Singapore’s Power Outlook: Consumption , Demand & Capacity, and Consumer Choice

Capstone Project

Presented by: Jonathan Lee
Date: July 2025

Key Players in the Electricity Market

EMA

Energy Market Authority (EMA)
Government regulator overseeing the electricity and gas sectors to ensure reliability, competitiveness, and sustainability.

EMC

Energy Market Company (EMC)
Manages the Wholesale Electricity Market where electricity is traded every 30 minutes.

SP

SP Group
Operates the national power grid and provides backend support services (metering, switching, etc.).
Also sells electricity at regulated tariffs as the default retailer for those who do not switch providers.

Gencos

Power Generation Companies (Gencos)
Generate electricity from various fuel sources (mostly natural gas in SG).
Can also double as Electricity Retailers.

Retailers

Electricity Retailers
Offer electricity price plans to consumers; buy electricity from the wholesale market.

Consumers

Consumers
Residential or business users who choose to buy electricity either from SP Group or retailers via the open electricity market (OEM).

Electricity Market in Singapore

01

Wholesale Market with Retail Competition

Power generation companies (**Gencos**) **bid in the Wholesale Electricity Market every 30 minutes.**

Retailers then **purchase** electricity and **compete** to sell to consumers, fostering innovation and price competitiveness.

02

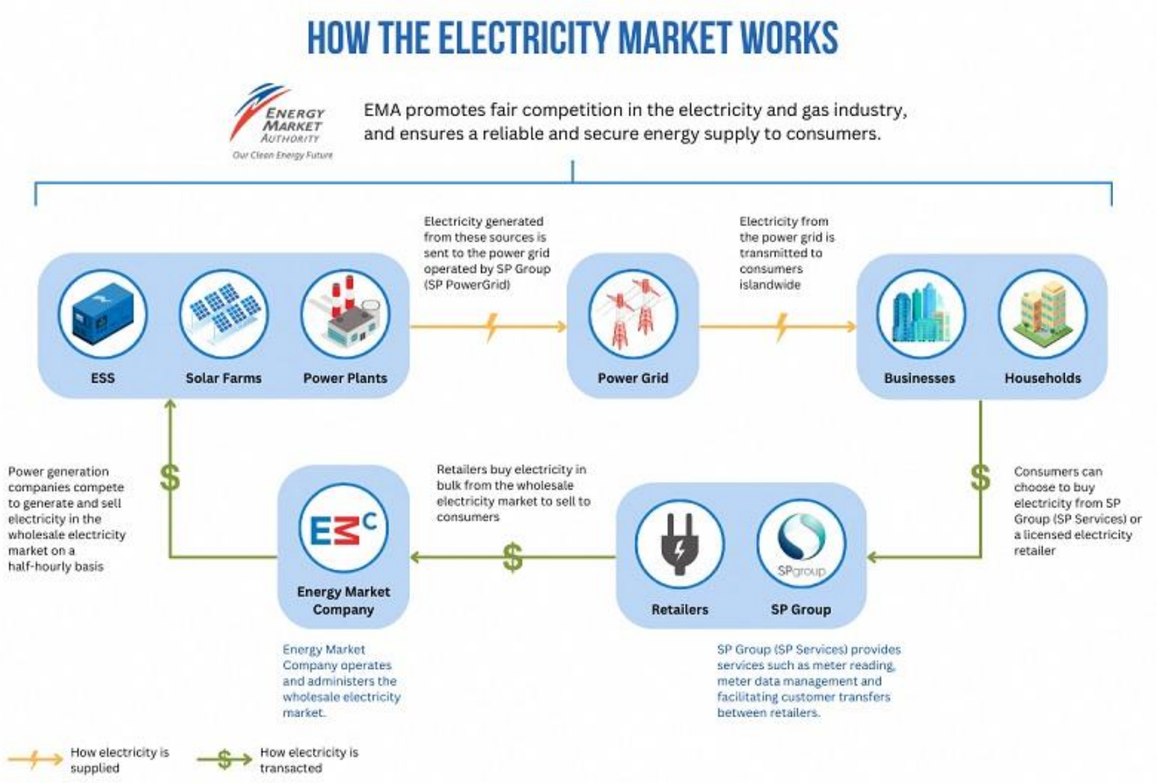
Consumer Choice Between Providers

Households and businesses can **choose** to **purchase electricity from SP Group** at the regulated tariff, **or from licensed electricity retailers** offering various plans.

03

Centralised Grid Operation and Services

SP Group continues to **operate Singapore's national power grid** and **provides essential backend services** such as meter reading, meter data management, and facilitating seamless customer transfers between retailers.



Source: Energy Market Authority (EMA), Singapore – ema.gov.sg

Meet the Personas

3 Perspectives Across the Electricity Ecosystem

EMA

Mr. Paul See

Director of Power System Development

Energy Market Authority (EMA)

Profile: Paul is responsible for **long-term planning of Singapore's electricity grid**. He ensures generation capacity keeps pace with demand, oversees reliability standards, and coordinates with gencos and other government bodies to shape energy policy.

Pain Point: Concerned about **rising peak demand and shrinking buffer**, and needs data-driven forecasts to justify capacity expansions.

Interest: Strategic planning, system resilience, generation mix.

Gencos

Ms. Hikari Watanabe

General Manager, Overseas Business Strategy (Southeast Asia)

JERA Co., Inc.

Profile: Hikari leads JERA's overseas business strategy in Southeast Asia. She aims **to identify and pursue opportunities to expand JERA's presence in the region** by establishing new power generation facilities to support sustainable growth in key markets like Singapore.

Pain Point: Needs **accurate demand forecasts** to assess the viability of future regional investments and the establishment of power generation facilities.

Interest: Identifying high-growth overseas markets, power plant ROI

Consumers

Watson & Julie

Newly-weds

Profile: Watson and Julie are a newly married couple who just moved into their BTO flat in Tengah. As first-time homeowners, they're setting up utilities and navigating the Open Electricity Market for the first time. Both are working professionals who **want a simple and cost-effective electricity plan without having to study the market in detail**.

Pain Point: Unsure whether **to pick a fixed-price plan or stay on the regulated tariff**; overwhelmed by the number of retailers and fluctuating prices.

Interest: Transparent pricing, easy plan comparisons, and cost-savings

Key Topics to Address

Singapore Electricity Consumption

Peak Demand vs Capacity

Household Sector Electricity Market

Singapore’s Growing Electricity Consumption

- Electricity is a critical resource in generating national output
- Total electricity demand continues to grow with population, housing, and digitalization

Consumption Projected to hit 59.2TWh in 2026, which is equivalent to approx.:

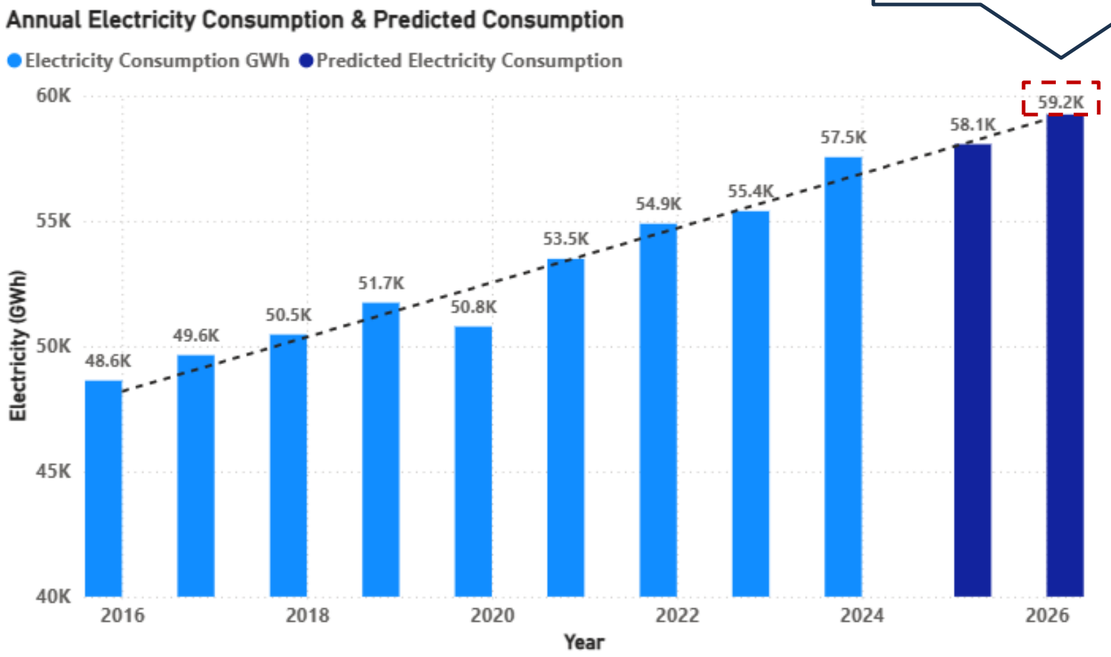
592 Billion hours of TV

or

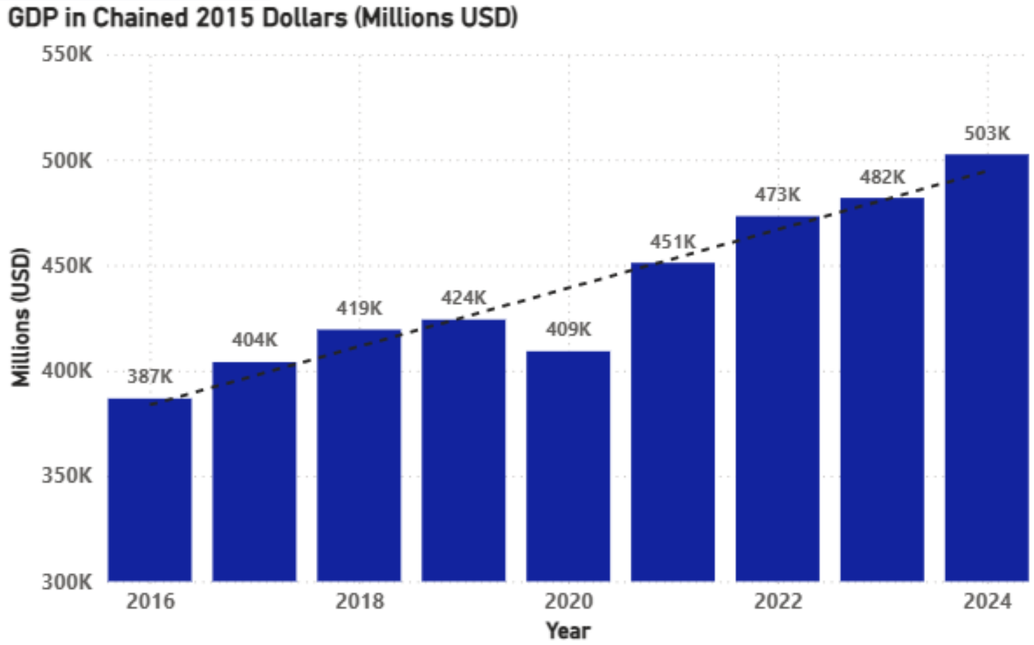
118 Billion loads of laundry

or

118 Billion hours of laptop use



Source: *Energy Market Authority (EMA), Singapore* – ema.gov.sg



Source: Government of Singapore, *Open Data Portal* – https://data.gov.sg

What is Peak System Demand?

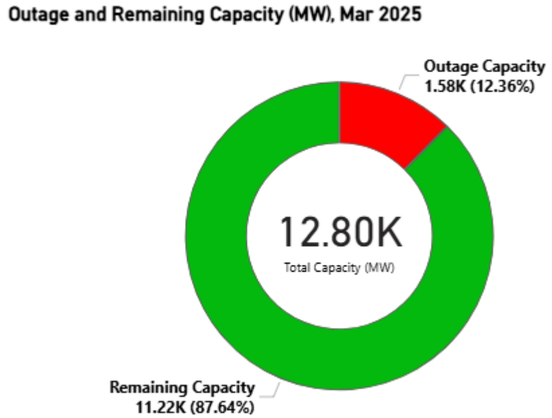
And why does it matter more?

Electricity Consumption	Peak System Demand
Total electricity used over a period (e.g. annually)	Highest level of electricity needed at a single time
Like tracking how much water you use over a month	Like the biggest flow of water through your tap at one time
Shows overall energy usage trends	Determines how much capacity the system must be ready for

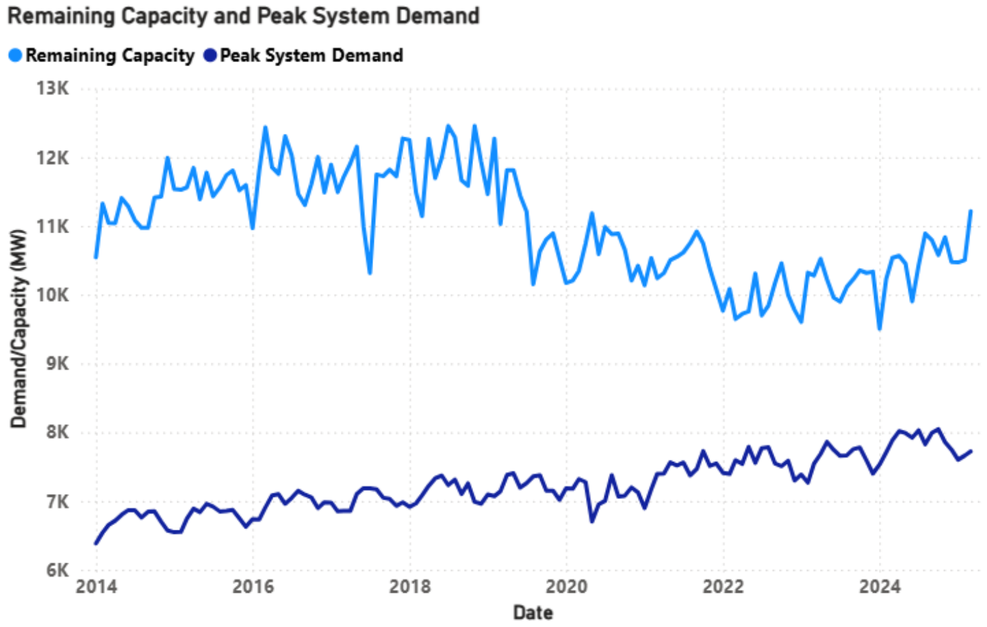
What Supports Peak System Demand?

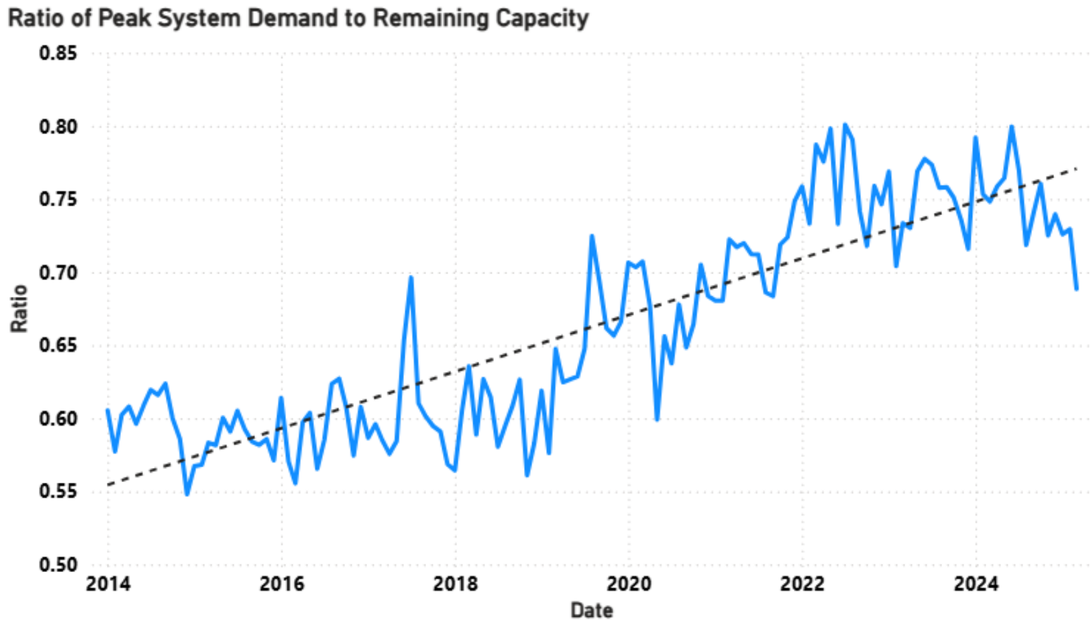
Peak System Demand	Installed Capacity
Highest level of electricity needed at a single time	Total potential supply at any time
Like the biggest flow of water through your tap at one time	Like how much water your pipes can deliver at full pressure
Determines how much capacity the system must be ready for	Must exceed demand to ensure system stability & prevent outages

So, Are We Producing Enough Power?



- Yes, but…
- The gap between Peak System Demand and Remaining Capacity is closing



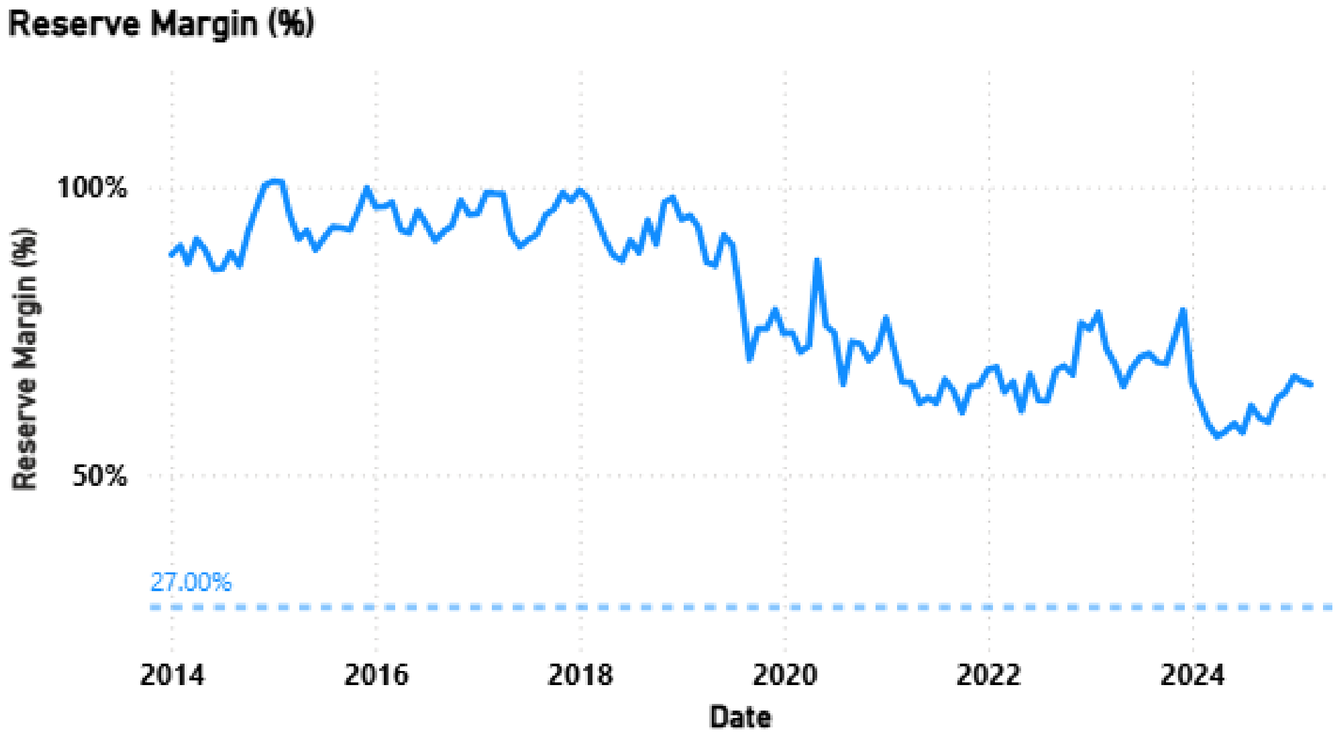


Source: Energy Market Authority (EMA), Singapore – [ema.gov.sg](ema.gov.sg)

How Much Room Do We Have?

- Reserve Margin - how much excess capacity a power system has to meet unexpected surges in demand or generation shortfalls.

- Singapore's Required Reserve Margin is set at 27%.
  - So good news, we are still safe for now!

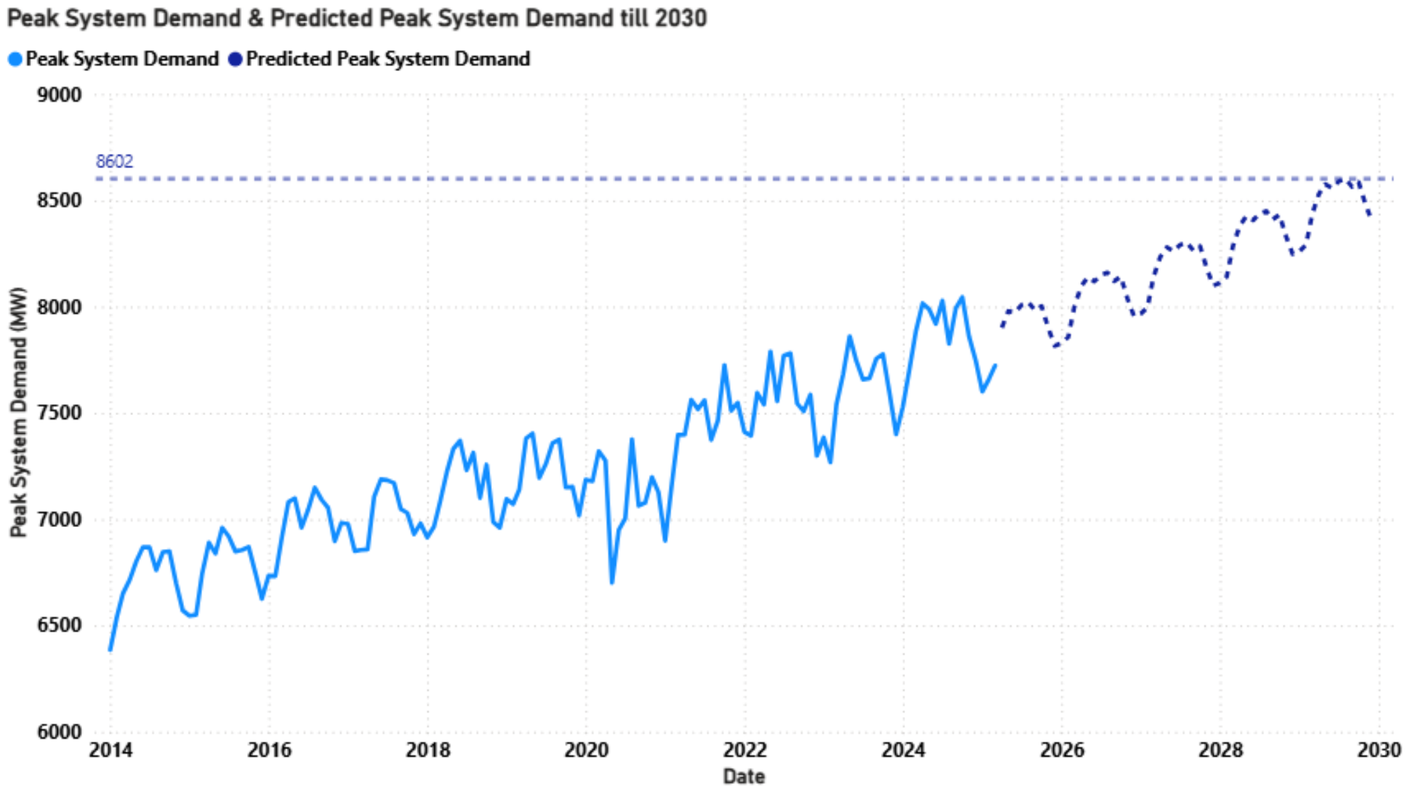


Source: Energy Market Authority (EMA), Singapore – ema.gov.sg

How We Predict Demand Will Move

Projected Capacity Needs by 2030:

- Peak demand expected to reach ~8,600 MW
- To operate at 70% generator load (optimal efficiency) and maintain ~85% remaining capacity, ~14,420 MW total capacity will be needed
- This is a ~12.7% increase from current capacity levels



Key Topics to Address

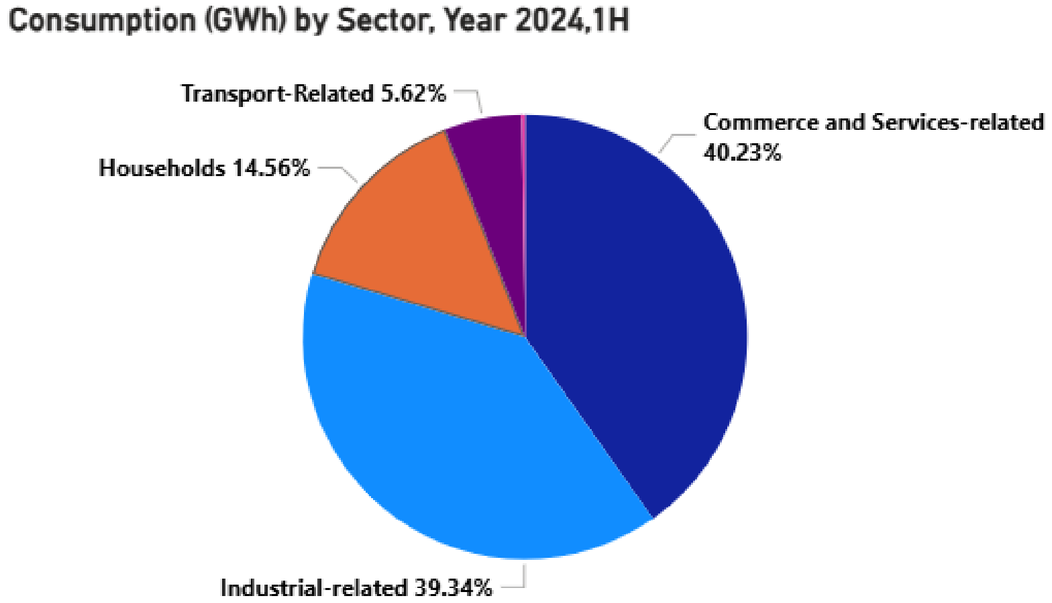
Singapore Electricity Consumption

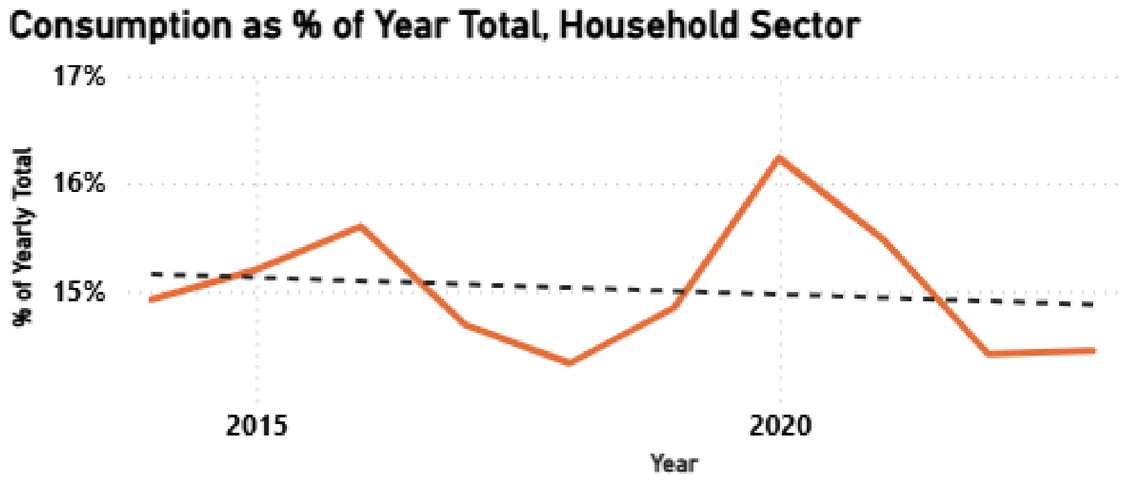
Peak Demand vs Capacity

Household Sector Electricity Market

Singapore’s Growing Household Demand

- Represents ~14.5% of Singapore’s annual electricity consumption (3rd Largest Sector).
- This has mostly maintained around 14-16% range.

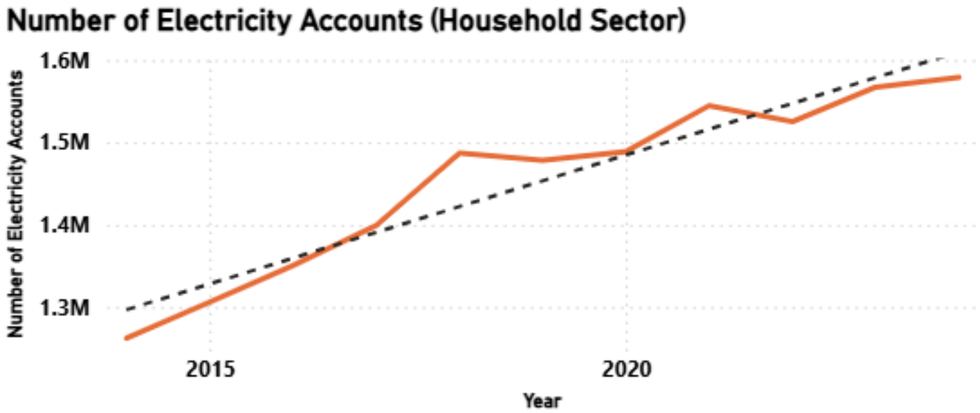


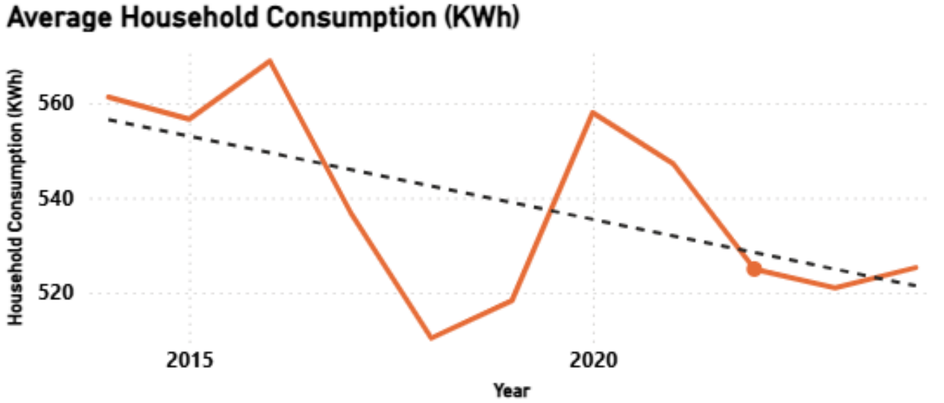


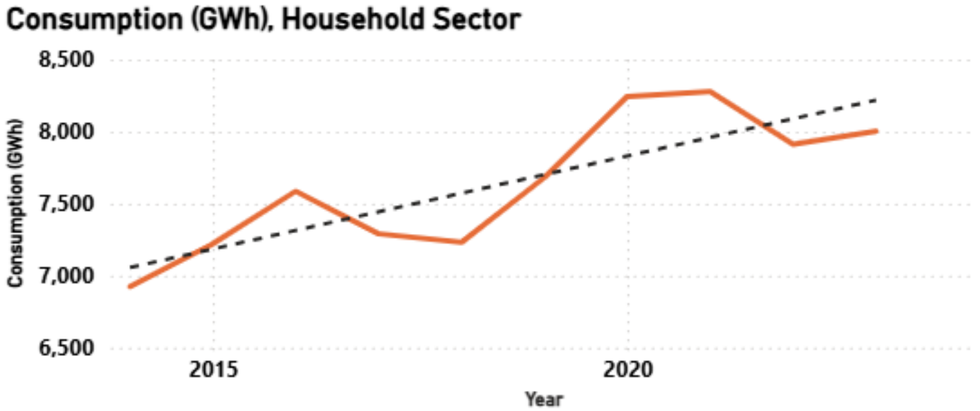
Source: Energy Market Authority (EMA), Singapore – ema.gov.sg

Singapore’s Growing Household Demand

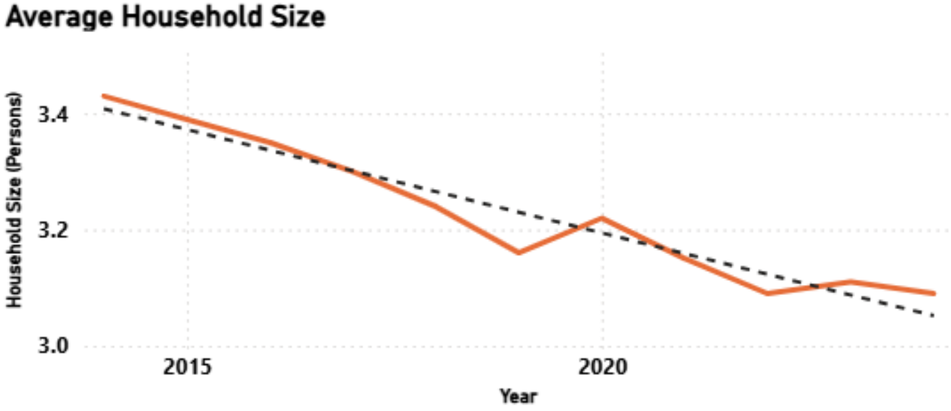
- Steady rise in number of electricity accounts and overall consumption.
- However, per household consumption has seen gradual decrease.







Source: Energy Market Authority (EMA), Singapore – ema.gov.sg



Source: Singapore Department of Statistics (SingStat) – https://www.singstat.gov.sg

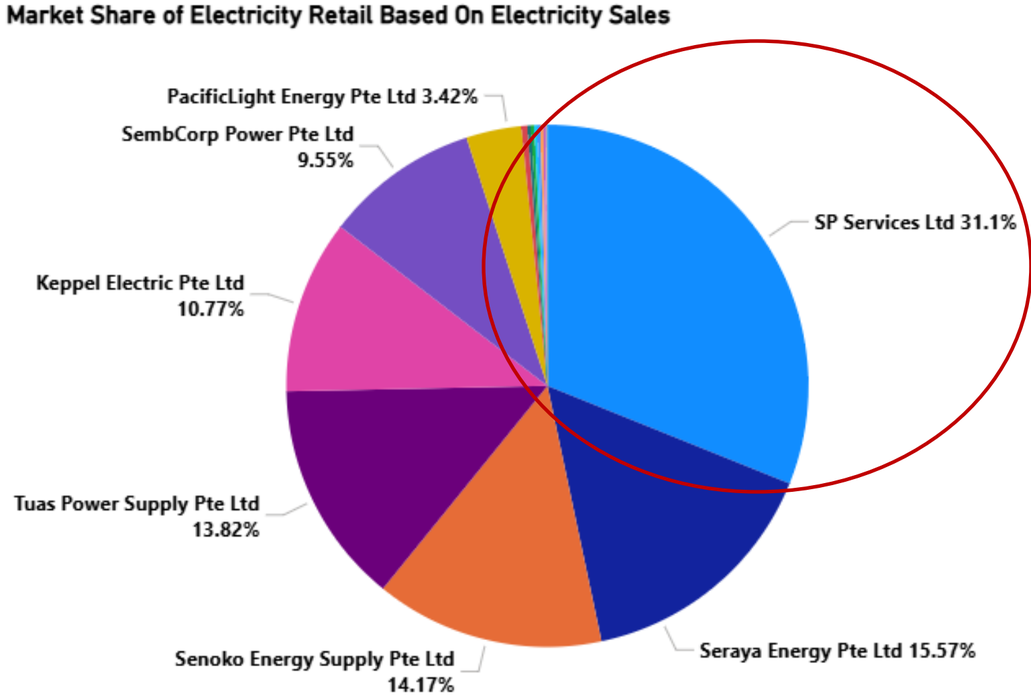
Open Electricity Market (OEM)

More Choices = More Savings?

- Launched in Nov 2018, fully rolled out by May 2019
- Lets households choose electricity retailers (not just SP Group)
- Offers competitive price plans:
  - Fixed-rate
  - Discount-off-tariff
- Enables potential cost savings for consumers

Plan Type	Description	Suitable for...
Fixed-Price Plan	Locked-in rate regardless of SP tariff	Those who want stability
Discount-off-Tariff	Always slightly cheaper than SP tariff	Those willing to take some risk
Regulated Tariff	Set quarterly by SP/EMA	Default for those who don't switch

Many consumers are overwhelmed or unaware — leading to missed savings!



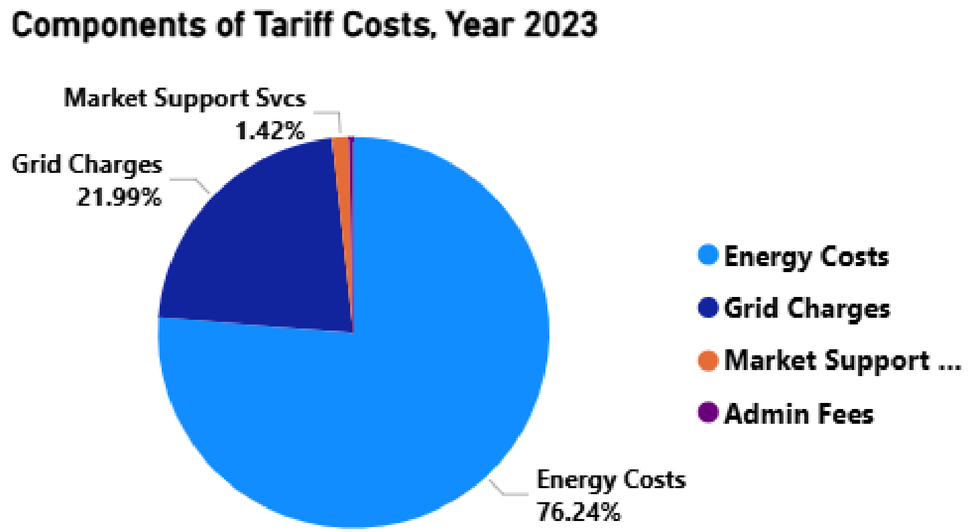
Source: Energy Market Authority (EMA), Singapore – ema.gov.sg

Wait, What is This “Tariff”?

- Regulated electricity rate set by EMA.
- Price is reviewed quarterly by SP Group based on EMA guidelines.
- All consumers are automatically on this if no retailer is chosen.
- There are different types of electricity tariffs, but for households, it’s specifically the **Low Tension Tariff – Domestic,** which we’ll refer to simply as the **Tariff** from here on.

What Drives Tariff?

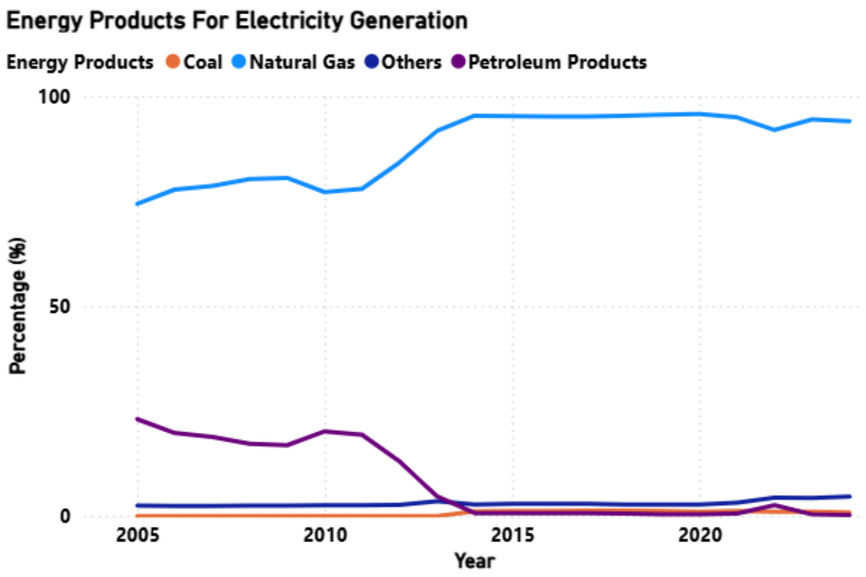
- Primary Driver: Energy Costs

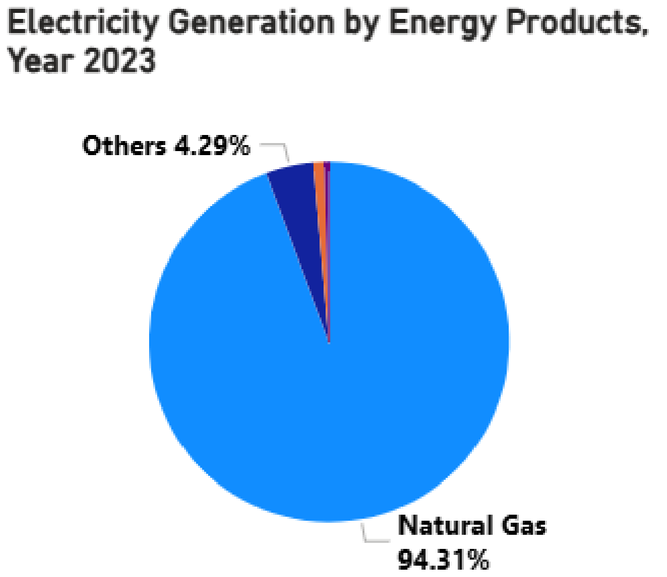


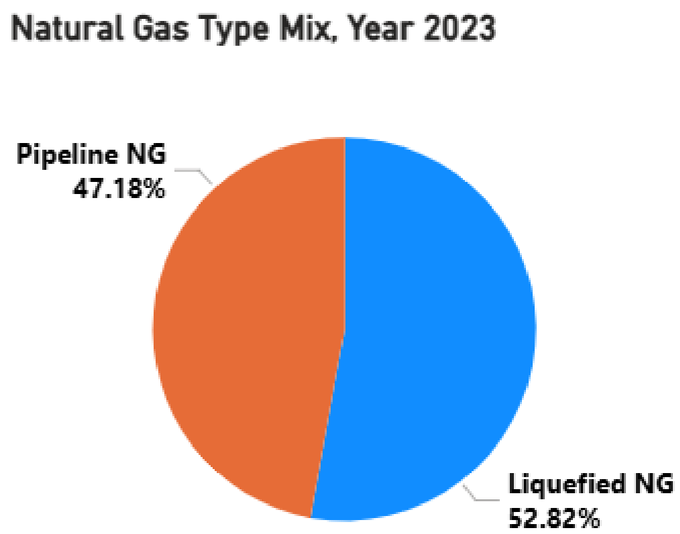
Source: Energy Market Authority (EMA), Singapore – [ema.gov.sg](ema.gov.sg)

Fuel Mix in Electricity Generation

- > 90% Natural Gas since 2013
  - Close to 50-50 split between PNG and LNG
  - LNG: **LNG price indices**
  - PNG: Contract rates are usually pegged to **crude oil prices**



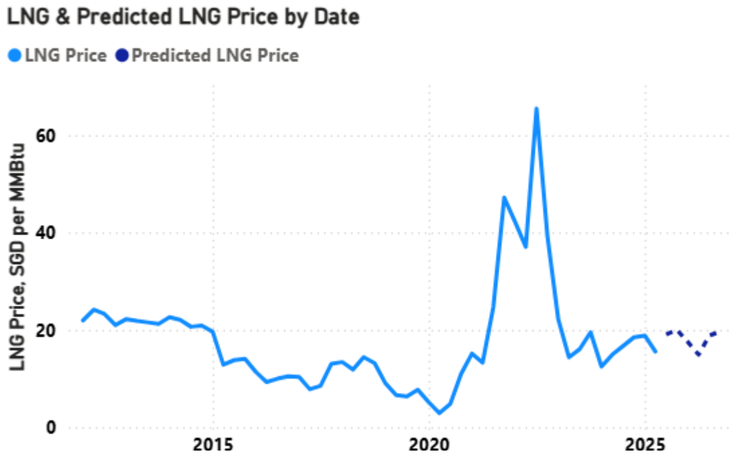


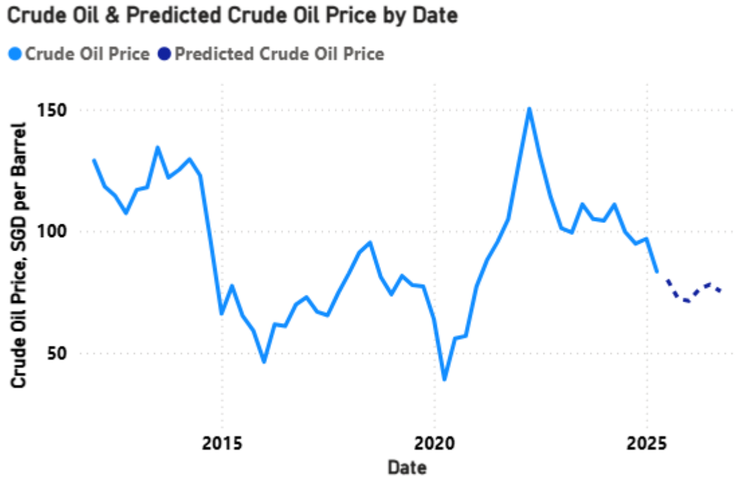


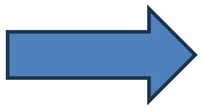
Source: Energy Market Authority (EMA), Singapore – ema.gov.sg

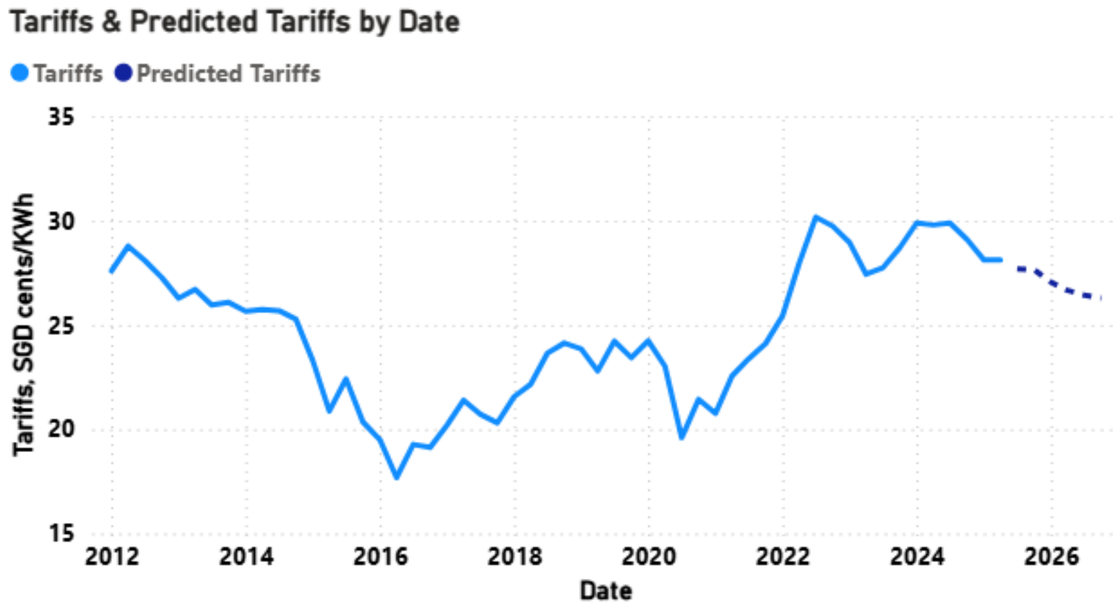
What Do We Do With This? – Tariff Prediction

- Made price predictions for LNG and Crude Oil, then used the values to predict Tariff until Q4 2026.







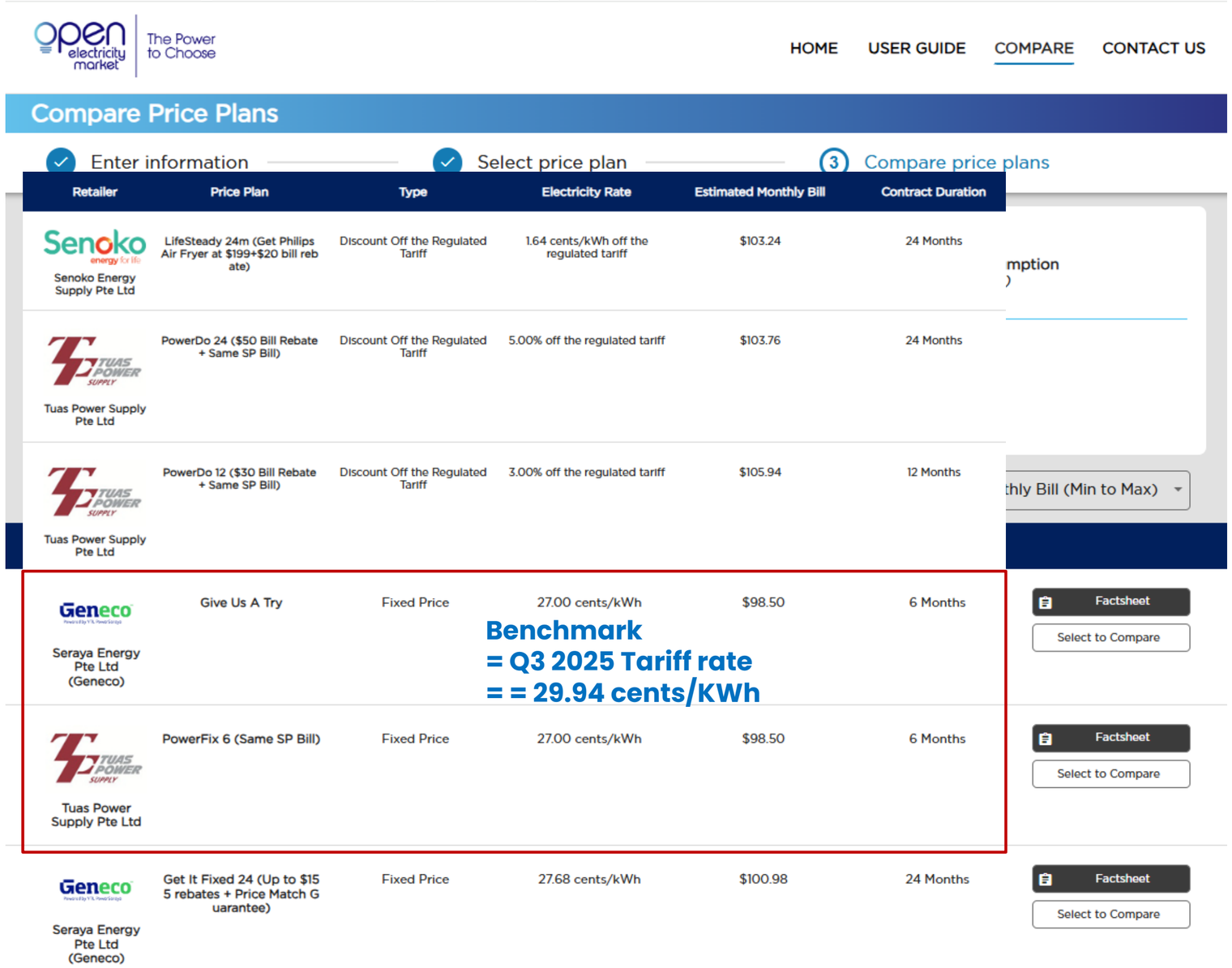


Predicted Low Tension Tariff

Period	Predicted Tarff, cents/KWh	Actual Tariff, cents/KWh
Q3 2025	27.69 (30.18 w/GST)	27.47 (29.94 w/GST)
Q4 2025	27.65 (30.13 w/GST)	TBC
Q1 2026	27.05 (29.48 w/GST)	TBC
Q2 2026	26.66 (29.06 w/GST)	TBC
Q3 2026	26.43 (28.80 w/GST)	TBC
Q4 2026	26.28 (28.65 w/GST)	TBC

<1% Difference

Comparing Against OEM Prices



Source: Open Electricity Market– openelectricitymarket.sg

What's Next? - Recommendations

Persona	Recommendation
EMA	• **Secure Future Capacity:** Launch procurement exercises to attract new and existing generation companies, aiming for ~15% more capacity by 2030 to ensure sufficient buffer (>27% reserve margin). • **Improve Forecasting:** Invest in better demand prediction tools to support long-term energy planning and policy decisions.
Gencos	• **Evaluate Investment Opportunities:** Use demand forecasts to assess whether building new plants or expanding capacity is financially viable. • **Stay Alert:** Be prepared to respond to EMA's future capacity procurement calls.
Consumers	• **Maximise Savings:** Consider 6-month fixed-price OEM plans, which are currently the most cost-effective. • **Review Regularly:** Re-evaluate plan options at the end of each contract period to ensure continued savings.

Assumptions & Caveats

- Projections are based on current trends; real-world changes may shift future outcomes
- Fuel price volatility (like LNG) can heavily influence electricity prices
- Consumer decisions are also shaped by awareness and convenience, not just price

Key Takeaways

- Singapore’s electricity demand is growing
- Maintaining sufficient reserve margin is crucial for energy security
- The OEM gives consumers real choice — but consumer awareness matters
- Strategic planning today ensures sustainable energy tomorrow

Q&A

Models Chosen

Prediction	Model	Result
Electricity Consumption	**ARIMA** (p = 3, d = 1, q = 3)	RMSE: 204.1 GWh AIC: 158.3
Peak System Demand	**SARIMA** (p = 1, d = 2, q = 2) (P = 0, D = 1, Q = 1, s = 12)	RMSE: 172.2 MW AIC: 1178.7
Crude Oil Prices	**SARIMA** (p = 2, d = 0, q = 3) (P = 1, D = 1, Q = 1, s = 4)	RMSE: S$3.18 AIC: 311.6
LNG Prices	**SARIMA** (p = 0, d = 1, q = 2) (P = 0, D = 1, Q = 1, s = 4)	RMSE: S$1.44 AIC: 254.2
Low Tension Tariff	**SARIMAX** (Exogenous Variables: LNG & Crude Oil Prices) (p = 1, d = 1 , q = 2) (P = 1, D = 0, Q = 1, s = 4)	RMSE: S$0.32 AIC: 153.4

Finding Best Hyperparameters

```python
p = d = q = range(0, 3)
P = D = Q = range(0, 2)
s = 4

pdq = list(itertools.product(p, d, q))
seasonal_pdq = list(itertools.product(P, D, Q))

best_rmse = float("inf")
best_order = None
best_seasonal_order = None
best_model = None

print("Running grid search for best RMSE...")

for order in pdq:
    for seasonal in seasonal_pdq:
        seasonal_order = (seasonal[0], seasonal[1], seasonal[2], s)
        try:
            model = SARIMAX(y_train,
                            exog=exog_train,
                            order=order,
                            seasonal_order=seasonal_order,
                            enforce_stationarity=False,
                            enforce_invertibility=False)
            results = model.fit(disp=False)

            # Predict on test set
            y_pred = results.predict(start=y_test.index[0],
                                     end=y_test.index[-1],
                                     exog=exog_test)

            # Compute RMSE
            rmse = np.sqrt(mean_squared_error(y_test, y_pred))

            if rmse < best_rmse:
                best_rmse = rmse
                best_order = order
                best_seasonal_order = seasonal_order
                best_model = results

            print(f"Tested SARIMAX{order}x{seasonal_order} - RMSE: {rmse:.2f}")

        except Exception as e:
            continue

print("\n✅ Best Model Based on RMSE:")
print(f"Order: {best_order}")
print(f"Seasonal Order: {best_seasonal_order}")
print(f"RMSE: {best_rmse:.2f}")
```

```python
p = d = q = range(0, 3)
P = D = Q = range(0, 2)
s = 4

pdq = list(itertools.product(p, d, q))
seasonal_pdq = list(itertools.product(P, D, Q))

best_aic = float("inf")
best_order = None
best_seasonal_order = None
best_model = None

print("Running grid search...")

for order in pdq:
    for seasonal_order in seasonal_pdq:
        seasonal_order_full = (seasonal_order[0], seasonal_order[1], seasonal_order[2], s)
        try:
            model = SARIMAX(y_train,
                            exog=exog_train,
                            order=order,
                            seasonal_order=seasonal_order_full,
                            enforce_stationarity=False,
                            enforce_invertibility=False)

            results = model.fit(disp=False)
            current_aic = results.aic

            if current_aic < best_aic:
                best_aic = current_aic
                best_order = order
                best_seasonal_order = seasonal_order_full
                best_model = results

            print(f"Tested SARIMAX{order}x{seasonal_order_full} - AIC: {current_aic:.2f}")

        except Exception as e:

            continue

print("\n✅ Best Model:")
print(f"Order: {best_order}")
print(f"Seasonal Order: {best_seasonal_order}")
print(f"AIC: {best_aic:.2f}")
```

What is Currently Being Done (1)

Energy Imports

1. **LTMS (Lao PDR–Thailand–Malaysia–Singapore Power Integration Project):**
    - Importing up to 200 MW of renewable electricity into Singapore
2. **ENEGEM pilot project (Energy Exchange Malaysia):**
    - Importing 50MW of renewable electricity from Malaysia into Singapore
3. **Plans to Scale up imports:**
    - To reach 6 GW of low-carbon electricity imports by 2035

What is Currently Being Done (2)

Scale up Generation

- **Incoming Generation Capacity:**
  - Fast-Start Generation Capacity by:
    1. Meranti Power (680MW) in 2025
    2. PacificLight Power (100MW) in 2025
  - New combined cycle gas turbine (CCGT) generation capacity by:
    1. Keppel Sakra Cogen (600MW) in 2026
    2. Sembcorp Cogen (600MW) in 2026
    3. YTL PowerSeraya (600MW) in 2028
  - Projected domestic solar PV growth to 2GWp by 2030 (~416MW)
  - Request for Proposal to Gencos Issued in 2024
    - for new generating units in 2029 and 2039

Possible Further Analysis

- **Tariff prediction for High, Extra High Tension electricity:**
  - Gencos/Retailers like a mix of Low, High and Extra High Tension for a balanced customer portfolio
    - Without diversification, there could be periods where there are very low demand, leading to lower consistency/efficiency.
- **Analysis on Uniform Singapore Energy Price (USEP)**
  - Half-hourly electricity price in Singapore’s wholesale electricity market
  - The price which electricity retailers buy power from the national grid in Singapore.

Required Reserve Margin

Derived based on target of 3 Loss of Load Hours (LLOH)/year:

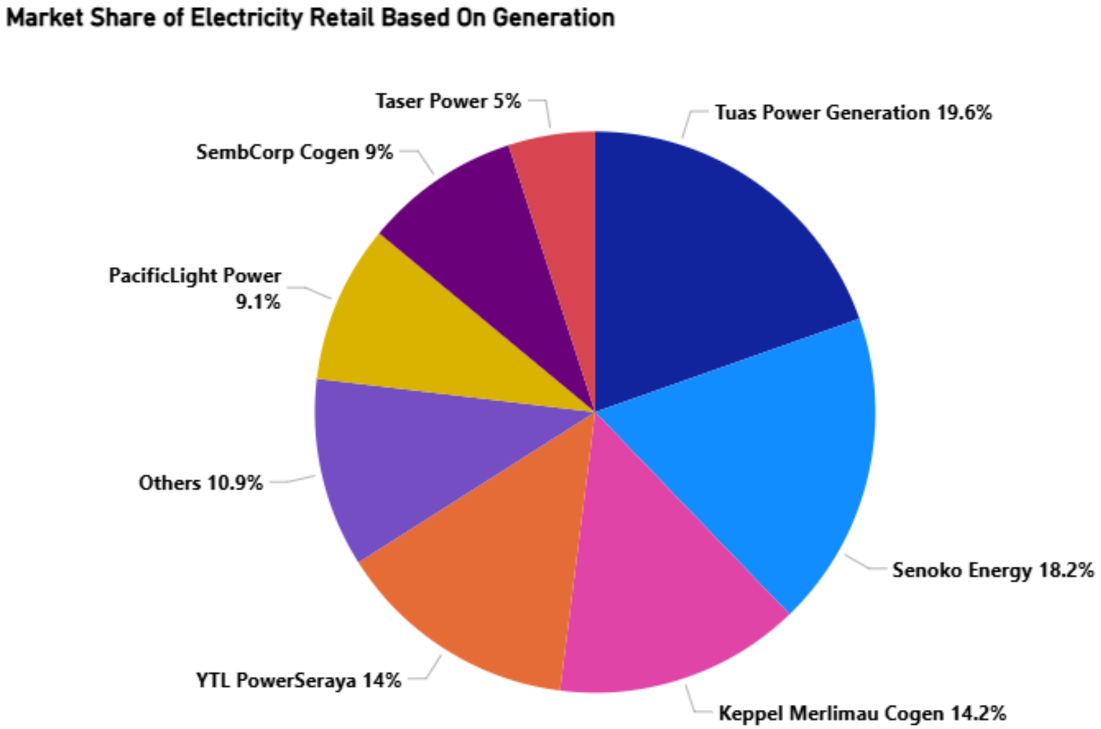
- 3 LLOH means that, based on simulations, the system is expected to face electricity shortfalls for around 3 hours in a typical year.
  - Randomly simulate outages, deratings, and demand profiles.
  - See how often demand exceeds available capacity.
  - Adjust reserve margin until expected Loss of Load Hours = 3.
  - 27%
- This is higher than many developed countries, because:
  - Singapore lacks large-scale interconnections (only 250 MW currently).
  - It has limited renewable/storage buffering.
  - It prioritizes very high reliability.

Year	Projected Total Electricity Supply	Projected Reserve Margin corresponding to the Projected System Peak Demand (Upper/Base/Lower)
2024	10.9	29 / 32 / 34
2025	11.6	29 / 32 / 35
2026	12.8	36 / 40 / 44
2027	12.9	28 / 34 / 39
2028	13.5	27 / 34 / 42
2029	13.4	18 / 26.6 / 37
2030	13.4	14 / 22 / 33
2031	12.7	3 / 11 / 22

Source: EMA (2024). *Request for Proposal to Build, Own and Operate New Generation Capacity.* EMA.gov.sg

Gencos & Retailers

- 8 Gencos
- 10 Retailers (Residential)



Source: https://www.openelectricitymarket.sg/residential/list-of-retailers

Possible Factors to Higher Consumption

- Higher Gross Net Income and higher temperature could also explain why there is increased consumption