TZ-CAT Malaysia 🇲🇾

Technical Annex

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About TZ-CAT

Launched in 2022, TransitionZero's Coal Asset Transition (TZ-CAT) tool is an open data product designed to assist high-level screening of coal plants for retirement and replacement across Southeast Asia.

The dataset provides users with foundational plant-level data to analyse the potential for system-level transition. This includes a broad range of plant-level metrics, including technology specifications, operational performance, cash flows, environmental and social impacts, as well as estimates for buy-out and clean energy replacement costs.

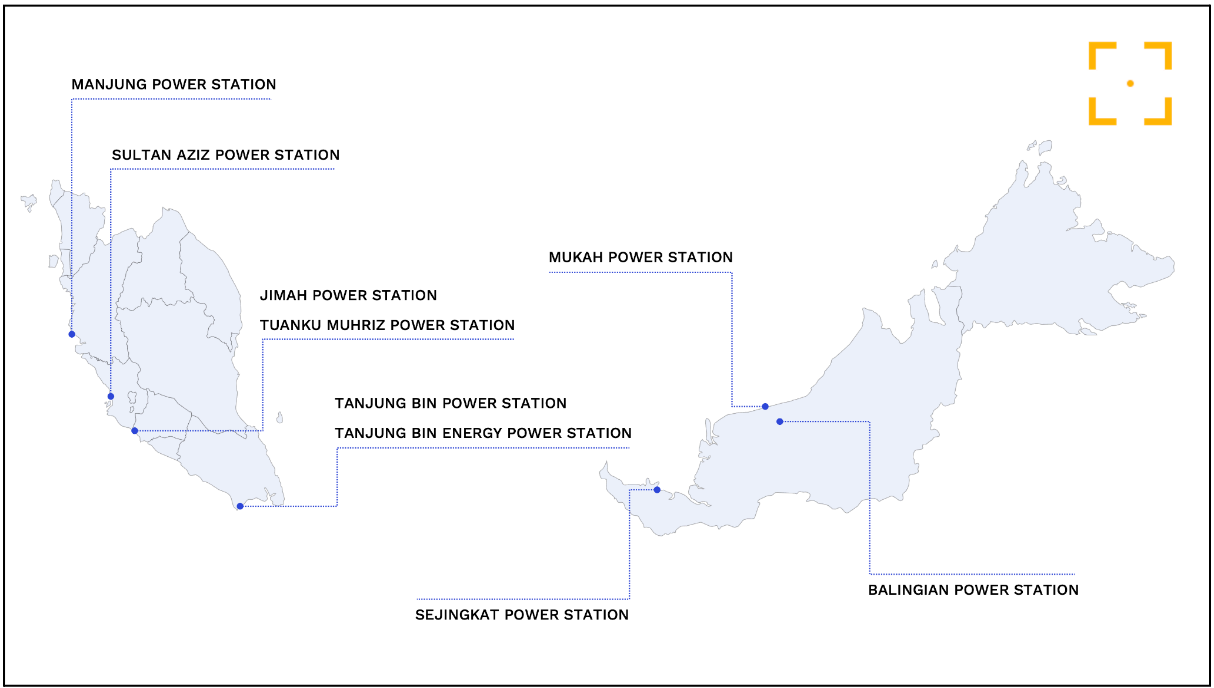
To date, TransitionZero has released TZ-CAT datasets for Indonesia (2022), the Philippines (2024), and Malaysia (2025). While the underlying principles remain consistent across countries, the methodology is adapted to reflect each market's specific structure and data availability.

This document outlines the methodology used for Malaysia.

About TZ-CAT Malaysia

The TZ-CAT Malaysia dataset covers the entire country's coal fleet. This includes 25 operational coal units from nine power stations, with a combined capacity of 13.3GW. These assets are located on the Peninsular Malaysia and Sarawak power grids.

Market- and plant-level statistics cover the four-year period from 2020 to 2023.



Methodology

We break down the sources, assumptions and methods used for each plant metric.

While other estimates or reported values may exist in public filings or alternative sources, the strength of the TZ-CAT database lies in its use of a standardised methodology across all plants. This consistency enables meaningful comparison across technologies, regions and ownership structures, and allows for a robust sizing of the market. By applying uniform assumptions and definitions, the database reduces variability introduced by differing reporting standards, making it a reliable foundation for cross-plant and cross-country analysis.

1. Technology and environmental metrics

Emissions factor

The emissions factor of each canonical coal type is based on internationally recognised standards[1]:

Canonical coal type	Emissions factor
Anthracite	0.354
Bituminous	0.341
Sub-bituminous	0.346
Lignite	0.364

Age-adjusted thermal efficiency

We use base efficiency values as reported by the plants or utilities.

In cases where this is unavailable, we apply the thermal efficiency rate of an equivalent plant with reported data (similar boiler technology, start year, and coal type).

We assume a 1% reduction in efficiency rate for every five years of operation.

Emissions intensity

We use emission intensity values as reported by the plants or utilities.

[1] Koffi, Brigitte; Cerutti, Alessandro; Duerr, Marlene; Iancu, Andreea; Kona, Albana; Janssens-Maenhout, Greet (2017): CoM Default Emission Factors for the Member States of the European Union - Version 2017, European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/jrc-com-ef-comw-ef-2017

In case this is not available, we use the following formula:

$$Emissions\ intensity\ (tCO2/MWh)\ = \frac{Emissions\ factor\ of\ coal\ used}{Adjusted\ thermal\ efficiency\ of\ plant}$$

2. Operational metrics

Capacity factor

We estimate the plant's capacity factor using the following formula:

$$Capacity\ factor\ (\%)\ = \frac{Annual\ generation\ (MWh)}{Installed\ capacity\ (MW) * 8760\ (hrs)}$$

Final values are four-year averages of annual capacity factors from the observed period.

Annual generation, annual unit sales

We use actual generation data and/or unit sales reported by the plants or utilities.

If either value is unavailable, we estimate it based on the principle that, depending on the plant's age, generation is typically 5–10% higher than unit sales due to self-consumption and transmission losses.

Final values are four-year averages of annual values from the observed period.

3. Financial metrics

Net present value

We estimate the financial value of the plant based on the annual Capacity Payment (CP) multiplied by the remaining years of the existing power purchase agreement (PPA).

$$Net\ present\ value\ (USD)\ = \frac{Annual\ CP\ (USD)}{Remaining\ PPA\ years}$$

Where:

- Annual CP = Four-year average CPs received by the plant, based on reported data from 2020-2023
- Remaining PPA year = Remaining lifetime of plant between 2025 and PPA expiry year

By extension, the cost of buying out a plant one year ahead of the scheduled expiry of its PPA would equate to one year of CP.

$$Cost\ of\ buy\ out\ per\ year\ (USD)\ =\ Annual\ CP\ (USD)$$

PPA tariff price

For plants in Peninsular Malaysia, we estimate the annual effective tariffs using the plant's reported annual revenue and unit sales. The values represent four-year averages over the observed period.

$$PPA\ tariff\ price\ (USD/MWh) = \frac{Annual\ revenue\ (USD)}{Total\ unit\ sales\ (MWh)}$$

For plants in Sarawak, due to revenue data constraints, we estimate annual effective tariffs using annual fuel costs, as reported by the utilities. We assume that average fuel cost represents 60% of tariffs.

$$PPA\ tariff\ price\ (USD/MWh) = \frac{Fuel\ cost\ (USD/MWh)}{60\%}$$

Final values are four-year averages of annual tariff prices from the observed period.

Fuel cost

For plants in Peninsular Malaysia, we use the average annual coal price (USD/tonne) reported by TNB. This is converted into per MWh cost using the following formula:

$$Average\ fuel\ cost\ (USD/MWh) = \frac{Average\ fuel\ cost\ (USD/ton) * 860.421}{Age{-}adjusted\ thermal\ efficiency\ /\ Coal\ calorific\ value\ (kcal.kg)}$$

For plants in Sarawak, we use annual coal costs and unit sales, as reported by the utilities, to estimate the average fuel cost of each plant.

$$Average\ fuel\ cost\ (USD/MWh) = \frac{Annual\ fuel\ cost\ (USD)}{Annual\ unit\ sales\ (MWh)}$$

Final values are four-year averages of annual fuel costs from the observed period.

Fixed Operations & Maintenance (FOM) cost

We use FOM values (USD/MW/year) as estimated by the plants in bond documents for the 2020-2023 period.

If unavailable, we use FOM values of an equivalent plant with reported figures, giving priority in matching plants with ones in the same grid region.

We convert FOM costs into USD/MWh values to incorporate into operating costs, using the following formula:

$$FOM\ (USD/MWh) = \frac{FOM\ (USD/MW/year) * Installed\ capacity\ (MW)}{Annual\ unit\ sales\ (MWh)}$$

Variable Operations & Maintenance (VOM) cost

We use VOM values (USD/MWh) as provided in the Danish Energy Agency's Technology Catalogues for Vietnam (2023) and Indonesia (2024), opting for the higher values in case the values differ between the catalogues.

Marginal costs

We estimate the plant's short-run marginal cost (SRMC) and long-run marginal cost (LRMC) using the following formula:

$$SRMC\ (USD/MWh) = Average\ fuel\ cost\ (USD/MWh) + VOM\ (USD/MWh)$$

$$LRMC\ (USD/MWh) = Average\ fuel\ cost\ (USD/MWh) + FOM\ (USD/MWh) + VOM\ (USD/MWh)$$

Profitability

We estimate the plant's profitability using the following formula:

$$Short\ term\ profitability\ (USD/MWh) = PPA\ tariff\ price\ (USD/MWh) - SRMC\ (USD/MWh)$$

$$Long\ term\ profitability\ (USD/MWh) = PPA\ tariff\ price\ (USD/MWh) - LRMC\ (USD/MWh)$$

CAPEX

The initial capital expenditure (CAPEX) of the coal plant is defined as the 2023 value of the project cost. This is based on the nominal project cost announced at the close of the initial financing or, if possible, the revised project cost after construction. The figure is adjusted for inflation to reflect constant 2023 prices.

We estimate the plant's CAPEX per MW using the following formula:

$$CAPEX\ (USD/MW) = \frac{Total\ CAPEX\ (USD)}{Installed\ capacity\ (MW)}$$