This publication presents the projected Grid Emission Factor (GEF) for Peninsular Malaysia from 2025 to 2034, based on Generation Development Plan 2/2025 (JPPET 2/2025). The analysis utilizes IPCC emission factors to model the decarbonization pathways.

Grid Emission Factor Projections

For Peninsular Malaysia (2025 - 2034)

Sustainability Management, Strategic Advisory, Single Buyer

1.0 Executive Summary

This publication presents the Single Buyer's projected Grid Emission Factor (GEF) for Peninsular Malaysia from 2025 to 2034, based on the Generation Development Plan presented to *Jawatankuasa Pembangunan Dan Pelaksanaan Pembekalan Elektrik Dan Tarif (JPPET) Bil. 2/2025*. The analysis demonstrates a clear pathway for the decarbonisation of Peninsular Malaysia's electricity grid, with the GEF projected to decline from 0.632 Gg CO_2e/GWh in 2025 to 0.332 Gg CO_2e/GWh in 2034, representing a 47% reduction over the decade. The methodology utilises IPCC emission factors and AR5 Global Warming Potential values

2.0 Introduction and Strategic Context

- **Mandate of the Single Buyer:** The Single Buyer is statutorily responsible to conduct electricity planning and plays a key role in promoting efficiency and facilitating competition in the generation sector. As part of this mandate, it advises the *Jawatankuasa Pembangunan Dan Pelaksanaan Pembekalan Elektrik Dan Tarif (JPPPET)* on the Generation Development Plan (GDP), outlining a strategy for a secure, reliable, and sustainable electricity supply for the nation towards net-zero by 2050.
- **Purpose of this GEF Projection:** The GEF, measured in Gigagrams of carbon dioxide equivalent per gigawatt-hour (Gg CO_2e/GWh), is a vital Key Performance Indicator (KPI) for tracking the environmental performance of the power sector. It enables accurate corporate Scope 2 emissions accounting and is critical for measuring progress towards national decarbonisation goals under the Paris Agreement.
- **Scenario for the Future:** This projection is based on the "Steady Progress" pathway from JPPET 2/2025. It is a balanced scenario aligns with current policy targets and assumes a compounding annual growth rate (CAGR) of 4.6% in electricity demand, incorporating the planned phase-down of coal, expansion of renewable energy, and increased reliance on natural gas as a transitional fuel.

3.0 Historical Context and Baseline

To establish a credible foundation for future projections, it is essential to review the historical carbon intensity of Peninsular Malaysia's grid. The GEF values published by the Suruhanjaya Tenaga (ST) for 2017-2024 are the official baseline.

Year	Peninsular Malaysia’s Grid Emission Factor (Gg CO_2e/GWh)
2024	0.740
2023	0.760
2022	0.769

Year	Peninsular Malaysia's Grid Emission Factor (Gg CO_2e/GWh)
2021	0.757
2020	0.821
2019	0.753
2018	0.797
2017	0.767

Table 1: Published Grid Emission Factor (GEF) for Peninsular Malaysia (2017-2024)

Source: "Grid Emission Factor (GEF) in Malaysia" and "Grid Emission Factor (GEF) in Malaysia, 2022-2024 (Provisional)" published by Suruhanjaya Tenaga (ST) dated 25 Nov 2024 and 23 Feb 2026 respectively.

4.0 Methodology

4.1 Calculation Formula:

GEF (Gg CO_2e/GWh) = Total Grid Emissions (Gg CO_2e) / Total Electricity Generation (GWh)

4.2 Emission Factor and Global Warming Potential (GWP) Sources: This analysis is grounded in the internationally recognised scientific standards of the Intergovernmental Panel on Climate Change (IPCC).

- **Emission Factors:** The underlying CO_2, CH_4, and N_2O emission factors for each key fuel type in the Peninsular Malaysia generation mix are sourced from the **IPCC Guidelines for National Greenhouse Gas Inventories (2006)** including update of **the 2019 Refinement,** using the default values for energy generation. These are summarised in Table 2.
- **Global Warming Potential (GWP):** To consolidate emissions of different greenhouse gases into a single carbon dioxide equivalent (CO_2e) metric, the conversion factors from the **IPCC Fifth Assessment Report (AR5)** are applied, as shown in Table 3.

The specific values applied in this study are summarised in the table below:

Default Emission Factors for Stationary Combustion in the Energy Industries			
Fuel	Carbon Dioxide (CO_2) kg/TJ	Methane (CH_4) kg/TJ	Nitrous Oxide (N_2O) Kg/TJ
	Default Emission Factor		
Gas/Diesel Oil	74,100	3	0.6
Residual Fuel Oil	77,400	3	0.6
Other Bituminous Coal	94,600	1	1.5
Sub-Bituminous Coal	96,100	1	1.5

Natural Gas	56,100	1	0.1

Table 2: Applied IPCC's Default Emission Factors for Stationary Combustion

Source: IPCC 2006, Ch. 2, Table 2.2

Major Greenhouse Gases	GWP values for 100-year time horizon
	IPCC Fifth Assessment Report (AR5)
Carbon Dioxide (CO_2)	1
Methane (CH_4) – non-fossil	28
Methane (CH_4) – fossil	30
Nitrous Oxide (N_2O)	265

Table 3: Applied AR5 Global Warming Potential

Source: IPCC Assessment Report 5 (AR5)

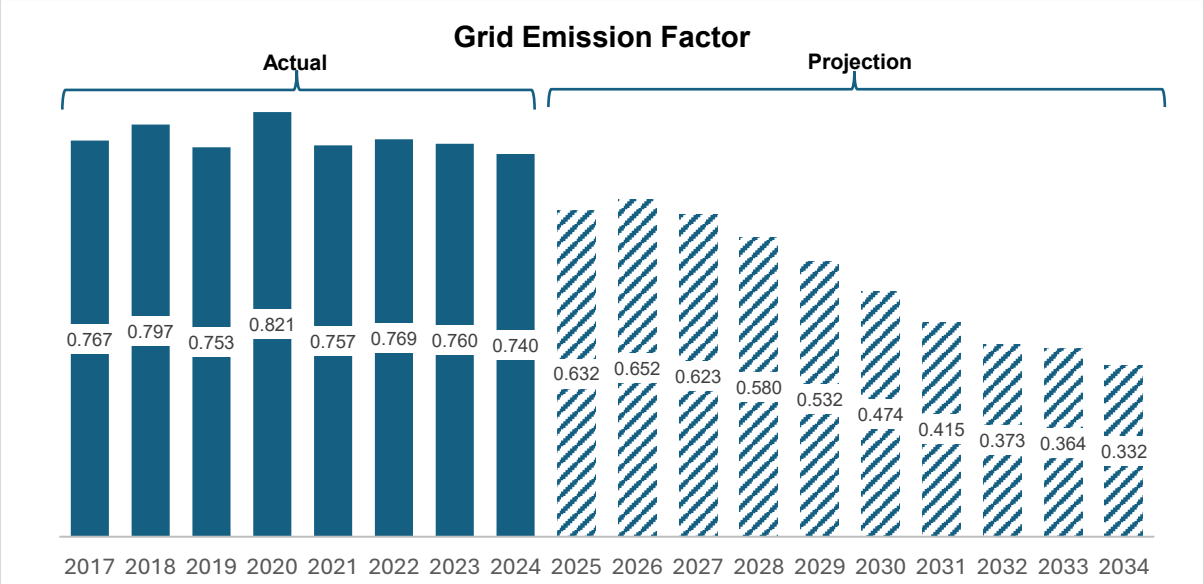
5.0 Projection Results: A Comparative Analysis

5.1 Projected GEF:

Fuel Type	Fuel Consumption (TJ)	GHG Emission (kg CO2e)	GHG Emission (Gg CO2e)	Net Electricity Generation (GWh)	GEF (Gg CO2e/GWh)
Year 2025					
Coal	813,808	78,554,816,970	78,555	158,307	**0.632**
Natural Gas	11,294	839,722,141	840		
Liquefied Natural Gas	366,555	20,584,425,641	20,584		
Total	1,191,657	99,978,964,752	99,979		
Year 2026					
Coal	843,362	81,407,663,101	81,408	166,826	**0.652**
Natural Gas	292,000	21,709,908,000	21,710		
Liquefied Natural Gas	101,175	5,681,641,749	5,682		
Total	1,236,538	108,799,212,850	108,799		
Year 2027					
Coal	856,615	82,686,859,045	82,687	179,063	**0.623**
Natural Gas	292,000	21,709,908,000	21,710		
Liquefied Natural Gas	128,484	7,215,187,037	7,215		
Total	1,277,098	111,611,954,082	111,612		
Year 2028					
Coal	865,625	83,556,646,146	83,557	191,200	**0.580**

Fuel Type	Fuel Consumption (TJ)	GHG Emission (kg CO2e)	GHG Emission (Gg CO2e)	Net Electricity Generation (GWh)	GEF (Gg CO2e/GWh)
Liquefied Natural Gas	485,857	27,284,001,104	27,284		
Total	1,351,482	110,840,647,250	110,841		
Year 2029					
Coal	789,721	76,229,775,487	76,230	201,886	**0.532**
Liquefied Natural Gas	554,130	31,118,005,838	31,118		
Total	1,343,851	107,347,781,325	107,348		
Year 2030					
Coal	666,780	64,362,589,075	64,363	211,466	**0.474**
Liquefied Natural Gas	637,770	35,814,943,921	35,815		
Total	1,304,550	100,177,532,996	100,178		
Year 2031					
Coal	533,239	51,472,223,711	51,472	222,067	**0.415**
Liquefied Natural Gas	725,120	40,720,190,610	40,720		
Total	1,258,359	92,192,414,322	92,192		
Year 2032					
Coal	420,518	40,591,596,613	40,592	234,665	**0.373**
Liquefied Natural Gas	833,908	46,829,328,770	46,829		
Total	1,254,426	87,420,925,383	87,421		
Year 2033					
Coal	419,998	40,541,315,438	40,541	246,226	**0.364**
Liquefied Natural Gas	875,508	49,165,444,786	49,165		
Total	1,295,505	89,706,760,224	89,707		
Year 2034					
Coal	319,207	30,812,210,255	30,812	256,980	**0.332**
Liquefied Natural Gas	969,210	54,427,417,779	54,427		
Total	1,288,416	85,239,628,034	85,240		

Table 4: Projected Grid Emission Factor from 2025 to 2034 for Peninsular Malaysia



Graph 1: Illustration of Projected Grid Emission Factor from 2025 to 2034 for Peninsular Malaysia

5.1 Interpretation of Results:

Graph 1 demonstrates a clear and consistent downward trend in GEF, directly correlated with structural changes in the generation mix:

- **Initial Phase (2025-2026):** The GEF remains relatively stable or sees a slight increase, reflecting near-term capacity constraints and demand growth.
- **Decarbonisation Acceleration (2027 onwards):** A sustained decline is driven by two key factors: (1) the **planned phase-out of coal-fired generation**, and (2) its replacement with a combination of **renewable energy (RE)** and lower-carbon **Liquefied Natural Gas (LNG)**. The most significant reductions occur post-2030 as coal's share in the mix diminishes substantially.
- **Overall Reduction:** The GEF is projected to fall by approximately **47%** from 2025 to 2034, showcasing a decisive pathway towards a lower-carbon grid.

6.0 Implications for Stakeholders

- **For Corporate Entities:** Companies can use this forward-looking GEF to improve the accuracy of their long-term Scope 2 emissions forecasts, stress-test their net-zero strategies, and make informed decisions regarding energy procurement and renewable energy investments.
- **For Investors and Project Developers:** The projected trend signals clear market direction and de-risks investments in renewable energy and supporting infrastructure, as the grid's carbon intensity is set to decline in line with national policy.

7.0 Limitations and Uncertainties

These are model-based projections contingent on the realisation of the GDP scenarios. Key uncertainties include:

- **Project Execution Risk:** Delays in RE project commissioning or plant retirements.
- **Fuel Price Volatility:** Significant shifts in global gas and coal markets.
- **Technological & Policy Evolution:** Faster-than-expected cost reductions in energy storage, hydrogen, or the introduction of more stringent climate policies could accelerate decarbonisation beyond this scenario.
- **Data Constraint:** The projection data is limited to the data available at Single Buyer. It might not be reflective of data outside of Single Buyer's outreach.

8.0 Conclusion and Next Steps

The publication of this GEF projection underscores the Single Buyer's commitment to transparent and strategic energy planning. The Single Buyer will continue to refine these projections annually, providing stakeholders with a reliable tool for navigating the energy transition.

9.0 Glossary of Terms

- **GEF (Grid Emission Factor):** The average emission rate of a given unit of electricity from the grid.
- **CO_2e (Carbon Dioxide Equivalent):** A standard unit for measuring carbon footprints, converting all greenhouse gases into the equivalent amount of CO_2 with the same global warming potential.
- **IPCC AR5:** The Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
- **GWP (Global Warming Potential):** A measure of how much heat a greenhouse gas traps in the atmosphere over a specific time period, compared to CO_2.