factors such as GDP per capita relate to renewable energy use and energy intensity in Southeast Asia?

To explore how economic factors like GDP per capita relate to renewable energy usage and energy intensity in Southeast Asia.

BASIC DESCRIPTION OF DATA

Attributes	Type	Description
Entity	Qualitative	country
Year	Quantitative	year where data is collected from 2000-2020
Access to electricity (% of population)	Quantitative	percentage of population in each country with access to electricity
Access to clean fuels for cooking (% of population)	Quantitative	percentage of population in each country with primary reliance of clean fuels on cooking
Renewable-electricity-generating-capacity-per-capita	Quantitative	amount of electricity generated by renewable energy per capita
Financial flows to developing countries (US \$)	Quantitative	amount of financial aid from developed countries for clean energy project
Renewable energy share in total final energy consumption (%)	Quantitative	percentage of renewable energy used in final energy consumption
Electricity from fossil fuels (TWh)	Quantitative	electricity generated from fossil fuels
Electricity from nuclear (TWh)	Quantitative	electricity generated from nuclear energy
Electricity from renewables (TWh)	Quantitative	electricity generated from renewable energy
Low-carbon electricity (% electricity)	Quantitative	percentage of electricity from nuclear energy and renewable energy
Primary energy consumption per capita (kWh/person)	Quantitative	energy consumed in kilowatt hours for each person
Energy intensity level of primary energy (MJ/\$2017 PPP GDP)	Quantitative	energy used per unit of GDP at purchasing power parity
Value_co2_emission (metric tons per capita)	Quantitative	carbon dioxide emission for each person
Renewables (% equivalent primary energy)	Quantitative	share of renewable sources in the total equivalent primary energy supply
GDP growth (annual %)	Quantitative	annual GDP growth rate based on local currency
GDP per capita	Quantitative	gross domestic product per person
Density (P/Km2)	Quantitative	population density in person per square kilometers
Land area (Km2)	Quantitative	total land area in square kilometers
Latitude	Quantitative	location of the country on the world map
Longitude	Quantitative	



PACKAGES REQUIRED

seaborn

Used to create interactive and informative plots

bokeh.plotting

create new plot by “figure”

matplotlib.pyplot

To build useful charts like bar charts, scatterplots, and line charts

bokeh.io

Ensure that the interactive Bokeh plots appear directly within a Colab notebook

google.colab.files

Upload CSV.

Pandas

Read datasets in CSV, clean data, merge datasets, filter rows, and summarize data

plotly.express

Quickly generate interactive charts such as scatter plots, bar charts and choropleth

plotly.graph_objects

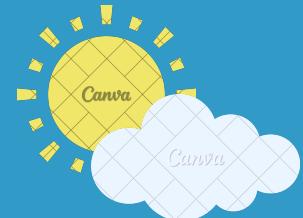
Define and combine multiple chart element and control “Year” widget.

bokeh.models

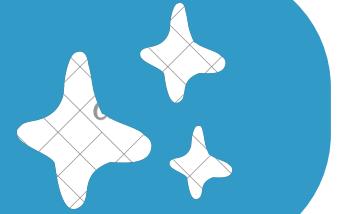
“ColumnDataSource” is used to act as the linkage between dataset and Bokeh’s visual elements .“HoverTool” helps on tooltip feature

bokeh.palettes

To provide uniform colour code to differentiate the data groups in a plot.



DATA IMPORT



1

Download dataset from Kaggle

2

Import data into Google Colab

```
import pandas as pd  
  
# Uploading excel data  
from google.colab import files  
uploaded=files.upload()
```

Choose Files global-data...-energy.csv

- **global-data-on-sustainable-energy.csv**(text/csv) - 513817 bytes, last modified: 5/27/2025 - 100% done
Saving global-data-on-sustainable-energy.csv to global-data-on-sustainable-energy.csv

```
# Making data frame from csv file  
data = pd.read_csv("global-data-on-sustainable-energy.csv")
```

Global Data on Sustainable Energy (2000-2020)

Data Card Code (51) Discussion (6) Suggestions (0)

global-data-on-sustainable-energy (1).csv (513.82 kB)

Detail Compact Column

About this file

Explore Global energy consumption patterns and indicators from all nations in this comprehensive dataset. Feel free to download and make notebooks.

Entity	Year	Access to electricity	Access to clean fuels for cooking	Renewable-electricity	Financial resources received for energy in
Name of the country	The year for which the data is reported, ranging from 2000 to 2020	% of population with access to electricity	% of population with access to clean fuels for cooking	Generating capacity of Renewable electricity (watts per capita)	International financial resources received for energy in
176 unique values	2000 2020	1.25 100	0 100	0 3.06k	0
Afghanistan	2000	1.613591	6.2	9.22	20000
Afghanistan	2001	4.074574	7.2	8.86	130000

Data Explorer

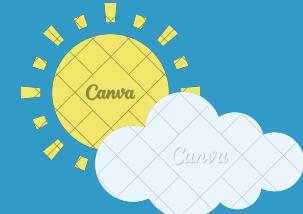
Version 7 (513.82 kB)

global-data-on-sustainable-e

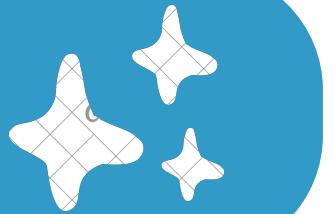
Summary

1 file

21 columns



DATA CLEANING



1

- Check **unique values** in Entity and Year columns to identify **noisy** or **inconsistent** data
→ All country names and years are correctly spelled and consistently formatted

2

- Filter **Southeast Asian** countries
→ Narrowed down dataset to 7 SEA countries for focused analysis

3

- Rename columns** for better readability
→ Removed unwanted characters

4

- Handle **incorrect data types**
→ Converted Population density column from string to numeric format

5

- Handle **missing values**
→ Removed Year 2020
→ Excluded unimportant columns
→ Replaced missing values in Electricity from nuclear with 0
→ Created a new dataset for analysis involving Renewables (% equivalent primary energy),
→ only 5 countries included due to missing data in Cambodia and Myanmar

6

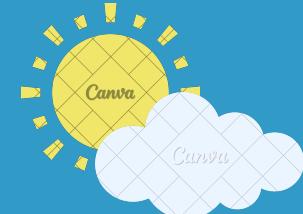
- Check for **duplicates**
→ No duplicate rows were found

7

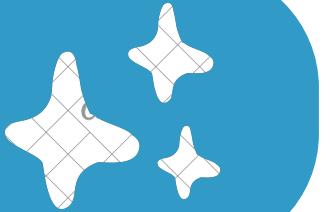
- Check for **outliers** using boxplots
→ Detected outliers but kept them to represent valid data variations

8

- Standardize inconsistent** data
→ Rounded numeric values to 2 decimal places



DATA PREVIEW



- 1 Preview of first 10 rows
- 2 Check the dimensions of the dataset
- 3 Preview dataset structure and data types
- 4 Preview of unique values in each column
- 5 Preview of descriptive statistics

Functions used:

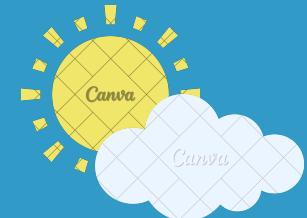
`head()`, `shape`, `info()`, `unique()`, `describe()`

Purpose:

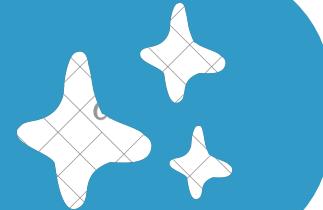
- Validate structure and content
- Confirm successful cleaning

Outcome:

- **`sea_data`**: 140 rows, 19 columns
- **`sea_data_renewables`**: 100 rows, 20 columns
- No missing values
- All columns correctly structured and typed



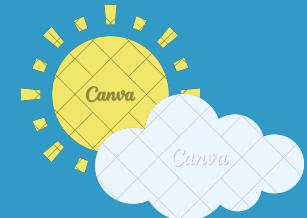
DATA DESCRIPTION



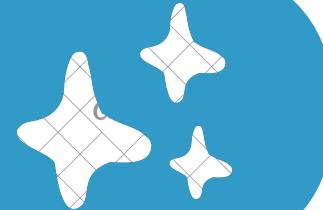
sea_data

Attributes	Type	Description
Year	Quantitative	Year from 2000 to 2019
Access to electricity (% of population)	Quantitative	Percentage of population having access to electricity
Access to clean fuels for cooking (% of population)	Quantitative	Percentage of population having access to clean fuels for cooking
Installed renewable electricity capacity per capita (kW)	Quantitative	Installed Renewable energy capacity per person
Renewable energy share in total final energy consumption (%)	Quantitative	Percentage of renewable energy in final energy consumption
Electricity from fossil fuels (TWh)	Quantitative	Electricity generated from fossil fuels (coal, oil, gas) in terawatt-hours
Electricity from nuclear (TWh)	Quantitative	Electricity generated from nuclear power in terawatt-hours
Electricity from renewables (TWh)	Quantitative	Electricity generated from renewable sources (hydro, solar, wind, etc.) in terawatt-hours
Low-carbon electricity (% of electricity)	Quantitative	Percentage of electricity from low-carbon sources (nuclear and renewables)
Primary energy consumption per capita (kWh)	Quantitative	Energy consumption per person in kilowatt-hours
Energy intensity level of primary energy (MJ/\$2017 PPP GDP)	Quantitative	Energy use per unit of GDP at purchasing power parity
CO2 emissions per capita (metric tons)	Quantitative	Carbon dioxide emissions per person in metric tons
GDP growth rate (annual %)	Quantitative	Annual GDP growth rate based on constant local currency
GDP per capita	Quantitative	Gross domestic products per person.
Population density (people per km2)	Quantitative	Population density in persons per square kilometer
Land area (km2)	Quantitative	Total land area in square kilometers
Latitude	Quantitative	Latitude of country
Longitude	Quantitative	Longitude of country
Country	Qualitative	Name of countries in Southeast Asia (Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, and Thailand)

- Columns are filtered for ASEAN countries only
- Renewables (% equivalent primary energy) and Financial flows to developing countries (US \$) are removed due to high percentage of null values.
- Null values for “Electricity from Nuclear” are replaced by 0



DATA DESCRIPTION

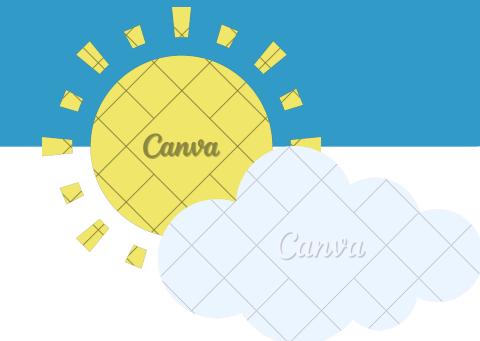


sea_data_renewables

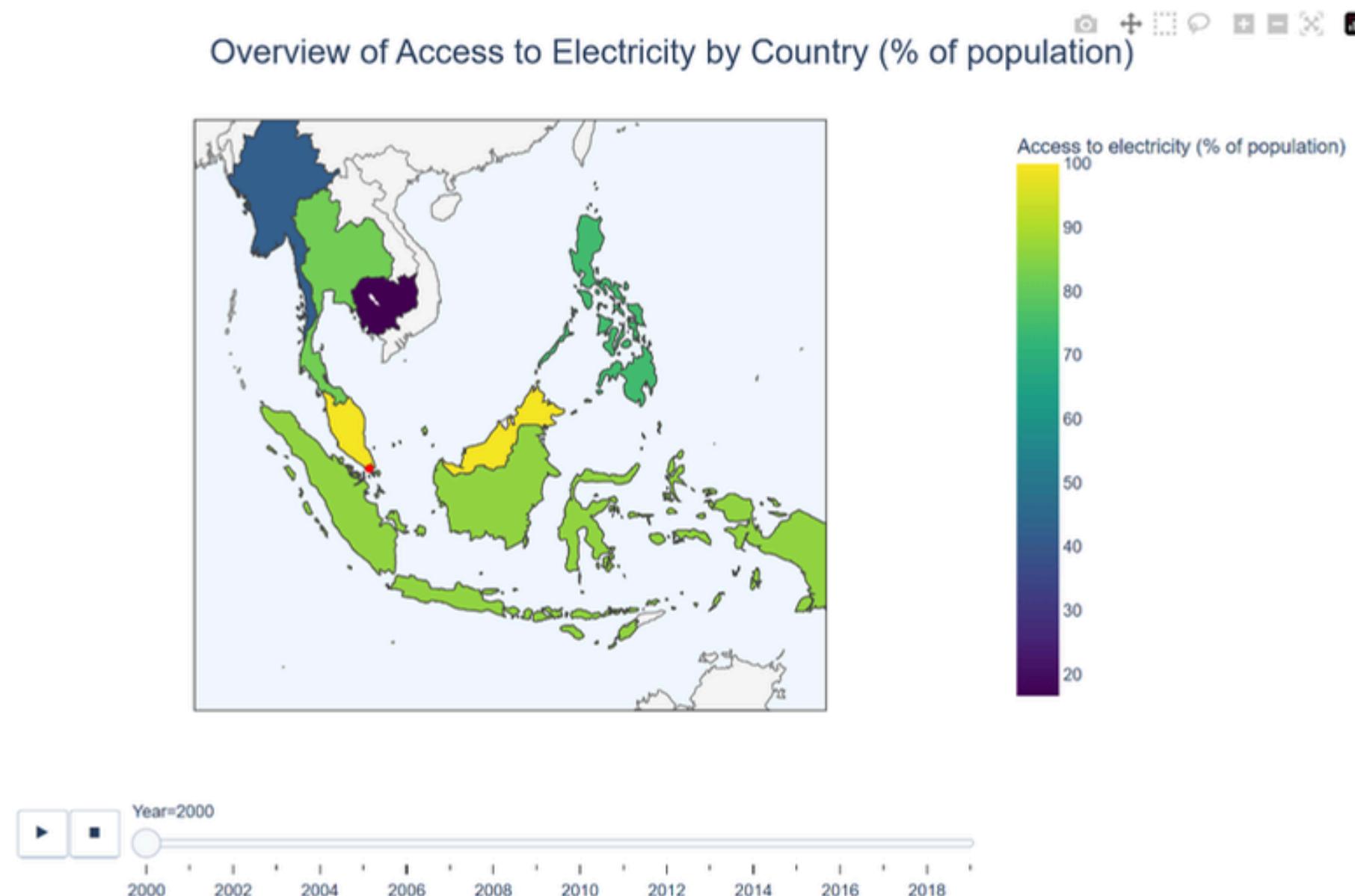
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Access to electricity (% of population)	Quantitative	Percentage of population having access to electricity
Access to clean fuels for cooking (% of population)	Quantitative	Percentage of population having access to clean fuels for cooking
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Renewable energy share in total final energy consumption (%)	Quantitative	Percentage of renewable energy in final energy consumption
Electricity from fossil fuels (TWh)	Quantitative	Electricity generated from fossil fuels (coal, oil, gas) in terawatt-hours
Electricity from nuclear (TWh)	Quantitative	Electricity generated from nuclear power in terawatt-hours
Electricity from renewables (TWh)	Quantitative	Electricity generated from renewable sources (hydro, solar, wind, etc.) in terawatt-hours
Low-carbon electricity (% of electricity)	Quantitative	Percentage of electricity from low-carbon sources (nuclear and renewables)
Primary energy consumption per capita (kWh)	Quantitative	Energy consumption per person in kilowatt-hours
Energy intensity level of primary energy (MJ/\$2017 PPP GDP)	Quantitative	Energy use per unit of GDP at purchasing power parity
CO2 emissions per capita (metric tons)	Quantitative	Carbon dioxide emissions per person in metric tons
Renewables (% equivalent primary energy)	Quantitative	Equivalent primary energy that is derived from renewable sources
GDP growth rate (annual %)	Quantitative	Annual GDP growth rate based on constant local currency
GDP per capita	Quantitative	Gross domestic products per person.
Population density (people per km2)	Quantitative	Population density in persons per square kilometer
Land area (km2)	Quantitative	Total land area in square kilometers
Latitude	Quantitative	Latitude of country
Longitude	Quantitative	Longitude of country
Country	Qualitative	Name of countries in Southeast Asia (Indonesia, Malaysia, Philippines, Singapore, and Thailand)

- Columns are filtered for ASEAN countries only
- Financial flows to developing countries (US \$) are removed due to high percentage of null values.
- Null values for “Electricity from Nuclear” are replaced by 0
- Renewables (% equivalent primary energy) are included for ASEAN countries that have data for this column

OVERVIEW OF ACCESS TO ELECTRICITY BY COUNTRY



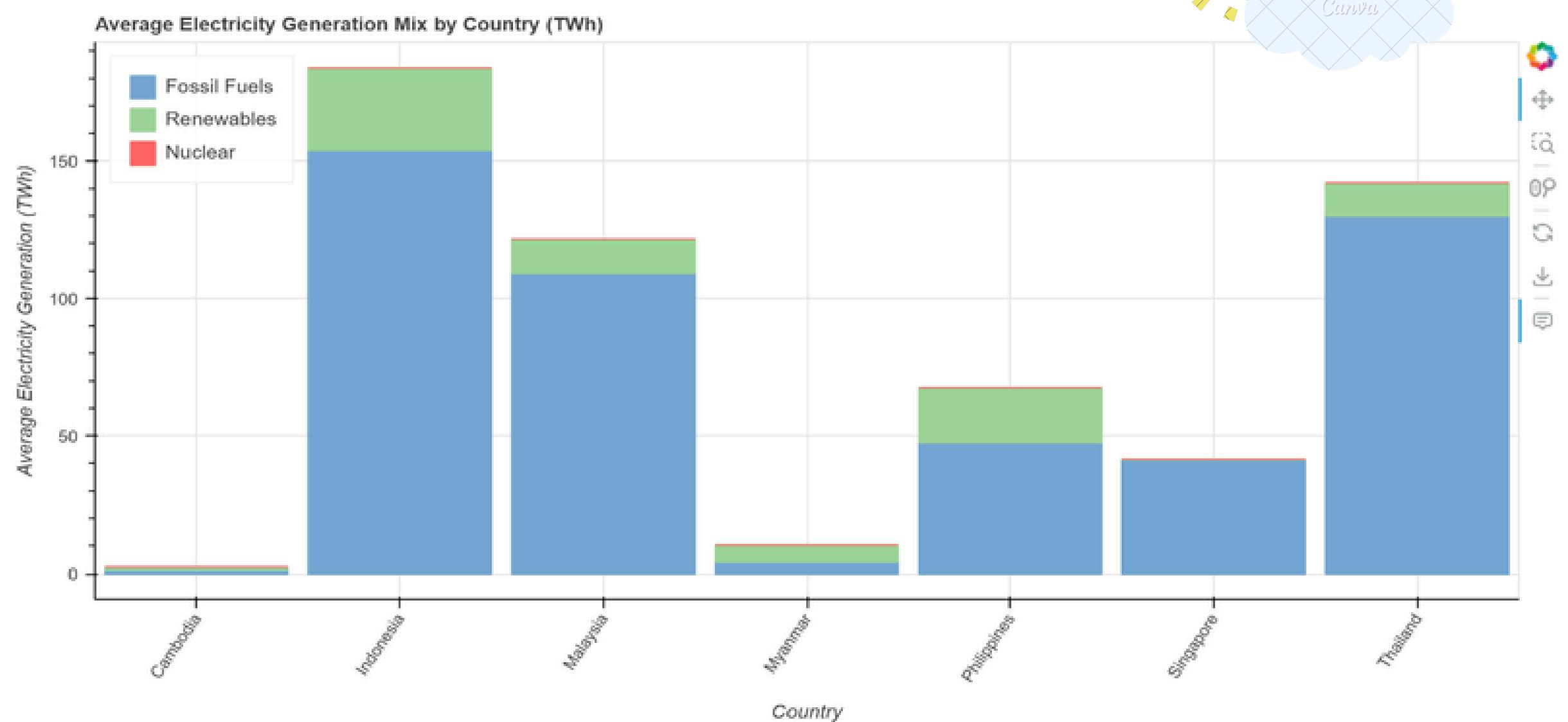
Overview of Access to Electricity by Country (% of population)



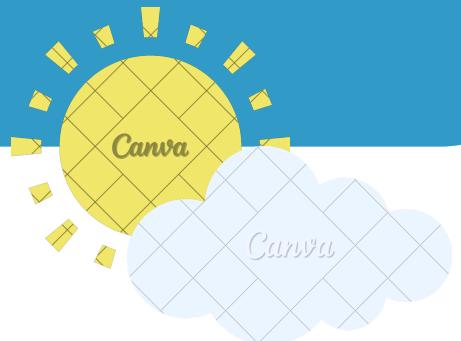
- Singapore stands out with 100 % electricity access throughout the years.
- Malaysia also appearing in the yellow zone for most of the years, which means near-complete access to electricity over time.
- Myanmar exhibit the slowest rates of progress. While access has improved over time, it is still the lowest compared to the six other countries
- Overall, the visualisation highlights the continued need for infrastructure development and energy access initiatives across the ASEAN region.

AVERAGE ELECTRICITY GENERATION MIX BY COUNTRY

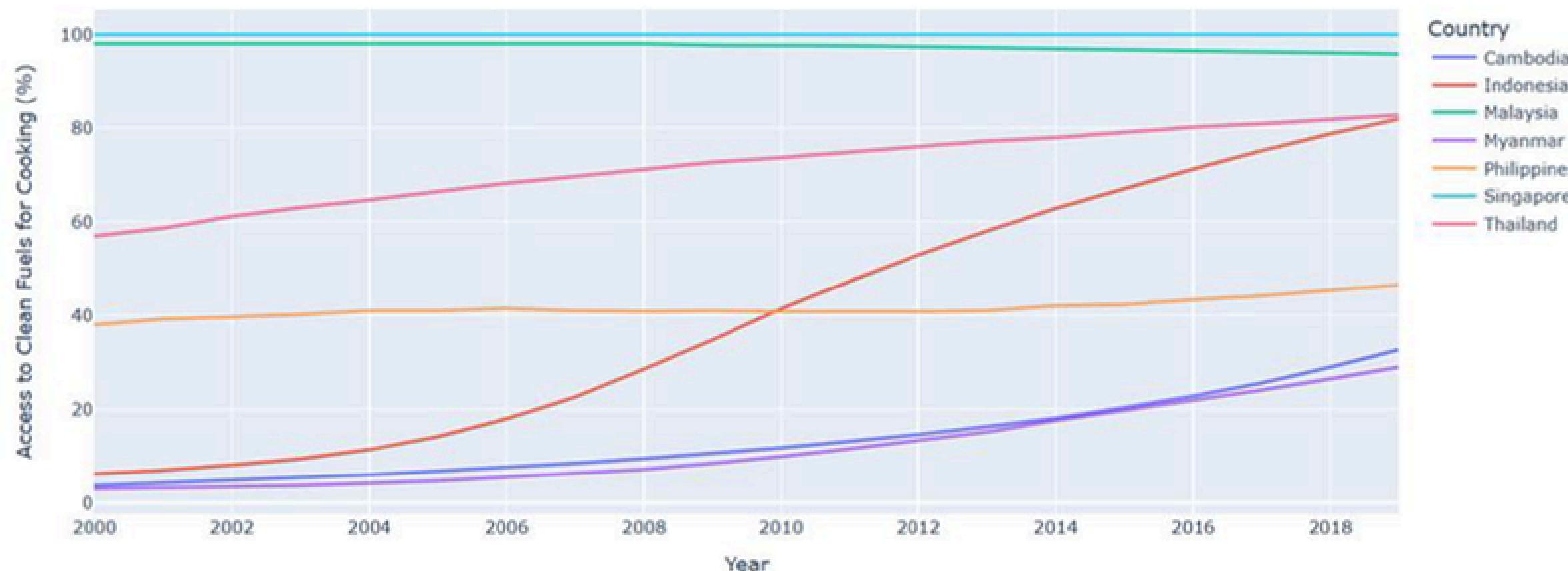
- Indonesia stands out as the largest electricity generator in the region for both fossil fuels and renewable energy
- Cambodia has the lowest electricity generation, with nearly equal reliance on fossil fuels and renewables, showing a still-developing energy sector.
- Notably, no Southeast Asian country is generating electricity from nuclear energy
- The graph shows Southeast Asia relies heavily on fossil fuels, with minimal use of renewable energy.



YEARLY TREND OF ACCESS TO CLEAN FUELS BY COUNTRY

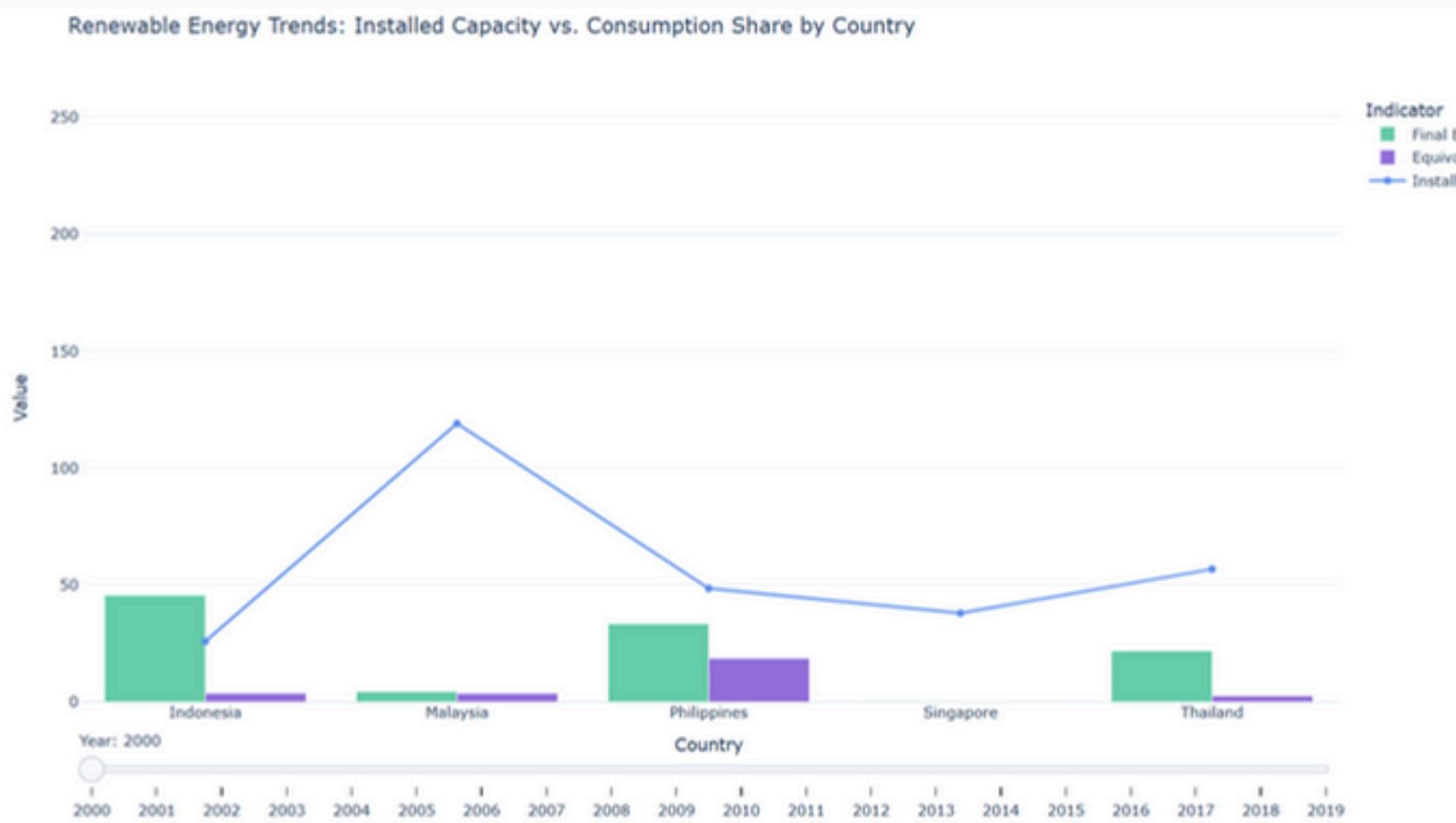


Yearly Trend of Access to Clean Fuels by Country (% of Population)



- Singapore and Malaysia has highest access to clean fuel due to uniform urban development and government subsidies
- Cambodia and Myanmar has low access, rely on biomass such as woods

RENEWABLE ENERGY TRENDS: INSTALLED CAPACITY VS. CONSUMPTION SHARE BY COUNTRY



In 2000,

- Thailand, Indonesia and Philippines performed well in applying renewable energy in their total energy consumption
- Malaysia has highest for installed renewable energy plant
- Although Indonesia has highest share of renewable energy consumed in total but still has the lowest installed capacity per capita due to the large population.

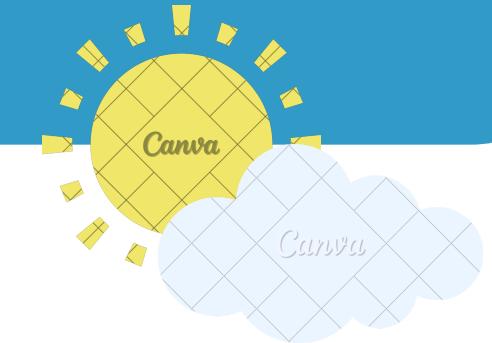
In 2009,

- Malaysia has higher percentage of equivalent primary energy compare to renewable energy in final total consumption

In 2018,

- Malaysia still remains higher percentage of equivalent primary energy than renewable energy in total consumption
- Philippines still steadily performed well in using renewable energy in their daily lives
- In contrast, Singapore still mainly relies on non-renewable energy due to geographical limitation.

CO₂ EMISSIONS VS. PRIMARY ENERGY CONSUMPTION PER CAPITA



Efficient Energy Use

- **Singapore:** high energy use, low CO₂



Inefficient Energy Use

- **Indonesia:** low energy use, high CO₂



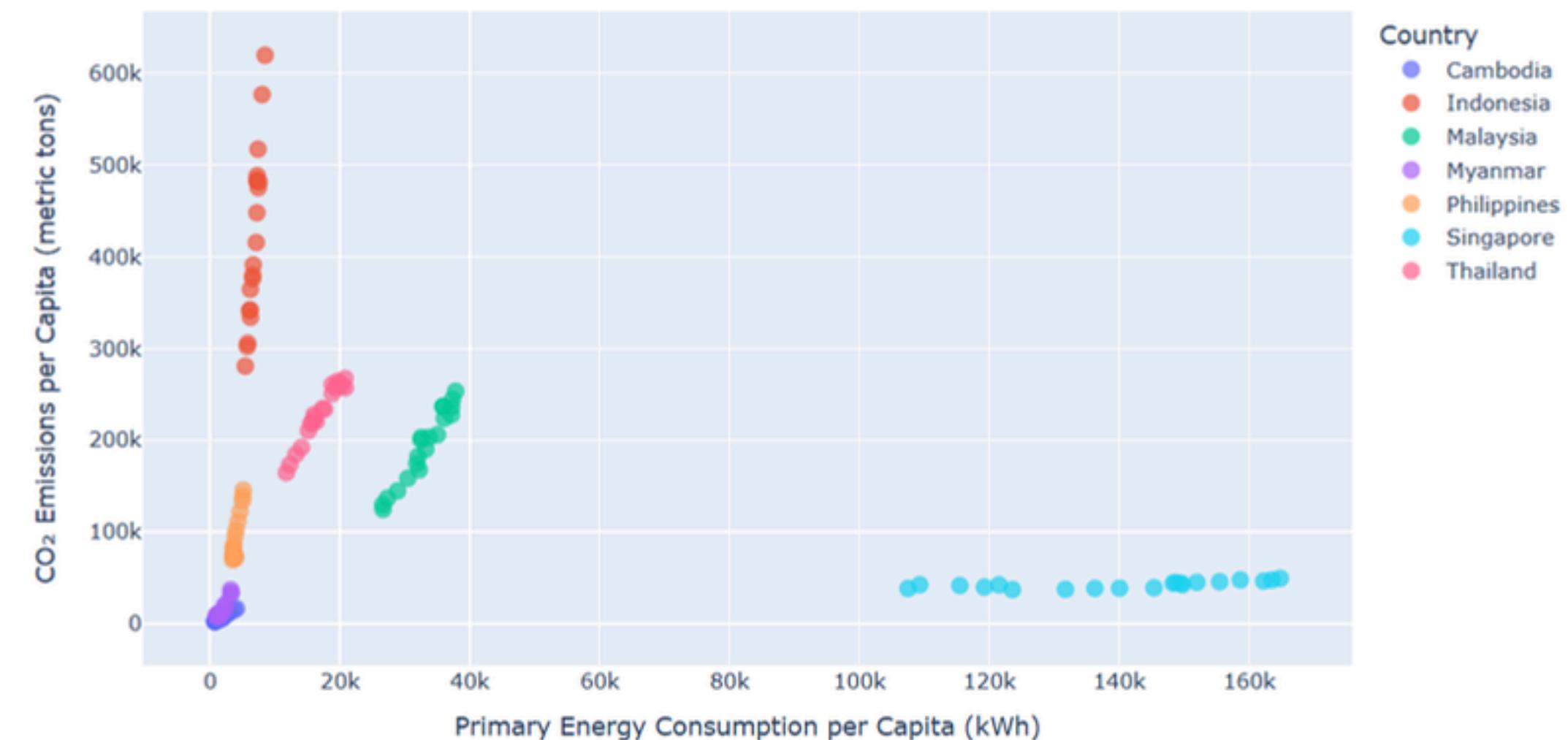
Balanced

- **Malaysia, Thailand:** moderate energy use & CO₂

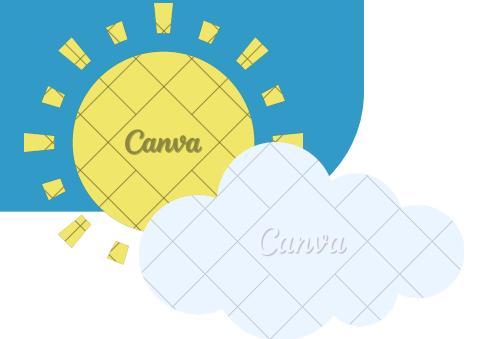
zzz Low Development / Low Activity

- **Philippines, Myanmar, Cambodia:** low energy use & CO₂

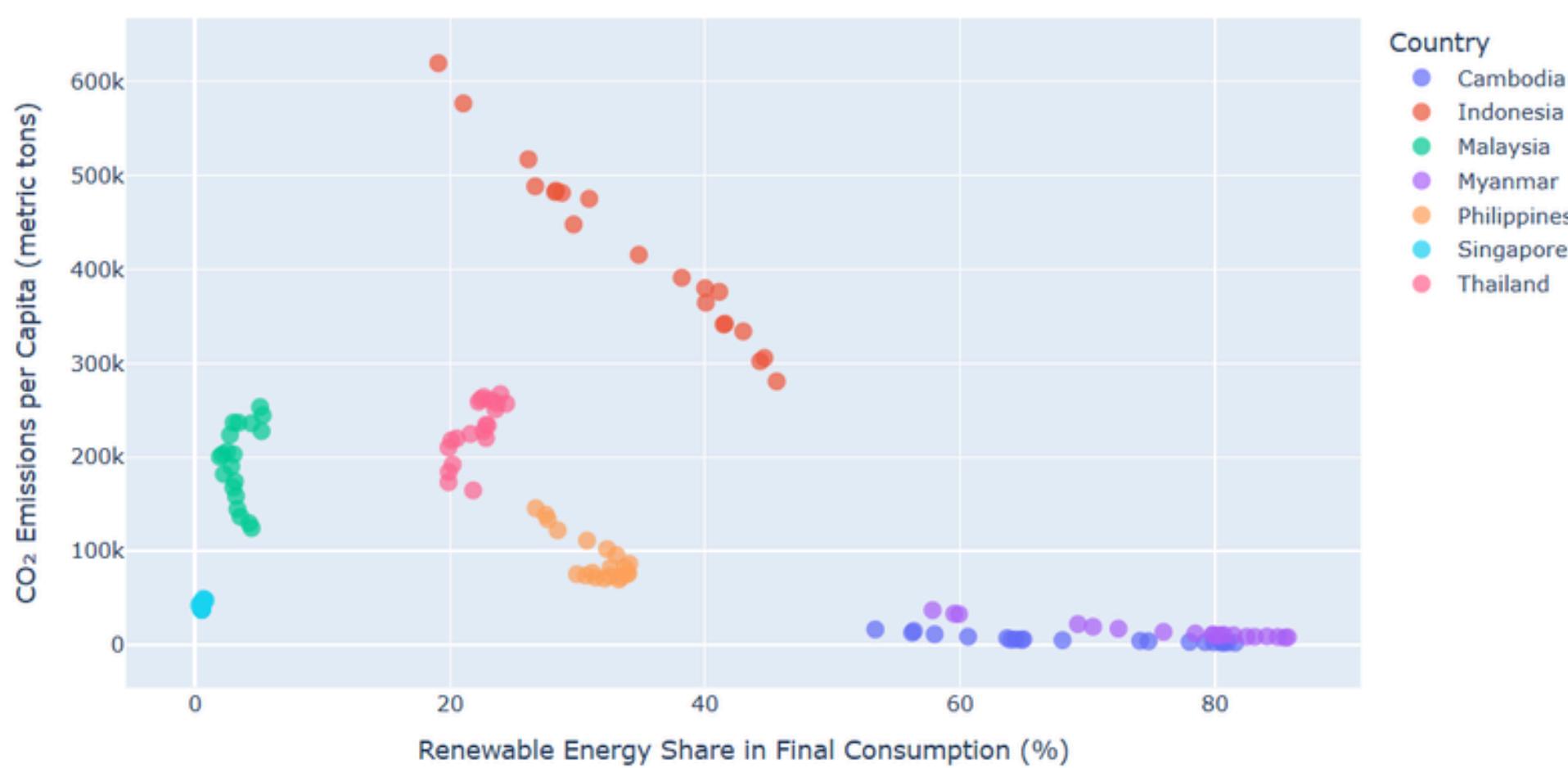
CO₂ Emissions vs. Primary Energy Consumption per Capita



CO₂ EMISSIONS VS. RENEWABLE ENERGY SHARE IN FINAL CONSUMPTION



CO₂ Emissions vs. Renewable Energy Share in Final Consumption



High Renewables, Low Emissions ↘

- **Indonesia:** more renewables → lower CO₂
- **Cambodia, Myanmar:** high renewables, very low CO₂

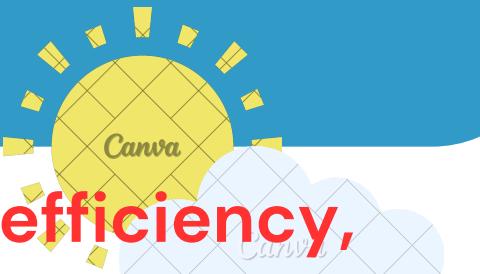
Low Renewables, Low Emissions !

- **Singapore:** almost no renewables, but low CO₂
→ efficient systems

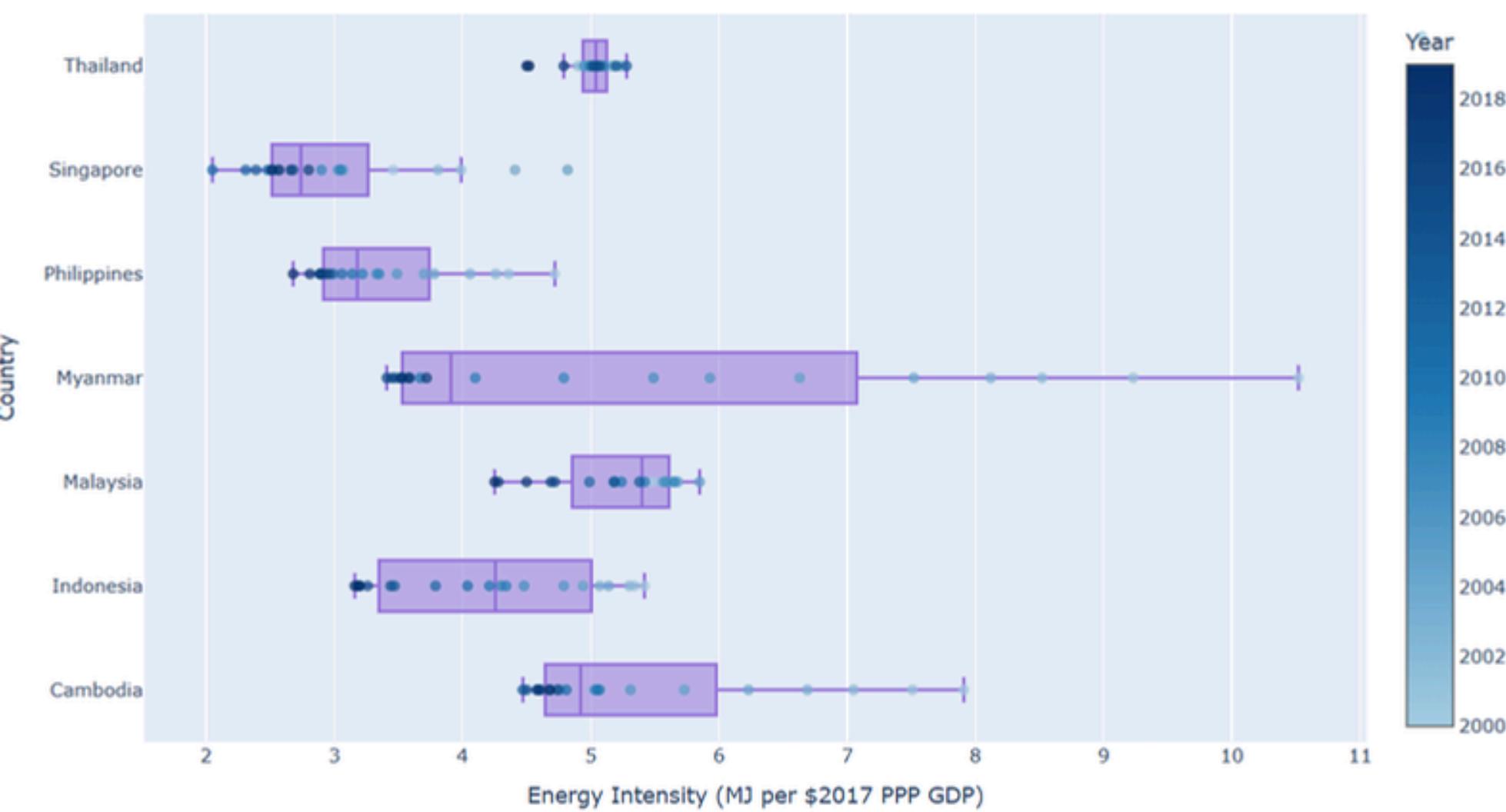
Unstable Trends ⚡

- **Malaysia, Thailand, Philippines:**
inconsistent renewables & CO₂
→ still in transition

ENERGY INTENSITY BY COUNTRY WITH YEARLY VARIATION



Energy Intensity by Country with Yearly Variation (MJ per \$2017 PPP GDP)



Singapore leads in energy efficiency, consistently recording the lowest energy intensity, while countries like **Myanmar and Cambodia** started with high values but showed significant improvements over time.

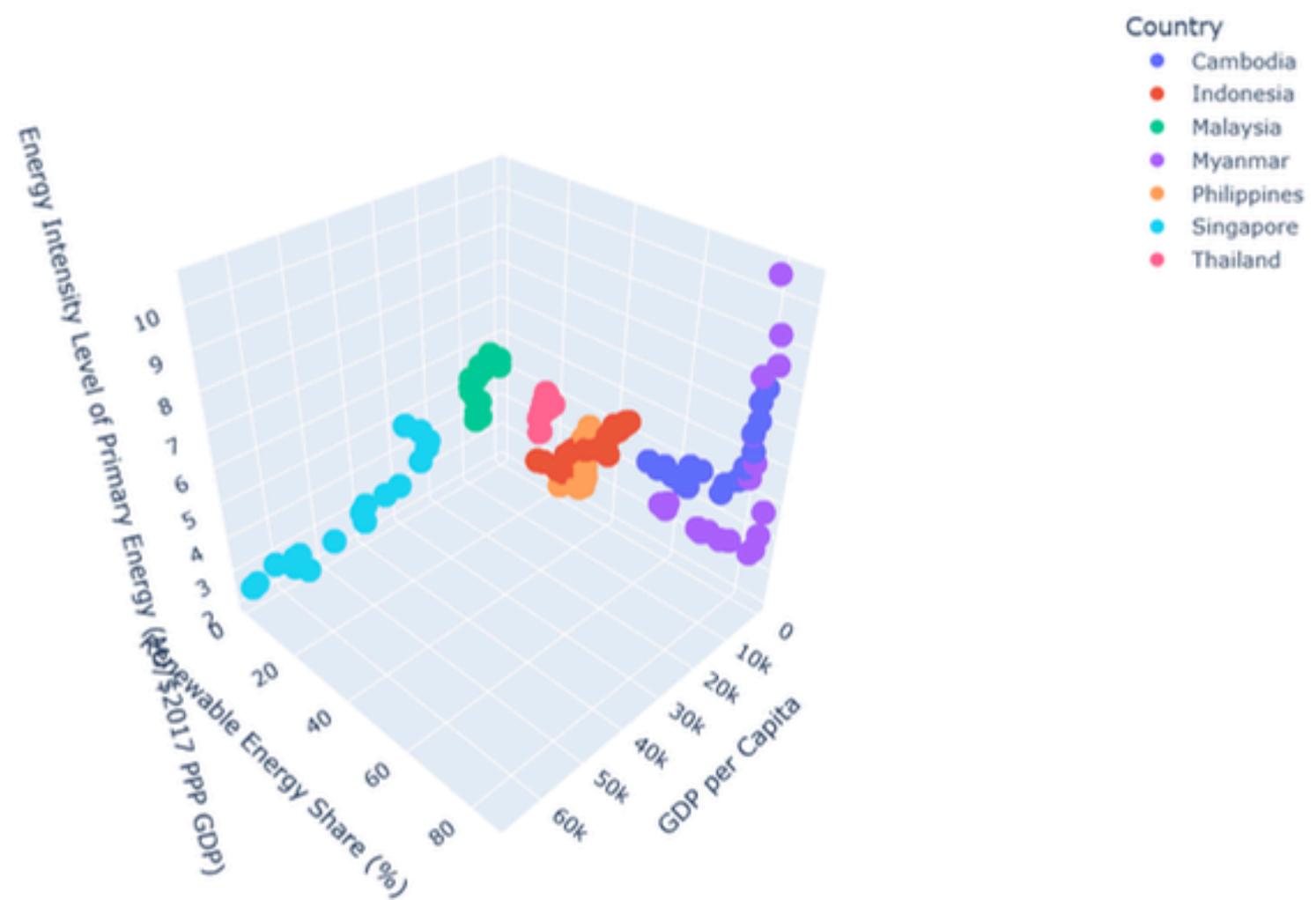


Thailand and Malaysia maintain higher, stable energy intensity, reflecting consistent reliance on energy-intensive sectors

Southeast Asian countries show varied progress, with some achieving steady gains in energy efficiency, highlighting the need for continued investment in cleaner, more efficient energy infrastructure.

3D VIEW: GDP PER CAPITA VS. RENEWABLE ENERGY SHARE VS. ENERGY INTENSITY LEVEL OF PRIMARY ENERGY

3D View: GDP per Capita vs. Renewable Energy Share vs. Energy Intensity Level of Primary Energy



- **Singapore stands out with high GDP per capita and low energy intensity**, showing strong energy efficiency despite minimal reliance on renewable energy due to resource limitations.
- **Less developed countries like Myanmar and Cambodia** have high renewable energy shares but suffer from high energy intensity and low GDP per capita, indicating inefficient energy use and underdeveloped economies.
- **Middle-income countries (Malaysia, Thailand, Indonesia)** show balanced progress, with moderate GDP, energy intensity, and renewable energy adoption.

SUMMARY

⚡ Energy Landscape Overview

- Fossil fuels dominate electricity generation, but renewables are starting to gain traction.

↗ Implications

- Shifting to renewables helps cut carbon emissions, benefiting the environment and climate.
- Countries with higher renewable energy shares show lower per capita CO₂ emissions.

🔧 Strategic Recommendations

- Enhance regional cooperation for faster renewable energy development.
- Seek foreign investment to boost capacity and innovation in clean energy.
- Tailor strategies to each country's unique economic and energy profile.

7 AFFORDABLE AND CLEAN ENERGY



🌿 Final Message

A balanced approach focusing on access, clean generation, and efficiency will guide Southeast Asia toward a more equitable and sustainable energy future.

THANK YOU

