World Bank and TGO

# Introduction to E3-Thailand

## Project: Impacts of carbon pricing instruments on national economy and contribution to NDC – Thailand

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# E3-Thailand

**A computer model designed to assess the macroeconomic impacts of climate policies in Thailand**

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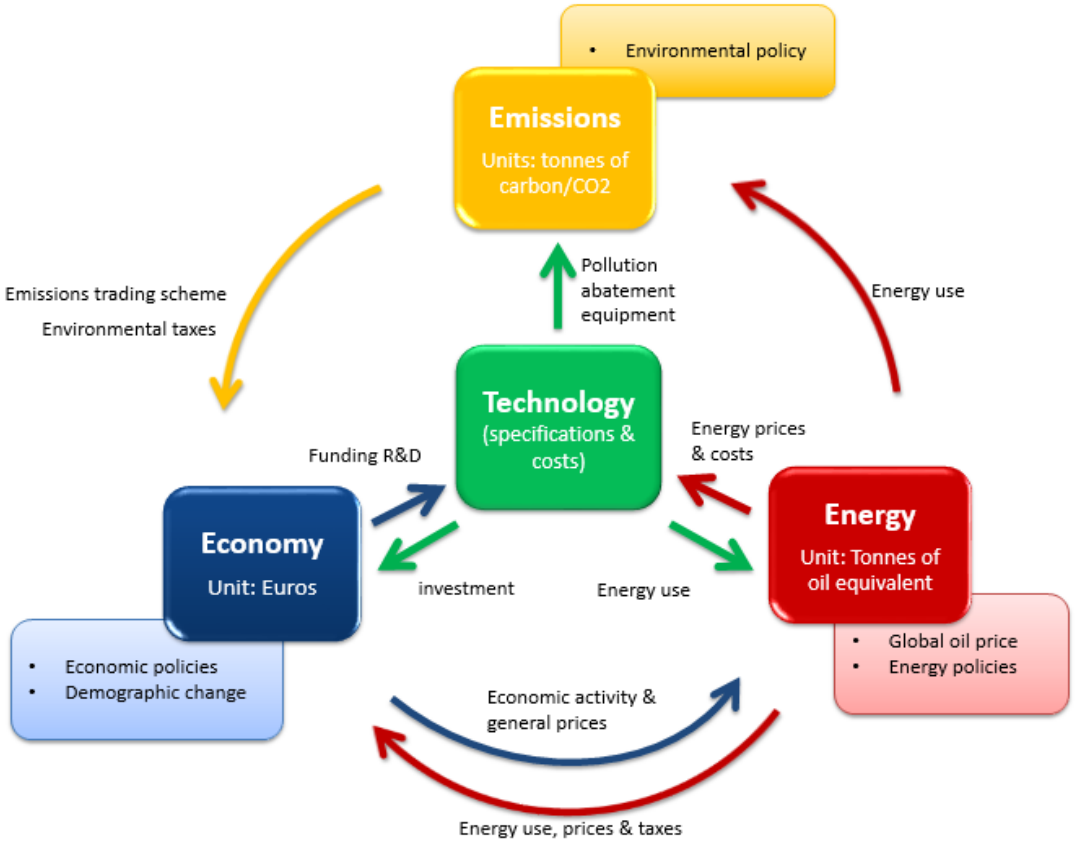
# What is E3-Thailand?

An advanced software tool that can be used to assess energy-environment-economy linkages in Thailand

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# Aims of E3-Thailand

| Aim | How E3-Thailand meet this aim? |
|---|---|
| Transparency | • The data used represent the best available data sources relevant to Thailand<br>• Its development is transparent –aims to capture local knowledge and expertise in Thailand<br>• A detailed model manual will be provided with the model<br>• Model code will be made available on requests |
| Usefulness | • Designed specifically to answer relevant real policy questions<br>• Covers wide range of climate, energy and economic policies<br>• Sensitivity test of scenario analysis under different conditions<br>• Detailed set of results allow for meaningful interpretation of policy implications |
| True representation of reality | • The parameters in the model reflect the behavioural characteristics Thailand<br>• Based on econometric approach and not reliant on optimisation assumptions<br>• The model represents best practice for sector policy simulations |
| Accessible | • Use of the model is accessible and affordable to a broad base of prospective users over time<br>• The model software is designed to be simple and easy to use<br>• The outputs of model simulations can be readily identified and explained<br>• Planned model workshops and ongoing support |

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# What policies can the model assess?

- As a general model of the economy, E3-Thailand can be used to assess a wide range of fiscal and general macroeconomic policies. However, it has been designed to have a particular focus on carbon pricing instruments (CPI)

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# How does the model work?

- E3-Thailand is a **macro-econometric simulation** model, meaning it is based on a series of econometric equations
- It is similar in design to the internationally recognised E3ME model (see www.e3me.com)
- Unlike the more common computable general equilibrium (CGE) approach to economic modelling, E3-Thailand does not assume full employment or perfectly competitive markets
- Instead it estimates behaviour based on available historical data

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# E3-Thailand Key Features

## Detailed Coverage

- 70+ economic sectors and 35+ consumption categories
- 23 fuel users of 5 fuels

## Comprehensive

- whole energy, environment and economy system
- two way feedbacks between each module
- many policy instruments

## Highly Empirical

- 1970-2016 database
- 16 stochastic equations
- relationships validated from data
- econometrics allows for short-medium and long term analysis

## Consistent

- based on system of national accounting
- input-output tables

## Forward Looking

- annual projections to 2040
- behavioural equations with effects from previous outcomes
- ex-ante scenario analysis (ex-post is also feasible)

## Modular

- E3: Energy, Environment, and Economy modules
- power generation sub-module*
- research can be decentralised

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# What are the main outputs from the model?

| Economy: | Labour market: | Energy & Environment: |
|---|---|---|
| ✓ **GDP** and the **aggregate components** of GDP (household expenditure, investment, government expenditure and trade)<br>✓ **sectoral** output and GVA, prices, trade and competitiveness effects<br>✓ **consumer prices** and **expenditures**, and implied household **distributional** effects | ✓ **sectoral employment**<br>✓ **labour force** and **participation rate** by gender and age groups<br>✓ **unemployment** rate and level<br>✓ **sectoral wage** rate<br>✓ **real income** of different **socio-economic** groups | ✓ **energy demand**, by users and by fuel<br>✓ energy **prices**<br>✓ **power** sector detailed results<br>✓ **$CO_2$ emissions** by sector and by fuel<br>✓ **other** air-borne **emissions** |

*all with **annual** results to **2040**

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# Mitigation options modelled in E3-Thailand

- Carbon taxes and emission trading schemes
  - with alternative recycling options, i.e. via reductions in income taxes, labour taxes or indirect taxes
  - covering different areas
  - allowing exemption/lower rates for energy-intensive industries
- Subsidies or feeds-in tariff for new technologies*
- Regulations
- Energy efficiency
- Environmentally harmful subsidies removal
- Funding/support of R&D
  - general R&D support
  - support for energy saving and low-carbon processes

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# ETS Options in the model

- Price can be entered exogenously or calculated by the model for a given level of caps
  - market clearing is assumed
  - yearly caps or prices
- Sectoral coverages and within sector coverages (benchmark, participation thresholds)
- Permits are allocated or auctioned
  - allocated allowances are used to increase profits and have opportunity costs
  - there are no awareness or signalling effects (banking and borrowing difficult*)
- Auctioned revenues can be used for revenue recycling

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# Carbon tax options in the model

- Sectoral coverage and within sector coverage (exemptions)
- Revenue recycling options
- Varying rates between sectors
- Varying rates between years

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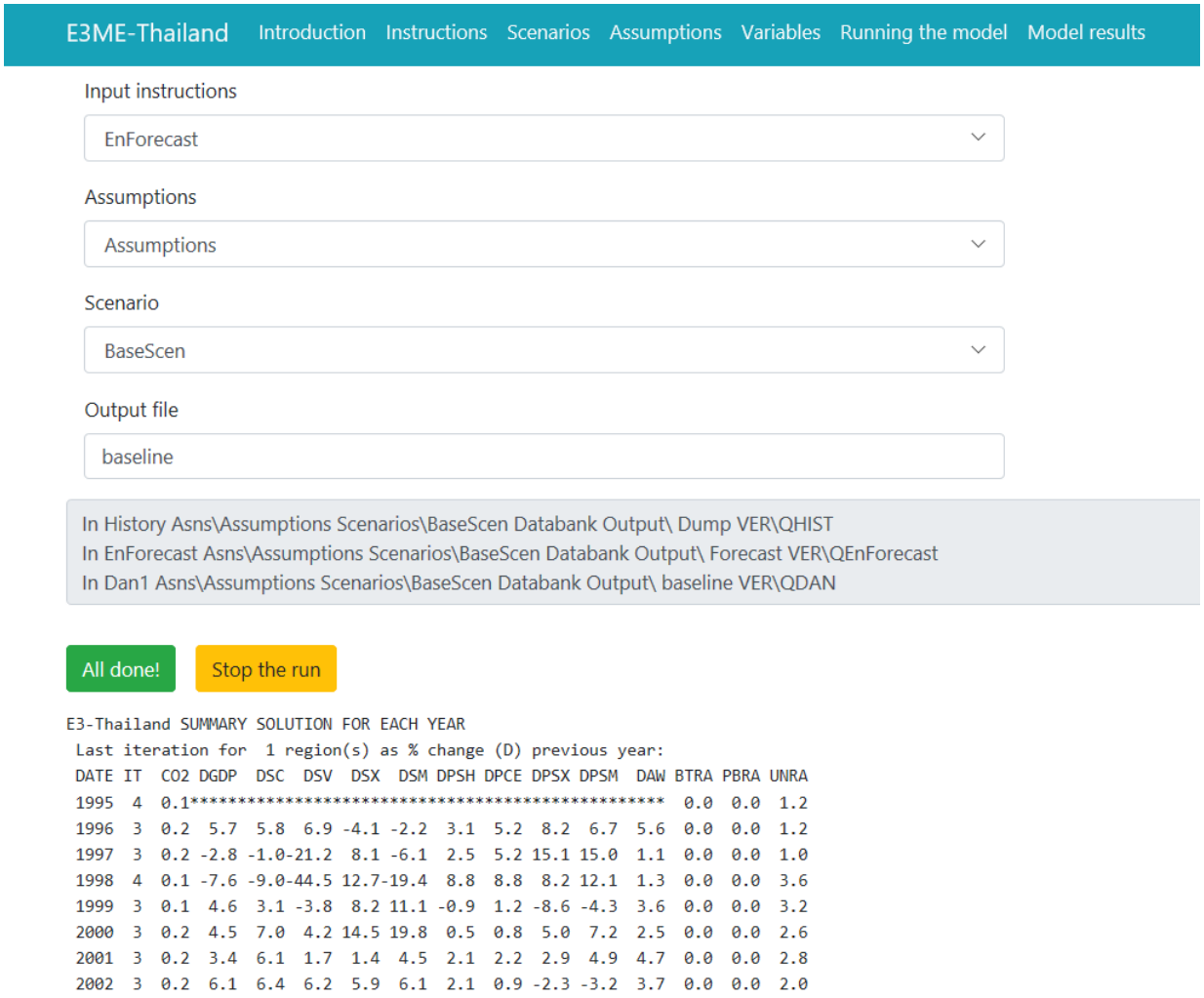
# What does the E3-Thailand software look like?

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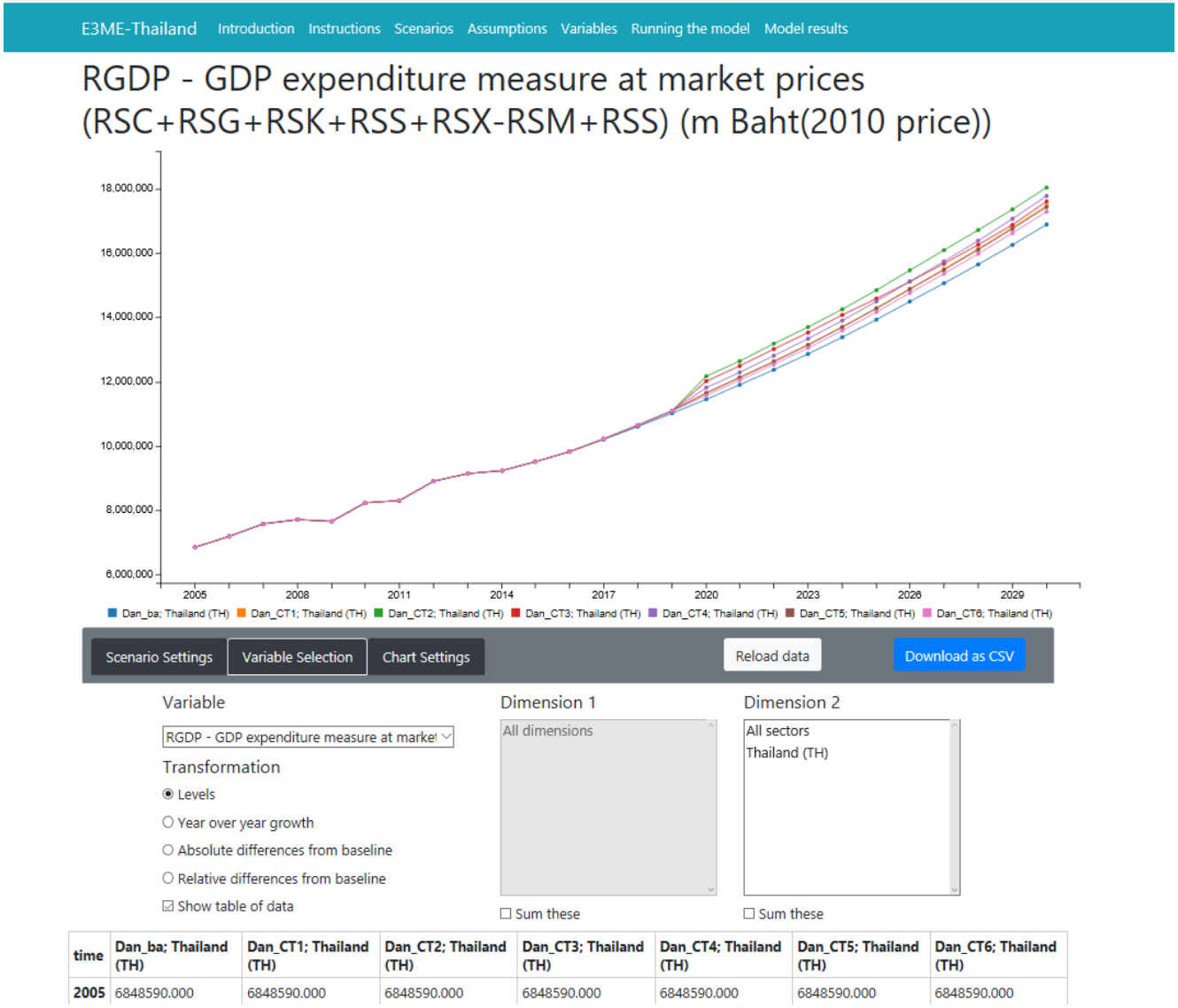


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# Impacts of carbon pricing instruments on national economy and contribution to NDC

| Run ID | Description | Sectoral coverage | Off-setting | Revenue use | Global energy price | Cap level | Free allocation | Tax rate |
|---|---|---|---|---|---|---|---|---|
| BAU | Baseline in NDC roadmap | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| NDC | BAU + full achievement of unconditional NDC (uNDC) | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| **ETS runs** | | | | | | | | |
| ETS core | Core case | Medium | No | N/A | Central | Consistent with NDC unconditional | 100% | n/a |
| ETS 2 | ETS core but will full auctioning | Medium | No | Revenue used to offset other taxation | Central | Consistent with NDC unconditional | 0% | n/a |
| ETS 3 | ETS small scope | Small | No | N/A | Central | Consistent with NDC unconditional | 100% | n/a |
| ETS 4 | ETS large scope | Large | No | N/A | Central | Consistent with NDC unconditional | 100% | n/a |
| ETS 5 | Offsetting | Medium | Yes | N/A | Central | Consistent with NDC unconditional but adjusted for offset volume | 100% | n/a |
| ETS 6 | Energy prices | Medium | No | N/A | Low | Consistent with NDC unconditional | 100% | n/a |
| ETS 7 | ETS ambition | Medium | No | N/A | Central | Consistent with cap required to achieve NDC unconditional throughout Thai economy | 100% | n/a |
| **Carbon tax runs** | | | | | | | | |
| CT core | Core case | Medium | No | Revenue used to offset other taxation | Central | n/a | n/a | Single rate to meet NDC outcomes for CT sectors |
| CT 2 | CT large scope | Large | No | Revenue used to offset other taxation | Central | n/a | n/a | Single rate to meet NDC outcomes for CT sectors |
| CT 3 | CT very large scope | Very large | No | Revenue used to offset other taxation | Central | n/a | n/a | Single rate to meet NDC outcomes for CT sectors |
| CT 4 | CT rate | Medium | No | Revenue used to offset other taxation | Central | n/a | n/a | Single rate consistent with NDC conditional for CT sectors |
| CT 5 | Revenue investment | Medium | No | Revs invested in emission reduction program | Central | n/a | n/a | Single rate to meet NDC outcomes for CT sectors |
| CT 6 | Revenue offsets other taxation | Medium | No | Revenues retained by treasury | Central | n/a | n/a | Single rate to meet NDC outcomes for CT sectors |

# Impacts of carbon pricing instruments on national economy and contribution to NDC

| Instrument | Sector coverage | Revenue recycling | Offsetting option (For ETS) | Scenario | Carbon tax rate |
|---|---|---|---|---|---|
| ETS | Small | 0% | 0% | TH-ETS1 | - |
| | | | 10% | TH-ETS2 | - |
| | | | 15% | TH-ETS3 | - |
| | | 25% | 0% | TH-ETS4 | - |
| | | | 10% | TH-ETS5 | - |
| | | | 15% | TH-ETS6 | - |
| | | 50% | 0% | TH-ETS7 | - |
| | | | 10% | TH-ETS8 | - |
| | | | 15% | TH-ETS9 | - |
| Carbon Tax | Very large | 0% | - | TH-CT1 | Standard |
| | | 25% | - | TH-CT2 | |
| | | 50% | - | TH-CT3 | |
| | | 0% | - | TH-CT4 | Low |
| | | 0% | - | TH-CT5 | High (NDC) |
| | | 0% | - | TH-CT6 | Flat (NDC) |
| | | 25% | - | TH-CT7 | |
| | | 50% | - | TH-CT8 | |
| | | 0% | - | TH-CT9 | Gradual (NDC) |
| | | 25% | - | TH-CT10 | |
| | | 50% | - | TH-CT11 | |
| Hybrid | ETS – Small Carbon Tax – remaining sectors | 0% | 0% | TH-HB1 | Standard |
| | | | 10% | TH-HB2 | |
| | | | 15% | TH-HB3 | |
| | | 25% | 0% | TH-HB4 | |
| | | | 10% | TH-HB5 | |
| | | | 15% | TH-HB6 | |
| | | 50% | 0% | TH-HB7 | |
| | | | 10% | TH-HB8 | |
| | | | 15% | TH-HB9 | |

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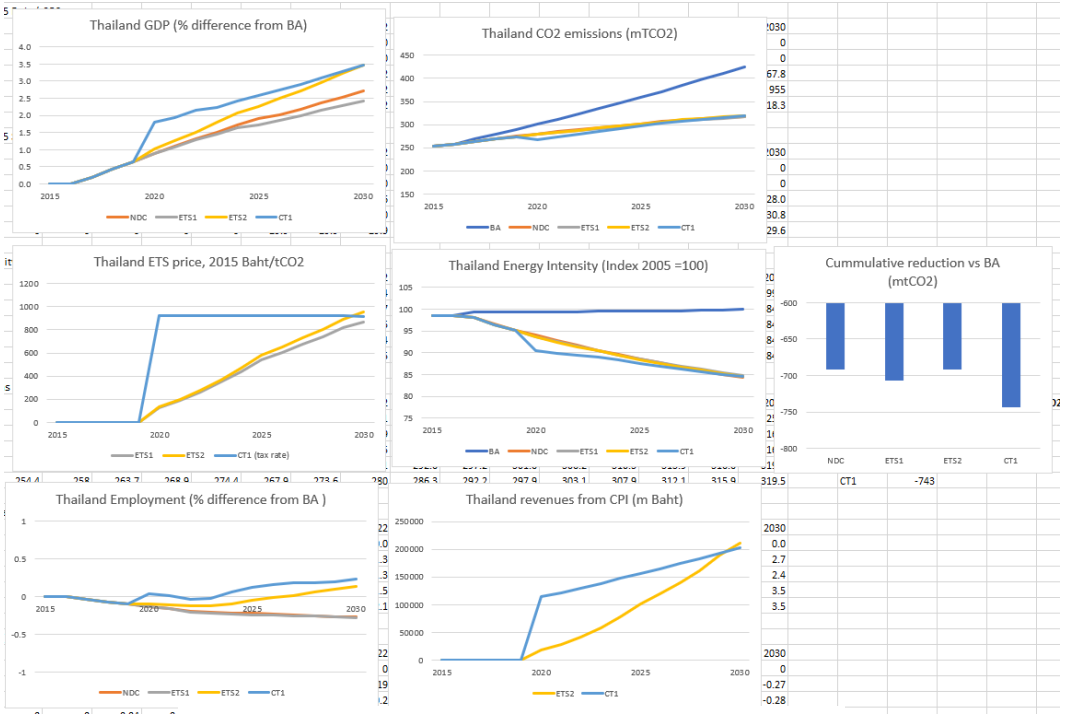
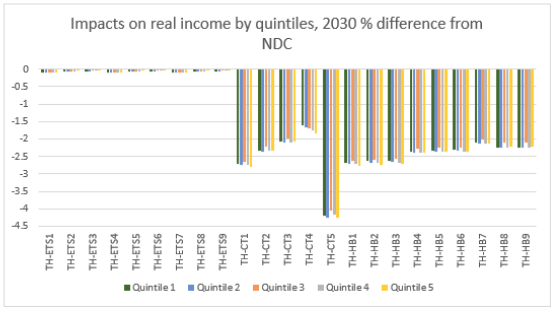
# Our findings




| Instrument | Scenario | Emission (mTCO2) | Cost to business (carbon price Baht/tCO2) | Cost to economy (GDP 2015 bn Baht) | Cost to society (Employment, m) |
|---|---|---|---|---|---|
| NDC Policy Package | Baseline | 315.6 | 2258* | 17401 | 40.03 |
| ETS | TH-ETS1 | 315.5 | 765 | 17383 | 40.01 |
| | TH-ETS2 | 314.9 | 471 | 17388 | 40.01 |
| | TH-ETS3 | 314.6 | 336 | 17391 | 40.01 |
| | TH-ETS4 | 315.1 | 738 | 17387 | 40.01 |
| | TH-ETS5 | 314.6 | 455 | 17391 | 40.01 |
| | TH-ETS6 | 314.4 | 326 | 17392 | 40.01 |
| | TH-ETS7 | 314.6 | 713 | 17390 | 40.01 |
| | TH-ETS8 | 314.3 | 440 | 17392 | 40.01 |
| | TH-ETS9 | 314.2 | 316 | 17394 | 40.01 |
| Carbon Tax | TH-CT1 | 336.9 | 1800 | 16902 | 39.98 |
| | TH-CT2 | 294.1 | 1800 | 17141 | 40.02 |
| | TH-CT3 | 265.8 | 1800 | 17319 | 40.03 |
| | TH-CT4 | 359.4 | 900 | 16935 | 40.07 |
| | TH-CT5 | 315.2 | 2754 | 16790 | 39.7 |
| | TH-CT6 | 314.4 | 2700 | 16710.6 | 39.6 |
| | TH-CT7 | 314.5 | 1300 | 17042 | 40.1 |
| | TH-CT8 | 315.4 | 860 | 17127.7 | 40.2 |
| | TH-CT9 | 315.5 | 3158 | 16849.2 | 39.7 |
| | TH-CT10 | 314.8 | 1323 | 17100.7 | 40.1 |
| | TH-CT11 | 315.4 | 853 | 17166.2 | 40.1 |
| Hybrid | TH-HB1 | 344.2 | ETS 1213 CT 1800 | 16898 | 39.99 |
| | TH-HB2 | 344.3 | ETS 869 CT 1800 | 16897 | 39.99 |
| | TH-HB3 | 344.3 | ETS 711 CT 1800 | 16896 | 39.99 |
| | TH-HB4 | 326.3 | ETS 381 CT 1800 | 17054 | 40.03 |
| | TH-HB5 | 327 | ETS 122 CT 1800 | 17049 | 40.04 |
| | TH-HB6 | 326.9 | ETS 15 CT 1800 | 17047 | 40.04 |
| | TH-HB7 | 310.9 | ETS 20 CT 1800 | 17189 | 40.04 |

# Model manual and download link

https://www.camecon.com/how/our-work/e3-thailand/

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