PAGE PARTNERSHIP FOR ACTION ON GREEN ECONOMY



The Just Transition Assessment Model for Thailand

Supporting Evidence-based Climate, Employment and Just Transition Policies

UN environment programme

International Labour Organization

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Contents

1. Introduction 6
1.1 Purpose of the Just Transition Assessment Model and its relevance for Thailand 6
1.2 Objectives of JTAM-Thailand 8
2 Methodology: JTAM-Thailand 10
2.1 Model overview 10
2.2 The mathematical core: A non-equilibrium approach 11
2.3 Scenario design 11
2.3.1. The baseline scenario 12
2.3.2 Carbon tax scenarios 12
2.2.3 ETS with and without a CBAM 13
2.3.4 Coal Phase-out 13
2.4 Strengths and limitations of JTAM-Thailand 14
2.4.1 Strengths 14
2.4.2 Limitations 14
3 Overview of data sources 15
3.1 Economic data 15
3.2 Energy and environment data 15
3.3 Social and demographic data 15
3.4 Data harmonization and use in JTAM-Thailand 16
4 Findings 17
4.1 Environmental impact 17
4.2 Macroeconomic and employment impacts 17
4.3 Selecting representative scenarios 21
4.5 Employment impacts by sector 24
5 Conclusion and policy implications 27
5.1 Conclusion 27
5.2 Policy recommendations with institutional responsibilities 28
5.2.1 Establish a coordinated cross-ministerial climate–labour policy process and social dialogue 28
5.2.2 Recycle carbon revenues towards productive green investment, human capital development and labour-market restructuring 28
5.2.3 Align industrial and trade policy with decarbonization and green growth objectives 28
5.2.4 Prioritize labour transition policies for affected sectors and workers 29
5.2.5 Use energy institutions to guide a gradual and predictable transition 29
5.2.6 Strengthen climate and emissions governance through technical agencies 29
5.2.7 Improve labour, social and sectoral data systems for just transition analysis 29
5.2.8 Institutionalize JTAM-Thailand as a planning tool, not a one-off exercise 30
5.3 Directions for further research 30
6 References 33
Appendix A 34

List of Abbreviations

Acronym	Definition
BOT	Bank of Thailand
CBAM	Carbon Border Adjustment Mechanism
DEDE	Department of Alternative Energy Development and Efficiency
DCCE	Department of Climate Change and Environment
EPPO	Energy Policy and Planning Office
E3ME	Energy-Environment-Economy Macro-Econometric model
ETS	Emissions trading system
FRAMES	Framework for Modelling Economies and Sustainability
FTT:Power	Future Technology Transformations power submodule
JTAM	Just Transition Assessment Model
NSO	National Statistical Office
TGO	Thailand Greenhouse Gas Management Organization

List of Figures

Figure 2.1: Illustrative structure of FRAMES 10
Figure 4.1: Environmental impact (all scenarios) 17
Figure 4.2: Macroeconomic impact (all scenarios) 18
Figure 4.3 Employment impact (all scenarios) 19
Figure 4.4: Macroeconomic and environmental impact of carbon tax policies 20
Figure 4.5 Macroeconomic and environmental impacts: Pure ETS vs. ETS + CBAM 22
Figure 4.6 Macroeconomic and environmental impact of key climate policies 23
Figure 4.7 Top 20 most-impacted sectors (2050) 25

List of Tables

Table 3.1: Summary table for data sources 16
Table A.1: Sectoral classification used in JTAM-Thailand 34

1. Introduction

Countries are increasingly adopting climate, green growth, and sustainability policies to address the urgent challenges posed by climate change while ensuring economic competitiveness, social protection, and decent work for all. Thailand is advancing its commitments under the Climate Change Bill, Nationally Determined Contributions (NDC), and emerging policies on carbon markets, Emission Trading Scheme (ETS) development, and fiscal reforms. With global policy shifts such as the EU CBAM affecting Thailand's major export sectors, policymakers face growing pressure to develop coherent cross-ministerial strategies that integrate climate, industrial, labour, social, and economic priorities.

The Partnership for Action on Green Economy (PAGE)—a collaboration of five UN agencies (UNIDO, UNDP, ILO, UNITAR, and UNEP)—works closely with Thailand's National Economic and Social Development Council (NESDC), the PAGE focal point agency, and the Subcommittee on Carbon Emission Management under the PAGE National Steering Committee to strengthen Thailand's capacity to establish carbon market mechanisms, focusing on developing an ETS tailored to the national context. As part of this initiative, UNIDO is conducting the stocktaking of ETS development, assess sectoral readiness for GHG reduction in key energy and industry sectors, and develop an overall ETS policy framework with an action plan based on inputs from other agencies. UNDP is assessing socio-economic and environmental impacts to inform policy coherence; ILO is in charge of a green jobs and Just Transition analysis to ensure labour market resilience; UNITAR is developing ETS training to build technical capacity; and UNEP is providing technical guidance on overall carbon pricing tools and market to align with international best practices and environmental integrity.

To address this complexity, the ILO and Cambridge Econometrics have developed the Just Transition Assessment Model (JTAM)—a modelling framework that integrates climate, energy, economic, labour market, and social indicators. JTAM enables governments to quantify policy impacts on employment, skills, sectors, GDP, emissions, and distributional outcomes, using methodologies grounded in international standards and the ILO's frameworks on employment, decent work, skills, green jobs, and Just Transition.

Thailand is among the first countries to apply this tool at scale through the development of JTAM FRAMES Thailand, a nationally calibrated model bespoke to Thailand's context. The model supports coherent evidence-based policy formulation and strengthens institutional collaboration across economic planning, climate policy, labour institutions, and social partners.

1.1 Purpose of the Just Transition Assessment Model and its relevance for Thailand

The Just Transition Assessment Model (JTAM) is a nationally adaptable, integrated modelling framework designed to assess the economy-wide impacts of climate and development policies on economic performance, labour markets, emissions and distributional outcomes. By linking macroeconomic and sectoral accounts with labour and environmental indicators, the JTAM enables the simulation of alternative policy scenarios – such as carbon pricing, renewable energy deployment and sectoral decarbonization – and the systematic assessment of their implications for output, employment and emissions. The model has been applied across multiple country projects under the Framework for Modelling Economies and Sustainability (FRAMES) to support analytical work related to



Nationally Determined Contribution updates, emissions trading system (ETS) design and just transition planning.

FRAMES is an integrated modelling architecture designed to analyse interactions between economic activity, environmental sustainability and labour-market outcomes in an economy-wide context. Within this framework, the JTAM functions as a specialized application focusing on just transition analysis, complementing macroeconomic and environmental modelling with labour and distributional perspectives. FRAMES and the JTAM were developed by Cambridge Econometrics, drawing on its long-standing expertise in economy-wide macro-econometric modelling for climate, energy and labour policy analysis. Aligning the JTAM with international statistical systems – such as the System of National Accounts, the System of Environmental-Economic Accounting and the International Standard Industrial Classification – and ILO analytical frameworks ensures consistency with established economic and labour metrics, facilitating the integration of modelling results into national policy analysis and planning processes.

The primary function of the JTAM within FRAMES is analytical and diagnostic. It translates policy assumptions into quantifiable economic and labour-market outcomes, allowing the identification of trade-offs and complementarities across policy objectives. In particular, the JTAM supports the assessment of distributional impacts across sectors, thereby informing the design of accompanying measures such as skills development, social protection and active labour-market policies. While the JTAM is not intended to capture firm-level behaviour or short-term labour-market adjustments, it provides robust medium- to long-term insights to inform strategic policy analysis and scenario comparison.

JTAM-Thailand is being undertaken in response to a rapidly evolving domestic policy context – including the development of the Climate Change Act, updated

Nationally Determined Contribution commitments, emerging discussions on carbon markets and a potential ETS – and external policy drivers such as the European Union's Carbon Border Adjustment Mechanism. The application provides a nationally calibrated analytical tool to assess the socioeconomic implications of alternative climate and development policy packages. It aims to support evidence-based policy dialogue and cross-ministerial coordination across economic planning, climate policy and labour institutions.

Experience from other FRAMES and JTAM country applications demonstrates the relevance of this approach for informing policy processes. Previous applications have shown how scenario-based modelling can be used to identify sectors and worker groups that may face adjustment pressures under different transition pathways. They can also inform the design of targeted labour-market and social policy responses, including reskilling initiatives, income support mechanisms and sectoral diversification strategies. These experiences highlight the importance of data consistency, stakeholder engagement and the combination of quantitative modelling with structured policy dialogue to ensure that analytical results are effectively interpreted and used.

JTAM-Thailand's inception phase establishes the analytical foundation for subsequent modelling, capacity development and policy engagement activities. The application is expected to deliver:

- diagnostic insights into sectoral, occupational and distributional impacts of alternative mitigation pathways;
- analytical support for policy design, through the assessment of integrated policy packages combining climate, labour and social measures;
- strengthened national capacity, by supporting coordinated use of modelling tools across relevant institutions and embedding just transition considerations within ongoing climate and development planning processes.

1.2 Objectives of JTAM-Thailand

JTAM-Thailand aims to establish an analytical foundation to support evidence-based assessment of climate and development policies from a just transition perspective. By applying an economy-wide modelling framework calibrated to national data, the project seeks to generate insights into the economic, labour-market and distributional implications of alternative transition pathways, thereby informing policy dialogue and decision-making.

The specific objectives of JTAM-Thailand are to:

1. Assess the economy-wide impacts of climate and development policy scenarios: Analyse the potential effects of selected policy scenarios – such as decarbonization pathways, carbon pricing instruments and sector-specific mitigation measures – on macroeconomic indicators, sectoral output, employment and emissions within an integrated modelling framework.
2. Identify labour market and distributional impacts of transition pathways: Examine how alternative scenarios affect employment levels, occupational structures and worker groups across sectors and regions, with particular attention to distributional outcomes and potential adjustment pressures faced by vulnerable workers.
3. Support the design of complementary labour and social policy measures: Provide analytical inputs to inform the design of accompanying policies,

including skills development and reskilling programmes, active labour-market measures and social protection instruments, to mitigate adverse social impacts and support inclusive transition outcomes.

4. Strengthen national analytical and institutional capacity: Build technical capacity among national counterparts to apply, interpret and use JTAM-Thailand outputs, promoting sustained use of modelling tools in policy analysis and enhancing coordination across institutions responsible for economic planning, climate policy, labour and social protection.
5. Facilitate informed policy dialogue and cross-ministerial coordination: Support structured policy dialogue by providing a common analytical basis for discussion among government agencies, social partners and relevant stakeholders, thereby contributing to coherent and coordinated approaches to climate and just transition policymaking.

Through these objectives, JTAM-Thailand is intended to support the development of coherent, evidence-based policy approaches that balance climate ambition with economic resilience, employment outcomes and social inclusion, in line with national priorities and international commitments.

This report is structured as follows:

- Chapter 2 outlines the FRAMES technical framework and methodology, including an explanation of the model structure, underlying assumptions and a clear discussion of what the model can and cannot do.
- Chapter 3 gives an overview of data sources, describing the economic, labour and environmental datasets used to calibrate the model for Thailand.
- Chapter 4 presents the final modelling outputs and simulation results, covering both the baseline scenario and selected policy scenarios.
- Chapter 5 closes the report with a set of conclusions and policy recommendations, highlighting key implications for Thailand's climate, labour and development policies and identifying areas for further analysis and stakeholder dialogue.

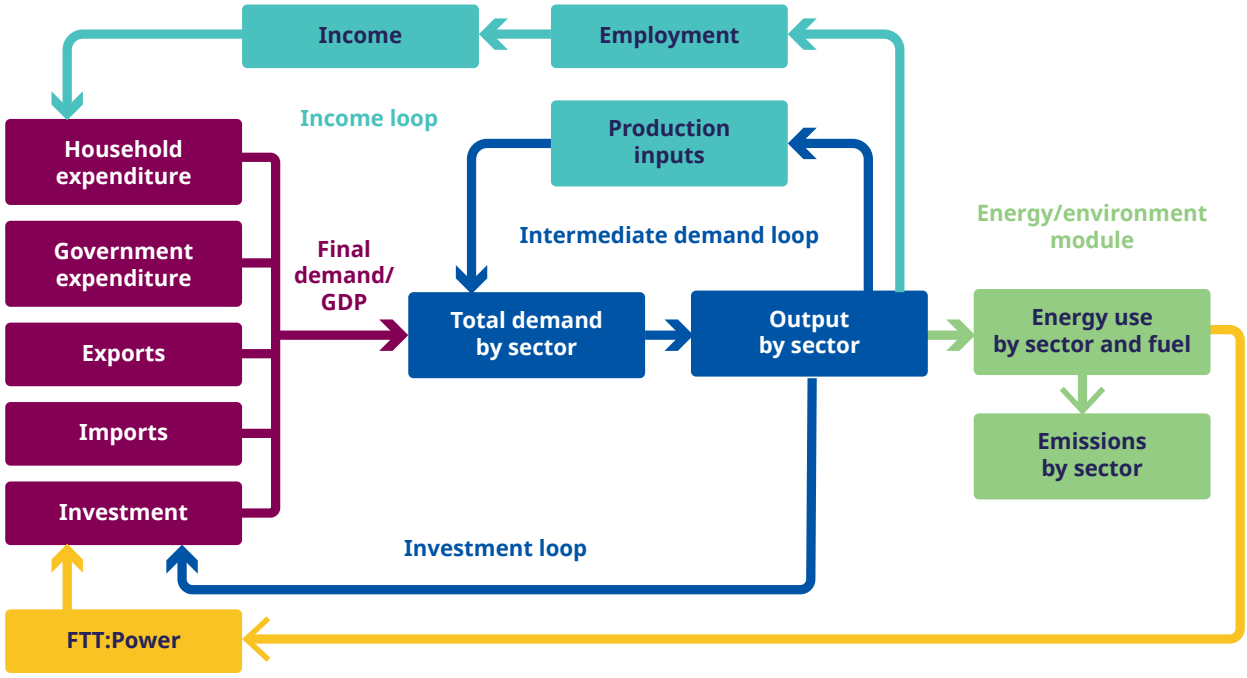
2 Methodology: JTAM-Thailand

2.1 Model overview

This study uses the JTAM, which is structured around FRAMES. FRAMES can be regarded as a simplified version of Cambridge Econometrics' global Energy-Environment-Economy Macro-Econometric (E3ME) model. JTAM-Thailand is a highly specialized custom-calibrated single-country derivative of the E3ME model designed to provide rigorous econometric analysis in economies where detailed data may be limited.

As a simulation tool founded on post-Keynesian economic principles, FRAMES differs from traditional Computable General Equilibrium models. It does not assume perfect knowledge, rational optimizing behaviour and market clearing. Instead, it allows for market frictions and assumes there is usually spare economic capacity (such as involuntary unemployment). This non-equilibrium approach makes the model suited to evaluate the transitional frictions and "what-if" scenarios of climate policy.

Figure 2.1: Illustrative structure of FRAMES



Source: Adapted from Cambridge Econometrics, *Just Transition Assessment Model for Thailand: User manual*.

Figure 2.1 is taken from the JTAM-Thailand user manual. It illustrates that the model integrates the economy, energy systems and the environment, driven by two primary macroeconomic feedback cycles:

1. Income loop: Sectoral output leads to employment, generating income for households. This household expenditure, combined with government spending, investment and exports, feeds back into total final demand.

2. Investment loop: Output drives investment, which in turn elevates total final demand and further stimulates output.

Additionally, the macroeconomic core is deeply integrated with the Future Technology Transformations power sector (FTT:Power) submodule. FTT:Power simulates how investors and systems operators in the power generation sector adopt new technologies based on cost minimization, grid stability and learning-by-doing feedback, ultimately determining the technological configuration required to meet the economic demand.

2.2 The mathematical core: A non-equilibrium approach

The JTAM operates by calibrating a historical "baseline" projection and then running alternative scenarios to estimate the impact of changed assumptions. Consequently, many equations in the model are expressed directly as a "change from baseline" in a given year – denoted by Delta (Δ) – to identify a change across scenarios, rather than across time.

The transmission mechanism of a climate policy centres on the determination of Gross Output. In the FRAMES accounting structure, Gross Output (Q) is an endogenous variable calculated as the sum of intermediate and final demand for products, less the supply that comes from imports:

$$Q_{i,t} = QY_{i,t} + QC_{i,t} + QK_{i,t} + QG_{i,t} + QX_{i,t} - QM_{i,t}$$

where for sector *i* at time *t*:

- *QY* is intermediate demand (determined by input-output linkages);
- *QC* is product demand by consumers;
- *QK* is product flows to gross fixed capital formation (investment);
- *QG* is product flows to final government consumption;
- *QX* is export demand;
- *QM* is import supply.

When a climate policy (such as a carbon tax) is introduced, it acts as a shock that disrupts these components. The tax cascades through the supply chain, inflating prices and suppressing consumer demand (QC). However, government interventions designed for a just transition – such as recycling carbon revenues into green infrastructure or public services – act as positive exogenous shocks to government spending (QG) or investment (QK). By drawing upon the model's spare economic capacity, these revenue recycling mechanisms can offset the downward pressure on consumption and maintain overall output.

Finally, sectoral employment is determined as a derived demand function of this newly calculated Gross Output, meaning job creation or destruction is mathematically tied to the shifts in the Q_(i,t) equation.

2.3 Scenario design

Following the framework proposed by the United Nations Partnership for Action on Green Economy and the Thai National Economic and Social Development

Council (NESDC), the scenarios examined in this paper are grouped into four categories:

3. the baseline;
4. carbon taxation;
5. ETS with and without a Carbon Border Adjustment Mechanism (CBAM);
6. regulatory phase-outs.

These scenarios are designed to simulate the macroeconomic outcomes of different climate policy instruments and revenue recycling mechanisms within the JTAM-Thailand architecture.

2.3.1. The baseline scenario

The baseline scenario represents a "business-as-usual" trajectory for the Thai economy from now until 2050. It incorporates existing economic trends and population projections but excludes the introduction of new, aggressive national climate mitigation targets. In the JTAM-Thailand framework, the baseline assumes no new carbon pricing is introduced, and the sectors expand according to historical market-driven capacity trajectories. This scenario serves as the foundational counterfactual: all results from the subsequent policy scenarios are reported as deviations from this baseline.

Concretely, this means that in almost all figures in this report, the horizontal zero line represents the baseline – not zero economic activity or zero emissions, but rather the level that the Thai economy would reach under current policies in that year. A policy scenario plotted above zero is performing better than business-as-usual on that indicator (or increasing in terms of emissions); one plotted below zero is performing worse (or decreasing in terms of emissions). The baseline trajectory itself is not drawn as a separate line in the figures: since every scenario result is already expressed as a percentage difference from it, the baseline is always implicitly present as the flat zero line. Drawing it explicitly would add no information while reducing visual clarity.

2.3.2 Carbon tax scenarios

This category, proposed by the NESDC, explores the macroeconomic impacts of introducing a carbon tax specifically targeted at the energy and transportation sectors to yield six specific scenario runs. It tests two distinct price trajectories:

- **Net Zero 2050 Carbon Tax**: A target-driven approach where the carbon tax rate escalates over time to achieve net-zero carbon emissions by 2050.[1]
- **Benchmark-fixed Carbon Tax**: A policy-driven approach that introduces a fixed carbon tax of US$20 per ton of CO2 (converted to Thai baht), mirroring regional benchmark policies such as the Singaporean carbon price.

For both price trajectories, the generated tax revenues are allocated in three ways to evaluate efficiency–equity trade-offs in the Thai economy:

1 The NESDC also proposed Net Zero 2065 as a price trajectory, but it could not be simulated given that only a pre-built browser version of the model that runs through 2050 was available.

- **Debt Reduction**: Carbon tax revenue finances government debt and interest paid. This acts as a standard macroeconomic fiscal drag, where revenue is extracted from the economy and held in the treasury.
- **Government Expenditure**: Carbon tax revenue finances non-specified government spending, providing a broad macroeconomic stimulus to offset the inflationary impacts of the tax on the energy and transport sectors.
- **Green Subsidies**: Carbon tax revenue finances targeted government investment in renewable or alternative energy sources. In the model, this is executed by subsidizing the capital costs of green technologies in the FTT:Power, driving a "double dividend" of accelerated decarbonization and targeted job creation.

2.2.3 ETS with and without a CBAM

This category, proposed by the United Nations Partnership for Action on Green Economy, shifts the focus to targeted industrial policies, assessing how Thailand can decarbonize its heavy manufacturing base without losing international competitiveness.

- **Pure ETS**: Simulates the introduction of an ETS with a specific emissions threshold set at 25,000 tons of carbon dioxide equivalent (tCO2eq). This targets large, carbon-intensive industrial facilities. To mimic an experimental phase using free allowances, the policy acts strictly as a price signal without artificially inflating government revenues.
- **ETS + CBAM**: Simulates the introduction of an ETS charge in parallel with a Thai CBAM. To prevent "carbon leakage" (where cleaner or regulated domestic production is undercut by high-carbon foreign goods), an equivalent carbon penalty is applied to imports. As with Pure ETS, no revenue recycling is applied, ensuring that the two scenarios are directly comparable: any differences in outcomes can be attributed solely to the addition of the CBAM. Because JTAM-Thailand is a single-country model, the CBAM cannot be simulated natively through endogenous trade responses, so this is instead simulated mathematically via an exogenous volume shock. The Armington elasticity is applied to determine the resulting drop in Thai demand for foreign goods, and this negative volume shock is injected directly into the exogenous import supply. By artificially restricting the exogenous import supply, the model's core equation forces domestic Gross Output to expand to meet the existing final demand, causing the model to substitute foreign goods with domestic production to protect Thai industrial output and employment. It is important to note that this expansion of domestic output does not necessarily imply the construction of new factories or the opening of new production lines. Rather, the model assumes that existing industrial capacity in Thailand is underused and that additional demand can be met through idle resources.

2.3.4 Coal Phase-out

Unlike the market-driven tax scenarios, this scenario, proposed by the NESDC, tests a regulatory "command-and-control" approach. It simulates the direct phasing out of fossil fuels in the energy and transportation sectors, accompanied by a mandated switch to renewable energy sources. JTAM-Thailand executes this by combining physical capacity mandates with targeted consumer price signals. The FTT:Power submodule is used to model the scheduled, forced retirement of existing coal infrastructure and the mandated expansion of renewable capacity.

2.4 Strengths and limitations of JTAM-Thailand

2.4.1 Strengths

- **Fit to data scarcity**: A primary limitation of the global E3ME model is its reliance on massive, comprehensive cross-country datasets covering 71 global regions and spanning decades. JTAM-Thailand bypasses this constraint: by isolating the Thai economy, the model requires only national-level input-output tables, labour force statistics and energy balances. This ensures the model is calibrated precisely to Thailand's economic structure.
- **Rapid and iterative testing**: Because the global E3ME model simultaneously solves complex bilateral trade equations for dozens of interconnected regions, computational run times can be heavy. JTAM-Thailand removes the computational overhead required to solve for the rest of the world. This allows the model to solve quickly, empowering policymakers to rapidly test and iterate complex "what-if" scenarios, such as tuning carbon tax rates to hit a specific 2050 net-zero target.
- **Granular technological integration**: Despite being a simplified macroeconomic model, JTAM-Thailand successfully retains the high-fidelity FTT:Power submodule. It evaluates the levelized cost of electricity across 24 specific generation technologies, allowing for a rigorous, technology-level simulation of Thailand's power grid transition.

2.4.2 Limitations

- **Exogenous international trade**: JTAM-Thailand, as a single-country model, treats the "rest of the world" as exogenous. Consequently, simulating complex trade protections, such as CBAM, cannot be done natively. It requires offline calculations and the manual injection of exogenous volume shocks to the import matrix. That is, although the run time for JTAM-Thailand may take only a few seconds, the input required to run the scenario properly may take many hours to complete.
- **Parameter borrowing**: While the model is highly calibrated to Thailand's input-output structure, developing economies often lack the robust long-term time-series data required to fully estimate all econometric behavioural equations. To resolve this, JTAM-Thailand occasionally borrows parameters estimated from the broader Association of Southeast Asian Nations region within the E3ME database.
- **Fixed behavioural responses and partial dynamism**: While FTT:Power has path dependency in its costs, the rest of the model is static and peri
- ods are independent: it lacks strict path dependency in its behavioural equations. While the outcome in a given year directly influences the following year's starting point – allowing physical and financial changes to the system to be carried forward through time – the underlying behavioural responses that determine these outcomes remain fixed in relative terms. This assumption of fixed behavioural coefficients is a standard limitation that must always be considered in analyses using macroeconomic models. Because JTAM-Thailand relies on historical data to simulate these future policy responses, it may underrepresent the impact of unprecedented, non-linear societal shifts or sudden technological disruptions that entirely rewrite historical consumption patterns.

3 Overview of data sources

JTAM-Thailand drew on a comprehensive set of economic, energy–environmental and social datasets, combining national administrative statistics with international databases to ensure internal consistency and policy relevance. Data selection and harmonization followed international statistical standards to support robust economy-wide and labour-market analyses.

3.1 Economic data

Economic data were primarily sourced from Thailand's System of National Accounts, compiled by the NESDC. These data provided the macroeconomic backbone of the model and include sector-level gross value added and investment expenditure, as well as aggregate household final expenditure and government expenditure, all expressed in constant 2021 prices.

To capture intersectoral linkages and multiplier effects, Input–Output tables from the NESDC were used to distinguish between final and intermediate outputs. These tables enabled estimates of both direct and indirect effects across industries under alternative policy scenarios. External trade data were informed by Input–Output tables and national accounts for imports, while sector-level statistics from the UN Comtrade database complemented export data. GDP data from the NESDC were used as a consistency check across economic datasets.

Labour-market variables were incorporated using sector-level employment data compiled by the National Statistical Office (NSO) and the Bank of Thailand (BOT). Disposable income estimates were derived from the Labour Force Survey conducted by the NSO, allowing the model to analyse income-related and distributional outcomes across sectors.

3.2 Energy and environment data

Energy system representation was based on Thailand's energy balance tables, accessed through the Thai Energy Policy and Planning Office (EPPO). These data provided aggregated information on energy production, consumption and imports disaggregated by fuel type, including coal, petroleum products and alternative energy sources (renewable and traditional renewable energy).

To enhance sectoral resolution, final energy consumption by sector was drawn from data compiled by the Thai Department of Alternative Energy Development and Efficiency (DEDE). Energy prices and key behavioural parameters, such as elasticities of energy demand, were informed by the E3ME modelling framework to ensure consistency between economic and energy system dynamics.

Environmental impacts were quantified using emission coefficients, which specify greenhouse gas emissions per unit of energy consumed. These coefficients were sourced from the Thailand Greenhouse Gas Management Organization (TGO) and EPPO and were applied consistently across fuel types to estimate emissions trajectories under alternative scenarios.

3.3 Social and demographic data

Social and demographic dimensions were captured using population data and projections, disaggregated by age and gender, obtained from the World Bank. These data supported labour force projections and enabled the assessment of

longer-term demographic influences on employment, income distribution and just transition outcomes.

3.4 Data harmonization and use in JTAM-Thailand

All datasets were harmonized to ensure consistency in sectoral classification, units of measurement and base-year prices. While data availability constrained the level of disaggregation in some dimensions – particularly for informal employment and gender-specific labour outcomes – the combined dataset provided a coherent and policy-relevant empirical foundation for scenario-based analysis of Thailand's climate transition pathways.

Table 3.1: Summary table for data sources

Description	Source	Classification	Unit
Economics			
Input-Output tables	NESDC	Sector	THB (millions, 2021 prices)
Gross value added	NESDC	Sector	THB (millions, 2021 prices)
Household final expenditure	NESDC	Aggregate	THB (millions, 2021 prices)
Government expenditure	NESDC	Aggregate	THB (millions, 2021 prices)
Investment expenditure	NESDC	Sector	THB (millions, 2021 prices)
Import	NESDC	Sector	THB (millions, 2021 prices)
Export	UN Comtrade	Sector	THB (millions, 2021 prices)
GDP	NESDC	Aggregate	THB (millions, 2021 prices)
Employment	NSO & BOT	Sector	Thousands
Disposable income	NSO	Sector	THB (millions, 2021 prices)
Energy			
Energy consumption	EPPO & DEDE	Sector	ktoe
Energy price	E3ME	Fuel type	THB / ktoe (2021 prices)
Environment			
Emission coefficients	TGO & EPPO	Fuel type	ktCO2
Social			
Population	World Bank	Aggregate	Millions

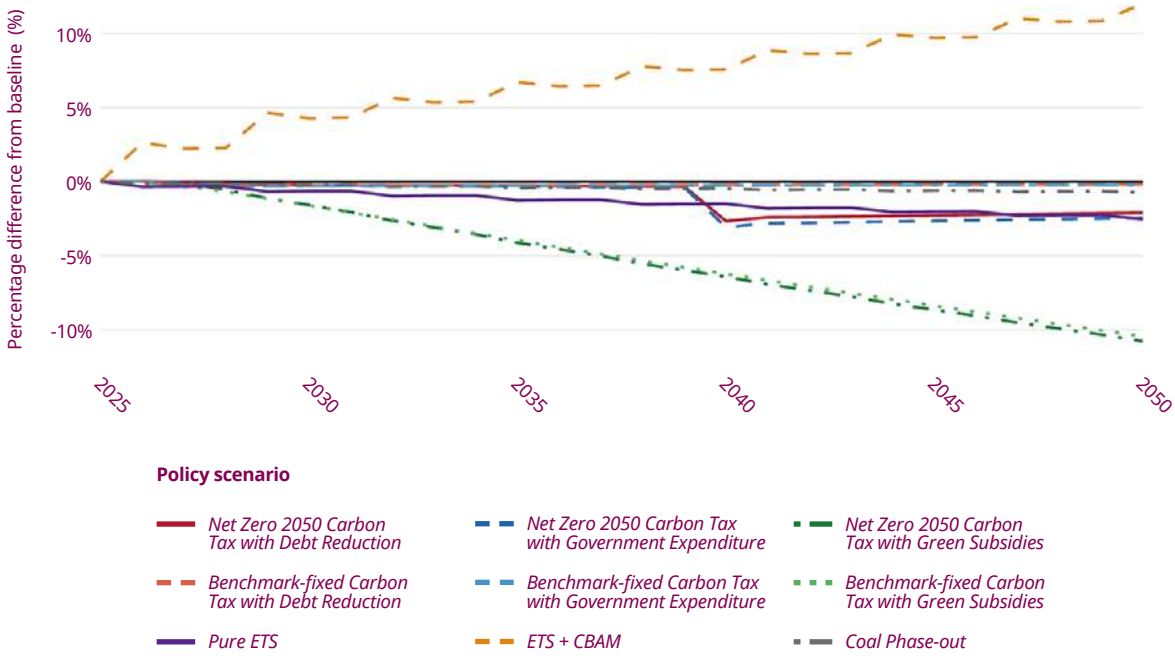
Notes: 1. ktoe = thousand tons of oil equivalent. 2. ktCO2 = thousand tons of carbon dioxide.
Source: Adapted from Cambridge Econometrics, slide presentation for the *Just Transition Assessment Model for Thailand: User Manual*.

4 Findings

4.1 Environmental impact

Thailand's Department of Climate Change and Environment (DCCE) has been actively developing the national Climate Change Act over the past few years; the Thai government recently approved a draft Act in principle, although it has not yet become law. As the government may be preparing to implement some of these policies, the scenarios simulated are highly relevant. By projecting the timeline forward and treating the Act as "recently approved in principle", a realistic and timely policy anchor is provided in this report.

Figure 4.1: Environmental impact (all scenarios)



Source: Authors' calculations using JTAM-Thailand.

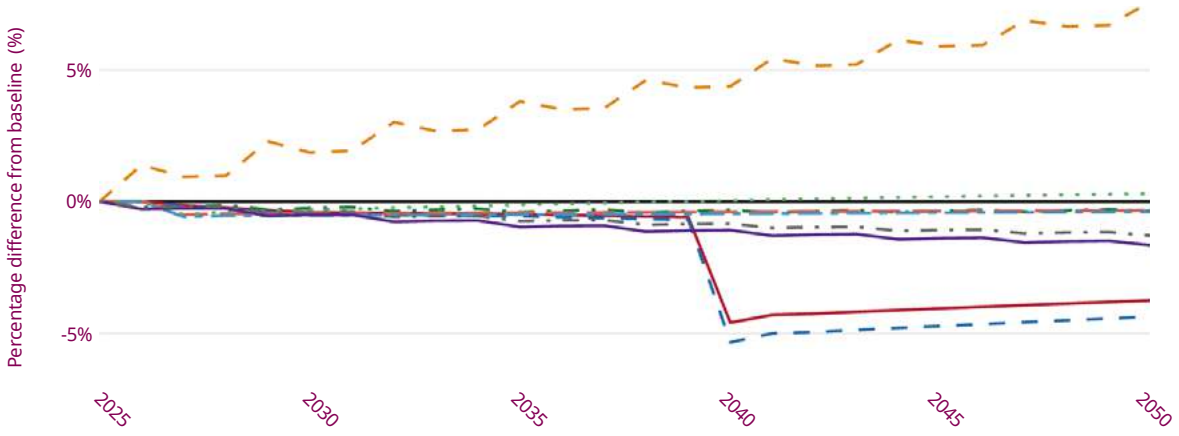
Note: GDP divergence relative to baseline.

Figure 4.1 shows substantial variation in carbon emissions trajectories across policy scenarios, highlighting the importance of policy design. In particular, scenarios combining a carbon tax with green subsidies generate the largest emissions reductions, with emissions declining by about −10 per cent below the baseline by 2050. By contrast, carbon price-only or contractionary policies yield limited or even counterproductive outcomes. Perhaps the most striking result is the ETS + CBAM scenario, where emissions increase steadily, reaching 10–12 per cent above the baseline by 2050.

4.2 Macroeconomic and employment impacts

Figure 4.2 illustrates how different policy designs and revenue recycling mechanisms shape Thailand's macroeconomic trajectory over the next 25 years.

Figure 4.2: Macroeconomic impact (all scenarios)



Policy scenario

- *Net Zero 2050 Carbon Tax with Debt Reduction*
- *Net Zero 2050 Carbon Tax with Government Expenditure*
- *Net Zero 2050 Carbon Tax with Green Subsidies*
- *Benchmark-fixed Carbon Tax with Debt Reduction*
- *Benchmark-fixed Carbon Tax with Government Expenditure*
- *Benchmark-fixed Carbon Tax with Green Subsidies*
- *Pure ETS*
- *ETS + CBAM*
- *Coal Phase-out*

Source: Authors' calculations using JTAM-Thailand.

Note: GDP divergence relative to baseline.

The results reveal a stark divergence in real GDP outcomes depending on how carbon tax revenues are used.

Scenarios that recycle carbon tax revenues into green subsidies produce the most favourable macroeconomic outcomes. In particular, the Benchmark-fixed Carbon Tax with Green Subsidies generates a sustained positive impact on GDP, reaching approximately 0.3 per cent above the baseline by 2050. The Net Zero 2050 Carbon Tax with Green Subsidies remains broadly neutral, with GDP close to the baseline over the long term. These results indicate that reinvesting revenues into domestic green investment can offset, and in some cases more than compensate for, the initial cost increases associated with carbon pricing.

In contrast, scenarios that allocate carbon tax revenues with no recycling act as a drag on economic activity. Under the Benchmark-fixed Carbon Tax with Debt Reduction, GDP declines modestly by around −0.5 to −1.0 per cent by 2050. However, under the more stringent Net Zero 2050 Carbon Tax with Debt Reduction scenario, GDP contracts sharply – falling by approximately −4 to −5 per cent – with a pronounced drop around 2040 following the large increase in the carbon tax rate. This reflects the absence of any compensating demand stimulus.

These outcomes can be understood through a demand-led macroeconomic mechanism. A carbon tax raises the cost of energy and intermediate inputs, reducing real income and dampening consumption. When revenues are not recycled into the domestic economy, this creates a persistent negative demand shock. In effect, income is withdrawn from the private sector without being re-injected, leading to lower aggregate demand and reduced output.

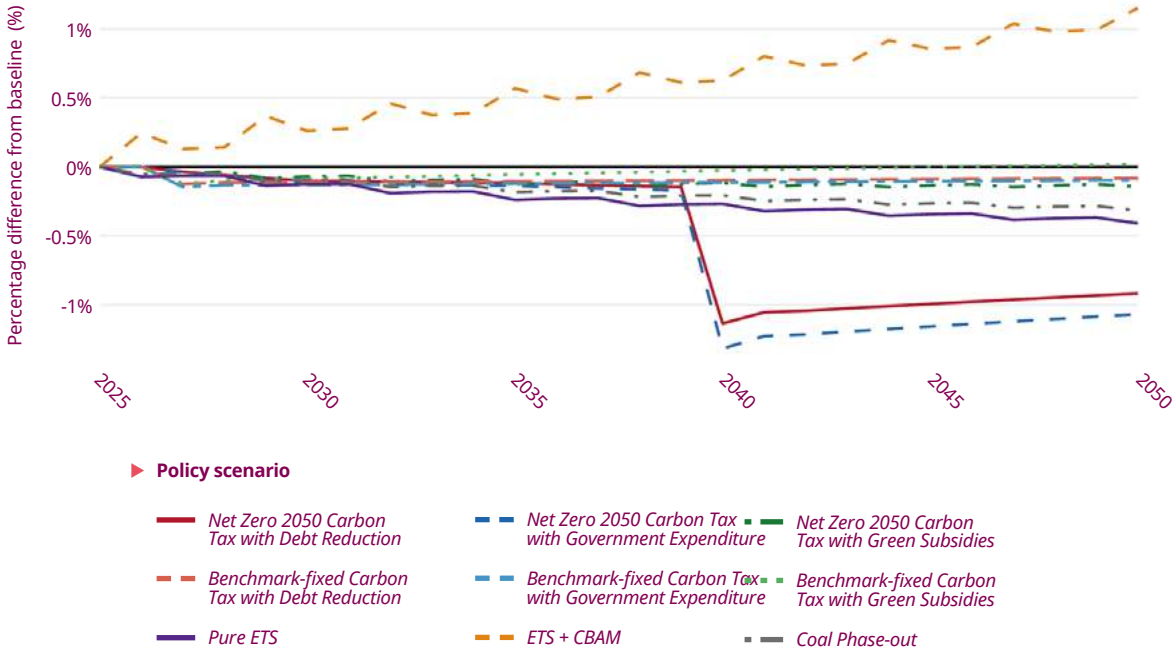
By contrast, recycling revenues into green investment generates a Keynesian multiplier effect. Public spending on green infrastructure stimulates demand across sectors, increases investment and supports employment. This not only

offsets the initial contractionary impact of the carbon tax but can also expand productive capacity over time, allowing GDP to exceed the baseline in well-designed policy scenarios.

The biggest positive GDP outcome is observed in the ETS + CBAM scenario. This is consistent with Figure 4.1, where the ETS + CBAM scenario generates the highest carbon emissions while Pure ETS has lower emissions and a negative GDP outcome. In the post-Keynesian framework, imports represent a "leakage" of demand out of the domestic economy. Pure ETS raises production costs for domestic heavy industries (like steel and cement), making them uncompetitive. Intuitively, buyers naturally switch to cheaper, high-carbon imports, which drains GDP. Unfortunately, a price elasticity in the import demand is not available in the current model version. However, introducing a CBAM can flip this story. By placing a carbon tariff on imported goods, the CBAM makes foreign products significantly more expensive. This forces a massive macroeconomic substitution effect: Thai construction firms and downstream supply chains shift their procurement away from imports and back towards domestic manufacturers. This captive surge in localized industrial demand, compounded by the new tariff revenues collected at the border, acts as a massive expansionary shock to the economy. However, combined with the results revealed in Figure 4.1, this growth is carbon-intensive, leading to rising emissions; that is, this policy is "brown growth" rather than green growth.

Scenarios combining a carbon tax with green subsidies or government expenditure generally show broadly neutral GDP effects. In this case, the carbon tax raises costs (negative effect) but the recycling of revenue from government expenditure stimulates demand (positive effect); where green sectors expand and offset contraction in fossil fuel sectors, GDP remains close to the baseline, ranging from −0.4 per cent to 0.3 per cent by 2050. The exception is the Net Zero

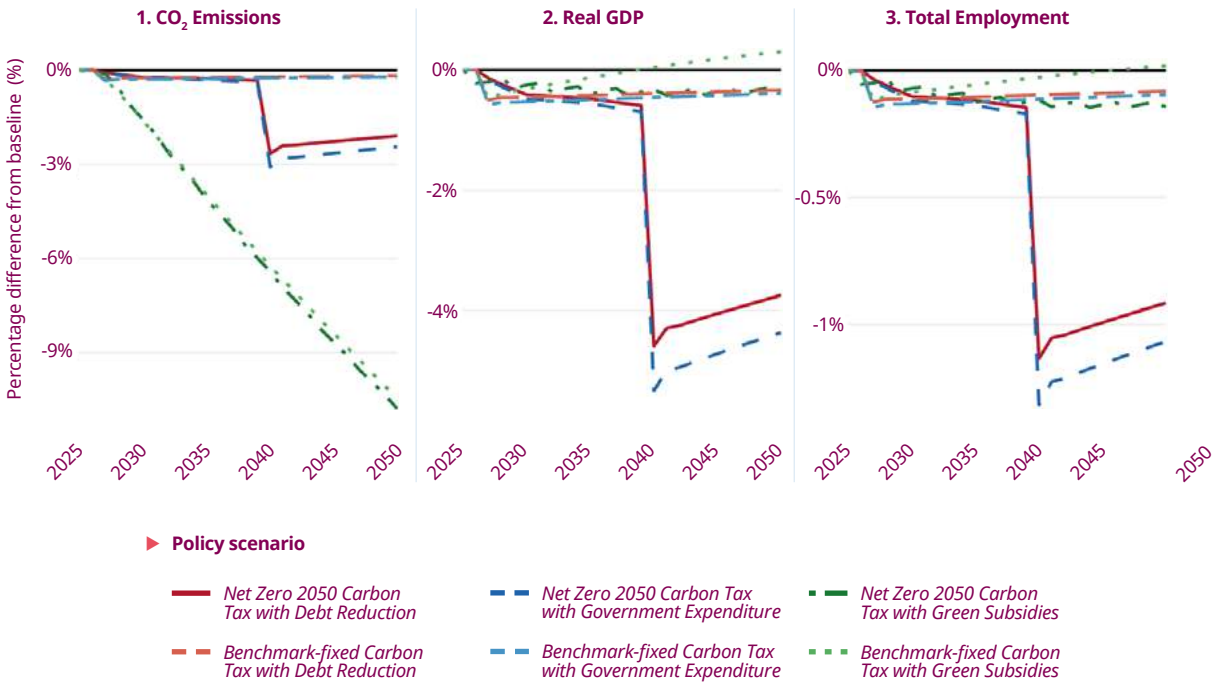
Figure 4.3 Employment impact (all scenarios)



Source: Authors' calculations using JTAM-Thailand.

Note: GDP divergence relative to baseline.

Figure 4.4: Macroeconomic and environmental impact of carbon tax policies



Source: Authors' calculations using JTAM-Thailand.

Note: Comparing Net Zero 2050 vs. Benchmark-fixed carbon taxes under different revenue schemes (vs. baseline).

2050 Carbon Tax with Government Expenditure, which records the largest GDP contraction of any scenario (−4.4 per cent). General government expenditure does not induce the low-carbon technology deployment that green subsidies drive, so emissions fall by only around 2.5 per cent, and the sharp carbon-price increase from 2040 applies to a largely undiminished tax base. These scenarios demonstrate that the negative cost effects of climate policy can be offset by demand stimulus.

The most negative GDP outcomes occur wherever Net Zero 2050 carbon tax revenues are not recycled into green investment, whether through debt reduction (−3.8 per cent) or government expenditure (−4.4 per cent). In both cases, the cost shock is not matched by structural change in production, and aggregate demand declines significantly.

Figure 4.3 illustrates the total employment trajectories across all 10 scenarios, with most paths mirroring the GDP predictions in Figure 4.2. However, the only exception is the Benchmark-fixed Carbon Tax with Green Subsidies scenario: in the GDP chart, this scenario is slightly positive; in the employment chart, however, the line is slightly negative and relatively flat.

One possible explanation is that the carbon tax creates an immediate, severe shock to traditional labour-intensive sectors – such as retail, traditional manufacturing and fossil fuels – because energy costs spike sharply. When the government recycles the revenue into green subsidies, this successfully drives substantial GDP growth through infrastructure investment (solar farms, grid upgrades etc.). However, while green infrastructure is capital-intensive (buying solar panels, steel, turbines etc.) it is not immediately labour-intensive enough

to offset the sheer number of jobs lost in the broader economy during the transition phase.

4.3 Selecting representative scenarios

With ten scenarios being considered at once, there is a risk of missing something important and focusing only on the most obvious outcomes. With four scenario categories available – the baseline, carbon taxation, emissions trading schemes with and without border adjustments and regulatory phase-outs – each one can be examined more carefully by selecting only a few policies within it.

Figure 4.4 shows both the environmental and macroeconomic impacts of all six carbon-tax scenarios outlined in 2.3.2, with a large drop observed in some of them. Starting from a relatively plausible level, the carbon price is set at 300 baht, starting in 2026 and held constant for three years. It is then increased by a further 300 baht and held constant for another three years, continuing in this manner until the carbon price reaches 2,700 baht in 2050. This setting is the default for all carbon-tax scenarios.

However, since the aim is to reach net zero by 2050, the results under this carbon-tax trajectory show they are still very far from that goal. After repeated trial-and-error runs with different carbon-price trajectories, a very high value of 8,000 baht is deliberately chosen for 2040–2050. This price is internationally benchmarked: at 2026 exchange rates, 8,000 baht/tCO_2 is approximately US$245/$tCO_2$, placing it near the upper end of the mid-century carbon price ranges implied by the IEA's Net Zero Emissions by 2050 Scenario. Starting at this high level would be very unrealistic; instead, a jump in the carbon tax is introduced in 2040, which explains the sharp drop in carbon emissions, GDP and employment in 2040 across all subplots. The conclusion is that it is not possible to achieve net zero through an extremely large, sudden carbon-price shock in 2040.

The results suggest that achieving net-zero emissions by 2050 cannot be accomplished through late-stage increases in carbon pricing alone. Even with very high carbon prices introduced after 2040, emissions reductions remain insufficient, highlighting the importance of early and sustained policy action.

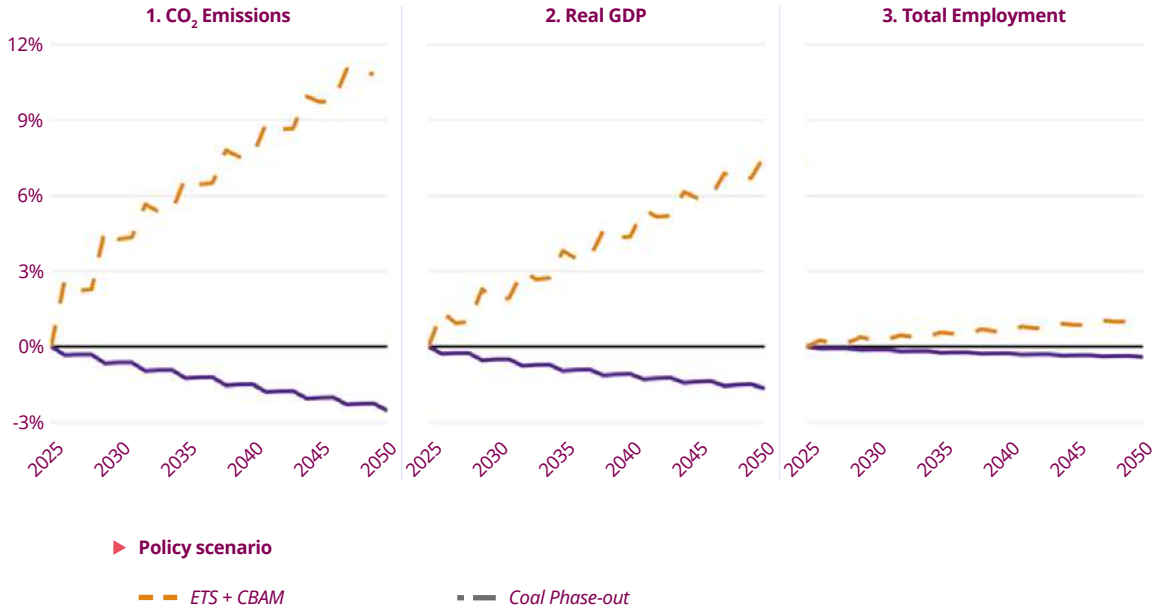
From these six scenarios, only a few of them have been selected to represent the carbon-tax scenarios. The criteria are intuitive: for carbon emissions, a policy that leads to lower emissions is better; for GDP and total employment, a policy that leads to higher values is better. The Net Zero 2050 Carbon Tax with Green Subsidies and Net Zero 2050 Carbon Tax with Debt Reduction scenarios are often the dominant policies in terms of these criteria, so they are taken as representative of carbon taxes.

Figure 4.5 plots both the environmental and macroeconomic impacts of Pure ETS and ETS + CBAM. Both scenarios give different results: as discussed earlier, ETS + CBAM raises carbon emissions, GDP and total employment. Since there are only two scenarios considered here, the opposite pattern is clearly visible in Pure ETS.

The Pure ETS scenario penalizes domestic heavy industries, which has important policy implications. As trade policy is industrial policy, to protect and expand the blue collar manufacturing workforce, Thai policymakers cannot implement strict carbon pricing on domestic industry without simultaneously erecting border protections. A CBAM is essential to prevent deindustrialization and secure a net positive labour outcome for the manufacturing sector.

However, while the ETS + CBAM scenario is an overwhelming macroeconomic success, the carbon emissions panel reveals that it is environmentally harmful. Pure ETS manages to reduce national carbon emissions by roughly −3 to −4 per cent. Conversely, the ETS + CBAM scenario causes emissions to ultimately surge

Figure 4.5 Macroeconomic and environmental impacts: Pure ETS vs. ETS + CBAM



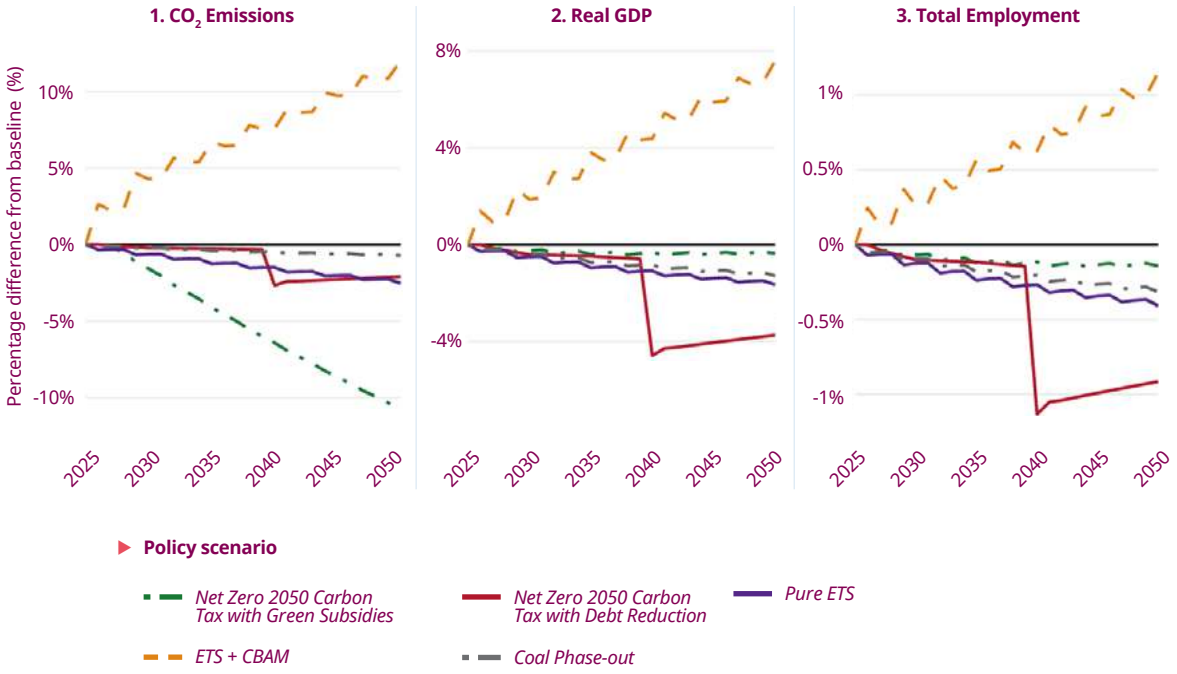
Source: Authors' calculations using JTAM-Thailand.
Note: Comparing a pure domestic ETS against an ETS with CBAM.

to 12 per cent above the baseline by 2050. A CBAM secures jobs, but it actively harms the net-zero target if left unaccompanied by stronger climate policies. To prevent this brown growth, the government must intervene aggressively to invest in greening industrialization and the electrification of transport. As the sector analysis in 4.5 reveals, the strongest impacts come from iron and steel, oil and gas, and paper and printing. Recycling revenues to green these three sectors could potentially lead to a triple-win scenario for green industrial growth, jobs and emissions reductions. Further interventions in skills development, research and technology, and labour-market policies might be needed to make these policies feasible and more appealing. Because the two ETS scenarios move in opposite directions, both are included in the analysis.

Figure 4.6 compares only five selected policy scenarios against the baseline emissions across three key dimensions: carbon emissions, real GDP and total employment. The Net Zero 2050 Carbon Tax with Green Subsidies scenario is the only one that achieves substantial emissions reductions, with a drop of approximately −10 per cent below the baseline by 2050, while maintaining near-neutral GDP and employment outcomes. This reflects a successful investment-driven structural transition, where increased spending on low-carbon technologies offsets the negative effects of higher carbon prices. In the JTAM-Thailand framework, this outcome is driven by strong investment and income multiplier effects, allowing emissions to fall without compromising macroeconomic stability. The results suggest that deep decarbonization can be achieved without significant trade-offs in growth or jobs, provided that policies actively support green investment.

In contrast, the Net Zero 2050 Carbon Tax with Debt Reduction produces the weakest overall performance. While emissions decline modestly (around −2 to −3 per cent below the baseline), the policy leads to a significant contraction in GDP

Figure 4.6 Macroeconomic and environmental impact of key climate policies



Source: Authors' calculations using JTAM-Thailand.

Note: Comparing Net Zero 2050 carbon taxes, ETS + CBAM and Coal Phase-out (vs. baseline).

(−4 to −5 per cent) and employment (around −1 per cent), particularly after 2040. As discussed earlier, this outcome reflects the introduction of a sharp increase in the carbon tax rate to test whether achieving net-zero emissions is feasible under such conditions. Although carbon pricing raises production costs, the absence of revenue recycling means that no additional economic activity is generated to offset these effects. As a result, both output and employment decline, and the policy fails to deliver substantial emissions reductions. This scenario illustrates that carbon pricing alone, without reinvestment, can be both economically costly and environmentally ineffective.

The ETS + CBAM scenario delivers the strongest economic performance but at the expense of environmental outcomes. GDP rises steadily to approximately 7–8 per cent above the baseline, and employment increases by around 1.0–1.2 per cent, reflecting strong domestic production supported by trade protection. However, emissions increase significantly – by more than 10 per cent above baseline – indicating that the policy reinforces carbon-intensive activity. This outcome highlights the risk of brown growth, where economic expansion occurs without structural decarbonization.

A closer examination of this scenario reveals the absence of relative decoupling, that is, a reduction in emissions per unit of economic output. In the ETS + CBAM scenario, the carbon intensity of GDP does not fall; instead, the economy expands by drawing more heavily on the same carbon-intensive industrial base, particularly in iron and steel, petroleum and gas, and paper and printing. The CBAM protects domestic heavy industry from foreign competition and generates a large captive demand surge, but it does not alter the technological or sectoral structure of production. Because no green investment or low-carbon technology

deployment is stimulated, output and emissions rise together, and the emissions-to-GDP ratio remains unchanged or worsens relative to the baseline. This is the defining characteristic of brown growth: growth without decoupling.

The Pure ETS and Coal Phase-out scenarios produce moderate negative impacts on GDP and employment, with declines of approximately −1 to −2 per cent in GDP and −0.3 to −0.4 per cent in employment, while delivering only limited emissions reductions. In both cases, the policies are insufficient to encourage large-scale technological change or investment. Pure ETS relies primarily on price signals, which do not translate into strong structural shifts, while Coal Phase-out represents a narrow, sector-specific intervention that is offset by substitution effects elsewhere in the economy.

Overall, the findings demonstrate that policy design is critical in shaping the joint outcomes of emissions, growth and employment. In a demand-led system such as JTAM-Thailand, successful decarbonization depends on the extent to which policies stimulate investment; drive technological change; reallocate demand towards low-carbon sectors; and, potentially, compensate low-income households to ensure policy support while reducing inequality. Policies that combine carbon pricing with targeted green investment offer the most effective pathway, achieving significant emissions reductions without undermining economic performance. By contrast, policies that impose costs without supporting demand are contractionary, while those that stimulate growth without structural change risk increasing emissions.

4.5 Employment impacts by sector

Figure 4.7 identifies the top 20 most affected sectors in 2050 under the five selected policy scenarios. The results show that most sectors experience modest and fairly similar shifts, with only a few seeing very large changes.

The most striking structural change occurs in coal and lignite, which contract dramatically under the Net Zero 2050 Carbon Tax with Green Subsidies scenario (−59.6 per cent), confirming that deep decarbonization is driven by a rapid phase down of fossil fuel extraction. In contrast, most other sectors under this scenario show only small declines (generally −0.2 to −0.5 per cent), suggesting that the transition is targeted and concentrated rather than economy wide.

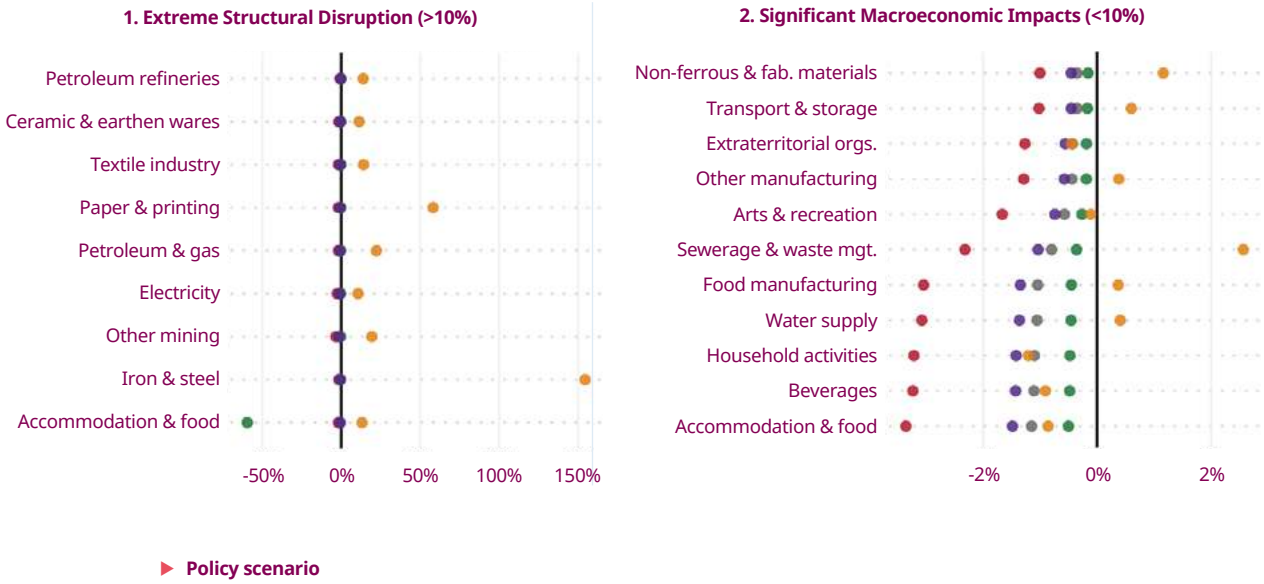
The ETS + CBAM scenario generates exceptionally large employment gains in a few industrial sectors, most notably:

- Iron and steel (154 per cent)
- Paper and printing (58 per cent)
- Petroleum and gas (22 per cent)
- Other mining (19 per cent)

The 154 per cent employment figure in iron and steel reflects a combination of two effects. First, CBAM makes imported steel significantly more expensive, causing Thai buyers to switch to domestic suppliers, directly expanding Thai steel production. Second, this production increase ripples through the economy via supply chain linkages and household wealth effects, amplifying the initial demand. However, this figure should be interpreted carefully: as a simulation based on post-Keynesian economic principles, it assumes that Thai steel mills have sufficient idle capacity to more than double output without building new facilities, which may be unrealistic in the short to medium term.

These results reflect strong domestic production expansion under trade protection, which disproportionately benefits energy intensive and

Figure 4.7 Top 20 most-impacted sectors (2050)



Source: Authors' calculations using JTAM-Thailand.

Note: Separating extreme transition outliers from broader macroeconomic shifts.

manufacturing sectors. However, these gains are highly concentrated and do not extend broadly across the economy.

The Net Zero Carbon Tax with Debt Reduction produces the most consistently negative outcomes across sectors, with declines typically ranging from −1.0 to −3.5 per cent. Notably, this contraction hits both:

- industrial sectors (e.g. mining, electricity, manufacturing);
- service sectors (e.g. accommodation, food, household activities).

This pattern points to a generalized reduction in labour demand, consistent with the contractionary macroeconomic effects seen earlier.

Both the Pure ETS and the Coal Phase out scenarios show moderate but widespread employment declines, generally between −0.3 and −1.5 per cent across sectors. These policies do not generate large positive outliers, suggesting they lack strong mechanisms to stimulate new employment in expanding industries.

Finally, outside a few extreme cases, most sectors – including transport and storage, food manufacturing, water supply and many services – show relatively small changes across all scenarios. This suggests that the majority of the economy is affected mainly through macro level demand channels, rather than through direct policy exposure.

Overall, the findings highlight that the employment impacts of climate policies are shaped by a mix of structural transformation and macroeconomic demand effects. Investment led policies (such as green subsidies) produce deep but targeted sectoral shifts, especially in fossil fuel industries, while leaving the rest



of the economy relatively stable. In contrast, policies that stimulate production without decarbonization (ETS + CBAM) generate large but concentrated gains in carbon intensive sectors, and policies that impose costs without reinvestment (carbon taxes without revenue recycling) lead to broad based employment losses. These results underscore the need for targeted labour-market policies and reskilling programmes, especially for workers in fossil fuel dependent sectors.

5 Conclusion and policy implications

5.1 Conclusion

This study demonstrates that the effectiveness of climate policy in Thailand depends critically on policy design, and in particular the interaction between carbon pricing, revenue recycling and investment strategies, and trade measures. The findings show that there is no inherent trade-off between emissions reduction and economic performance; rather, outcomes are shaped by whether policies generate demand, investment and structural transformation.

Policies that combine carbon pricing with green investment – especially the Net Zero 2050 Carbon Tax with Green Subsidies scenario – deliver the most balanced outcomes. These policies achieve substantial emissions reductions (around −10 per cent below the baseline by 2050) while maintaining broadly neutral impacts on GDP and employment. This reflects the importance of investment-led transitions, where public spending stimulates economic activity and facilitates the shift towards low-carbon sectors.

In contrast, carbon taxes without revenue recycling produce contractionary effects, leading to declines in GDP and employment while achieving only limited emissions reductions. Similarly, policies such as Pure ETS or Coal Phase-out generate modest environmental gains but fail to induce large-scale structural change.

The ETS + CBAM scenario highlights an important policy trade-off. While it delivers strong economic growth and employment gains, these outcomes are driven largely by expansion in carbon-intensive industries without inducing structural change, resulting in rising emissions. This pattern of brown growth underscores the risk of pursuing industrial expansion without simultaneously investing in green industrialization and electrification.

This also points directly to a natural extension for future iterations of the model: a combined ETS + CBAM with Green Subsidies scenario. In such a policy package, CBAM would help secure domestic industrial demand and employment, while carbon revenues from the ETS would be recycled into green investment targeting the most carbon-intensive sectors, including iron and steel, paper and printing, and petroleum and gas. This combination would be expected to induce genuine structural change by enabling the industrial demand protected by CBAM to be met increasingly through lower-carbon domestic production supported by subsidized technology adoption and investment. The result could be an economy that achieves both robust growth and emissions reduction, thereby delivering absolute decoupling rather than the brown growth observed under the ETS + CBAM scenario alone.

Such an integrated policy package would also align closely with Thailand's just transition objectives by linking industrial competitiveness with a managed transition towards greener production. Modelling this scenario in a future iteration of JTAM-Thailand would provide a stronger evidence base for integrated trade, climate and industrial policy design, while reinforcing the central finding of this study: policy design, rather than climate ambition alone, determines whether economic growth and decarbonization can be achieved simultaneously.

From a labour perspective, the results show that the transition is not neutral. Even in scenarios with positive GDP outcomes, employment effects can lag behind, particularly when growth is driven by capital-intensive green investments. At the sectoral level, employment impacts are uneven: fossil fuel-related sectors experience sharp contractions, while gains in other sectors

are often limited or concentrated. This highlights the need for a managed and inclusive transition, rather than assuming labour markets will adjust automatically.

Overall, the findings suggest that Thailand's transition should be understood as a managed structural transformation, not as a simple carbon-pricing exercise. Policies that impose costs without reinvestment reduce aggregate demand and employment and may widen inequality. Policies that stimulate demand without changing production structure may raise GDP and create jobs in the short run but can also lock in carbon-intensive activity. The most effective approach is therefore one that combines carbon pricing, public investment and targeted industrial transformation.

The labour and social implications are especially important. Even when aggregate GDP is stable or positive, employment gains are not guaranteed, particularly where growth is driven by capital-intensive investment rather than labour-intensive expansion. Similarly, inequality may increase as low-income households are most impacted by energy price increases. This means that the transition will not be automatically "just"; it must be actively managed through labour-market measures, skills development and worker support.

5.2 Policy recommendations with institutional responsibilities

5.2.1 Establish a coordinated cross-ministerial climate–labour policy process and social dialogue

The findings show that climate policy outcomes depend heavily on how policy instruments are designed and combined, especially with respect to carbon pricing, revenue recycling and green investment. To translate these findings into policy, Thailand should strengthen coordination across the NESDC, the DCCE, the Ministry of Energy and the Ministry of Labour. The NESDC can play a central role in aligning climate scenarios with national development planning, while the DCCE leads climate policy design and target-setting. The Ministry of Labour should ensure that employment and worker adjustment concerns are incorporated into policy appraisal from the outset.

5.2.2 Recycle carbon revenues towards productive green investment, human capital development and labour-market restructuring

The results indicate that carbon pricing without revenue recycling tends to reduce GDP and employment, while carbon pricing combined with green subsidies generates the most balanced economic and environmental outcomes. In practice, the Ministry of Finance should work with the NESDC, the DCCE and the Ministry of Energy to design revenue recycling mechanisms that support green public investment, industrial upgrading and labour-market adjustment. A portion of carbon revenue should also be considered for human capital and skills development, including retraining, social protection and transition assistance; support to greening enterprises, notably small and medium-sized ones; and temporary income protection through the Ministry of Labour.

5.2.3 Align industrial and trade policy with decarbonization and green growth objectives

The ETS + CBAM scenario in the study shows strong GDP and employment gains, but also rising emissions, which points to the risk of brown growth if industrial expansion is not aligned with green industrialization, electrification and decarbonization goals. The Board of Investment Thailand, the Ministry of Industry and the Ministry of Finance should therefore ensure that industrial promotion measures are tied to low-carbon technology upgrading, notably greening the iron and steel and paper and printing industries; electrification; cleaner production standards; and energy efficiency improvements. Trade-related measures should support domestic competitiveness without locking Thailand into more carbon-intensive production patterns.

5.2.4 Prioritize labour transition policies for affected sectors and workers

The sectoral results show that employment losses are concentrated in fossil fuel-related industries and other carbon-intensive sectors, while gains in other sectors are often limited or uneven. The Ministry of Labour, together with the Department of Skill Development, should lead the development of targeted reskilling and upskilling programmes combined with social protection for workers in declining sectors. The Ministry of Labour should also work with sectoral agencies and employers to improve job matching, transition support and placement services. Where displacement risks are high, temporary income support and active labour-market measures should be considered. Given the large share of informal employment in Thailand, just transition policies should not be limited to workers in formal employment relationships. The Ministry of Labour, in collaboration with relevant agencies, should develop targeted support measures for informal workers, including access to skills development, income protection, social assistance and pathways to formalization.

5.2.5 Use energy institutions to guide a gradual and predictable transition

The study shows that late and abrupt policy shocks, especially sharp increases in carbon pricing, can create severe macroeconomic and labour disruptions. To avoid this, the EPPO and the DEDE should support a gradual transition pathway that provides clear investment signals and allows firms and workers to adjust over time. Energy planning should be coordinated with climate targets and labour-market implications so that the pace of change is both credible and socially manageable.

5.2.6 Strengthen climate and emissions governance through technical agencies

The emissions results show that policy design can produce very different environmental outcomes even when GDP or employment effects appear favourable. The TGO, in coordination with the DCCE and the EPPO, should therefore strengthen emissions monitoring, policy evaluation and scenario analysis. This would help ensure that trade and industrial measures do not undermine Thailand's long-term mitigation goals.

5.2.7 Improve labour, social and sectoral data systems for just transition analysis

A major implication of the study is that more detailed and better integrated data are needed to make labour analysis more accurate, especially for assessing

labour-market impacts across sectors. The NSO, the BOT, the NESDC and the Ministry of Labour should work together to improve sectoral employment data, occupational data, wage and income data, and worker transition information. Stronger data sharing across institutions would improve the accuracy of future modelling, especially for identifying vulnerable workers, informal employment and gender-differentiated impacts. Importantly, new research and analysis should be undertaken to assess the income and inequality impacts of the different scenarios. It is important to assess and design policies prior to an ETS or a carbon tax. This is key to avoiding any negative impact on low-income households and an increase in inequality, which has led to social protest and policy reversals in many countries across the world.

5.2.8 Institutionalize JTAM-Thailand as a planning tool, not a one-off exercise

Although a good policy should consider all relevant dimensions, in terms of carbon emissions, all policy scenarios considered in this study remain far from achieving the goals of the Paris Agreement. Bridging this emissions gap will require highly coordinated, concrete planning across all relevant organizations. In this context, JTAM-Thailand can play a critical role as a decision-support tool to assess alternative pathways and guide policy development, but its long-term value relies on continuous data refinement and active policy dialogue. Therefore, rather than treating this analysis as a one-time modelling exercise, JTAM-Thailand should be institutionalized within Thailand's ongoing climate and development framework. Embedding the model into regular policymaking will allow the NESDC to facilitate cross-sector dialogues; the DCCE to test dynamic climate scenarios; and labour institutions to evaluate employment impacts and design targeted compensation measures. Through this coordinated approach, Thailand can ensure that just transition analysis remains a central, continuous input in its pursuit of net zero.

Taken together, these recommendations imply that Thailand's low-carbon transition should be managed as a coordinated policy process involving all the relevant government ministries and agencies. The study shows that climate outcomes, macroeconomic performance and labour impacts are tightly linked, and that policy effectiveness depends on whether Thailand combines carbon pricing with investment, social protection, industrial upgrading and better data systems. Strengthening these institutional linkages will be essential for ensuring that the transition is both economically effective and socially just.

5.3 Directions for further research

Several important dimensions remain beyond the scope of the current modelling exercise. Four areas are identified here for future research.

1. **Decoupling and green revenue recycling**: The ETS + CBAM scenario produces strong GDP growth but rising emissions, a pattern of brown growth that falls short of Thailand's net-zero objectives. A natural extension would be to test whether recycling CBAM tariff revenues into green investment could shift the economy away from brown growth towards a decoupled growth path (either relative or absolute decoupling, depending on the magnitude of the emissions reduction). This would involve comparing the current no-recycling baseline with scenarios in which CBAM revenues are channelled into targeted green subsidies, allowing the model to assess the extent of revenue recycling required to align economic growth with emissions reduction objectives.



2. **Distributional impacts and household inequality**: JTAM-Thailand operates at the level of aggregate household income, not income group. Carbon pricing is inherently regressive – lower-income households spend a larger share of their disposable income on energy and energy-intensive goods such as food, housing and transport – meaning that the distributional burden of climate policy is likely underestimated in the current results. A further analysis combining JTAM-Thailand's outputs with household expenditure shares from Thailand's Socioeconomic Survey would enable an estimation of cost-of-living impacts by income quintile. This information would allow an assessment of whether revenue recycling mechanisms (particularly equal per-capita transfers) are sufficient to prevent inequality from widening under each scenario.
3. **Informal labour**: Thailand's labour force includes a large share of informal workers, particularly in agriculture, construction and services, who are not covered by standard social protection mechanisms and are therefore more exposed to the adverse effects of climate policy. JTAM-Thailand provides sectoral employment estimates but does not distinguish between formal and informal workers. A dedicated off-model analysis, applying sector-specific informality shares derived from Labour Force Survey to JTAM-Thailand's employment outputs, would provide a more complete picture of just transition risks. This would identify which worker groups face the greatest adjustment pressures and inform the design of targeted reskilling and income support measures.
4. **ETS with auctioned allowances and revenue recycling**: The ETS scenarios in this study use free allowances, which generate no government

revenue and therefore preclude revenue recycling. Modelling an ETS with auctioned allowances – a more common design in international practice – requires off-model calculation of permit revenues, followed by manual injection of recycled funds into the model as investment or expenditure shocks. Future work should formalize this process, testing how different recycling strategies affect the economic and environmental outcomes of the ETS. It should also investigate whether combining auctioned allowances with targeted green subsidies can deliver both competitiveness protection and meaningful emissions reductions to address the key limitation identified in the ETS + CBAM scenario.

Together, these additions would substantially strengthen the analytical basis for just transition planning in Thailand, moving from an aggregate macroeconomic assessment towards a more complete understanding of who bears the costs, who captures the benefits and under what conditions climate ambition and inclusive growth can be achieved simultaneously.

6 References

Dwesar, Isha, Zsófi Kőműves, Michael McGovern, An Vu and Francisco Arsenio. 2022. *E3ME Model Manual (Version 9.0).* Cambridge: Cambridge Econometrics. https://www.camecon.com/hubfs/E3MEManual2022-1.pdf

ILO and Islamic Development Bank. 2023. *The social, economic and employment impacts of decarbonization and green industrial growth scenarios for the Middle East and North Africa region*. https://www.ilo.org/publications/social-economic-and-employment-impacts-decarbonization-and-green-industrial

Smith, A., A. Bitomsky, G. Magnini and S. Cooper-Searle. 2026. *Just Transition Assessment Model for Thailand: User manual*. Cambridge: Cambridge Econometrics.

Appendix A

Table A.1: Sectoral classification used in JTAM-Thailand

Code	Sector	Code	Sector
1	Agriculture	21	Electricity
2	Forestry and fishing	22	Gas, steam and air conditioning supply
3	Coal and lignite	23	Water supply
4	Petroleum and natural gas	24	Sewerage, waste management and remediation activities
5	Other mining and quarrying	25	Construction
6	Chemicals and rubber	26	Wholesale and retail trade; repair of motor vehicles and motorcycles
7	Non-ferrous metal and fabricated metal products	27	Accommodation and food service activities
8	Industrial and electrical machinery	28	Transportation and storage
9	Motor vehicles and transport equipment	29	Information and communication
10	Other manufacturing	30	Financial and insurance activities
11	Food manufacturing	31	Real estate activities
12	Beverages	32	Professional, scientific and technical activities & administrative and support service activities
13	Textile industry	33	Public administration and defence; compulsory social security
14	Paper industries and printing	34	Education
15	Petroleum refineries	35	Human health and social work activities
16	Plastic wares	36	Arts, entertainment and recreation
17	Cement and concrete products	37	Other service activities
18	Ceramic and earthen wares	38	Unknown
19	Glass and glass products	39	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
20	Iron and steel	40	Activities of extraterritorial organizations and bodies

Source: Prepared by the authors based on the Thailand Standard Industrial Classification 2009 (aligned with International Standard Industrial Classification Rev.4).

PAGE PARTNERSHIP FOR ACTION ON GREEN ECONOMY

The Just Transition Assessment Model for Thailand (JTAM-Thailand) provides an economy-wide analytical framework for examining how climate and development policies could affect Thailand's economy, employment, emissions and distributional outcomes. Adapted from Cambridge Econometrics' FRAMES/E3ME modelling architecture, the model combines macroeconomic, sectoral, labour-market, energy and environmental data to simulate alternative transition pathways and identify potential trade-offs between decarbonization, economic growth and employment. Its purpose is not only to estimate policy impacts, but also to support evidence-based policy dialogue, strengthen national analytical capacity and help government institutions integrate labour and social considerations into climate and development planning.

The modelling compares carbon-tax scenarios, emissions trading systems (ETS) with and without a Carbon Border Adjustment Mechanism (CBAM), and a coal phase-out against a business-as-usual baseline. A central finding is that policy design and the use of revenues matter as much as the carbon price itself. Carbon pricing combined with targeted green subsidies produces the strongest emissions reductions—around 10 per cent below the baseline by 2050—while maintaining broadly neutral economic and employment outcomes. By contrast, high carbon prices without productive reinvestment can reduce GDP and employment without achieving comparable emissions reductions. The ETS + CBAM scenario produces strong GDP and employment growth through increased domestic industrial production, but also raises emissions by more than 10 per cent above baseline, illustrating the risk of "brown growth." Sectoral effects are also uneven: deep decarbonization produces substantial contraction in coal and lignite, while the ETS + CBAM scenario generates highly concentrated employment gains in industries such as iron and steel, paper and printing, petroleum and gas, although some of these results rely on assumptions about available industrial capacity and therefore require cautious interpretation.

Overall, the report concludes that Thailand's just transition will require integrated climate, economic and labour-market policies rather than isolated climate instruments. Effective decarbonization depends on using carbon-pricing revenues to stimulate green investment, technological change and demand in low-carbon sectors, while accompanying structural changes with skills development, social protection and labour-market measures for affected workers and sectors. The report therefore points toward stronger cross-ministerial coordination and social dialogue; strategic recycling of climate revenues; alignment of industrial, trade and energy policies with decarbonization objectives; targeted support for workers facing transition pressures; improved labour, social and sectoral data; and continued institutional use of JTAM-Thailand as a planning and policy-analysis tool rather than a one-off modelling exercise.

The Partnership for Action on Green Economy (PAGE) is a joint programme between UN Environment, the International Labour Organization (ILO), the United Nations Development Programme (UNDP), the United Nations Industrial Development Organization (UNIDO), and the United Nations Institute for Training and Research (UNITAR).

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