

How to Achieve Emission Targets with Less Impacts on Economy: Implications from Taiwan

Yi-Hua Wu and Tzu-Yar Liu

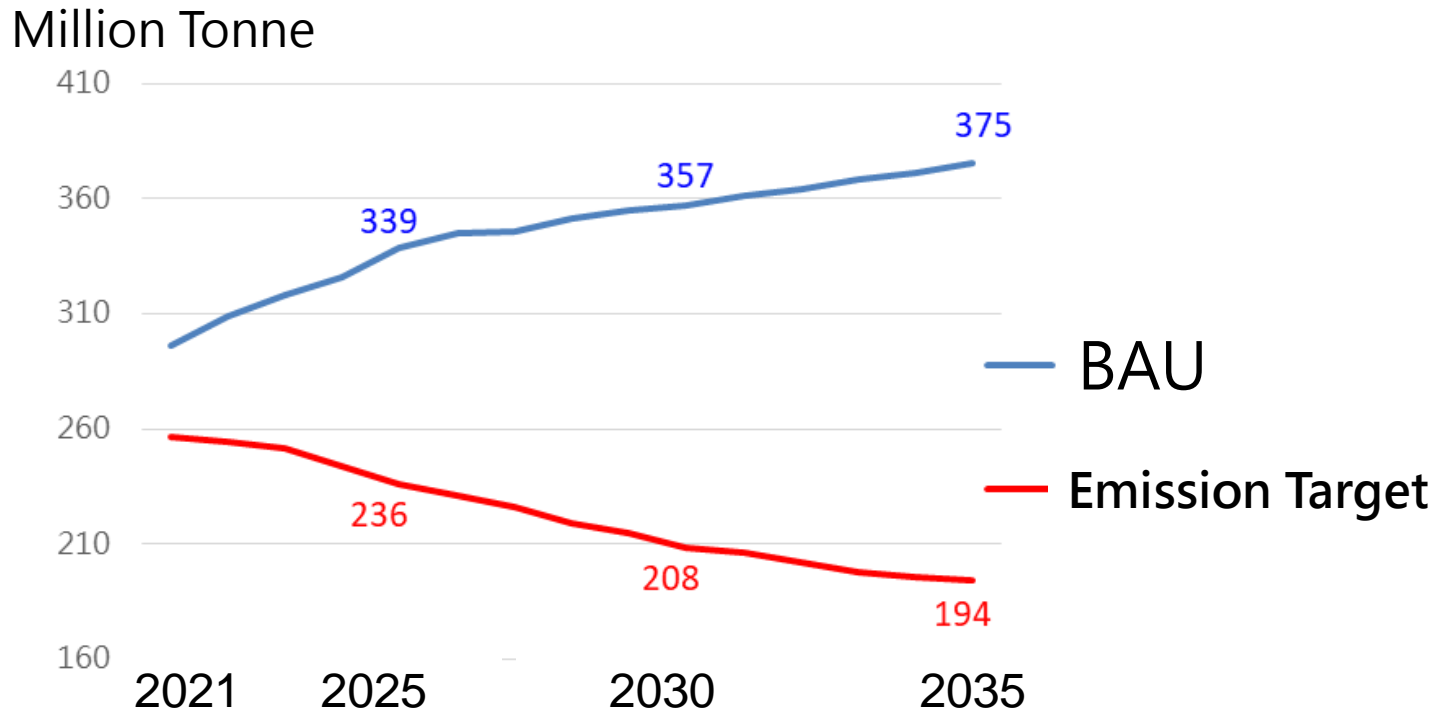
Green Energy and Environment Research Laboratories,
Industrial Technology Research Institute

May 24, 2022

The Emission Target in Taiwan

Background

- ◆ Emission target in 2035: From BAU of 375 to 194 million tonnes
- ◆ Taiwanese intends to launch multiple policies to achieve the target
- ◆ Taiwan will review its emission target every 5 year



Contributions and Policy Use

Contributions

- ◆ Numerous papers study how to use carbon pricing to achieve the emission target
- ◆ This paper: We identify economic effects of multiple policies/scenarios
 - ✓ **Positive Effects:** Renewable investment, investments in gas-fired power plants and energy efficiency improvements
 - ✓ **Negative Effects:** higher electricity price and carbon tax

Future Policy Implications

- ◆ The analysis might be used for the **negotiation between Ministry of Economic Affairs** (economic development) and **Environmental Protection Agency** (environmental regulation) in **Taiwan**

Comparison with carbon tax only

(1) BAU 2022-2035 annul GDP growth **2.30%**

(2) Carbon pricing only

- ◆ 2022-2035 average annul GDP growth **0.9%**
- ◆ Carbon price in 2035 is **436 USD/Tonne**

(3) Energy supply policy and carbon tax

- ◆ 2022-2035 average annual GDP growth **2.02%**
- ◆ Carbon price in 2035 is **33 USD/Tonne**

✓ Energy supply policy

- Renewable and natural gas investment (average annual GDP **+0.03%**)
- Electricity price (average annual GDP **-0.29%**)
- Induced energy investment (average annual GDP **+0.04%**)

✓ Carbon tax

- Average GDP growth **-0.06%**

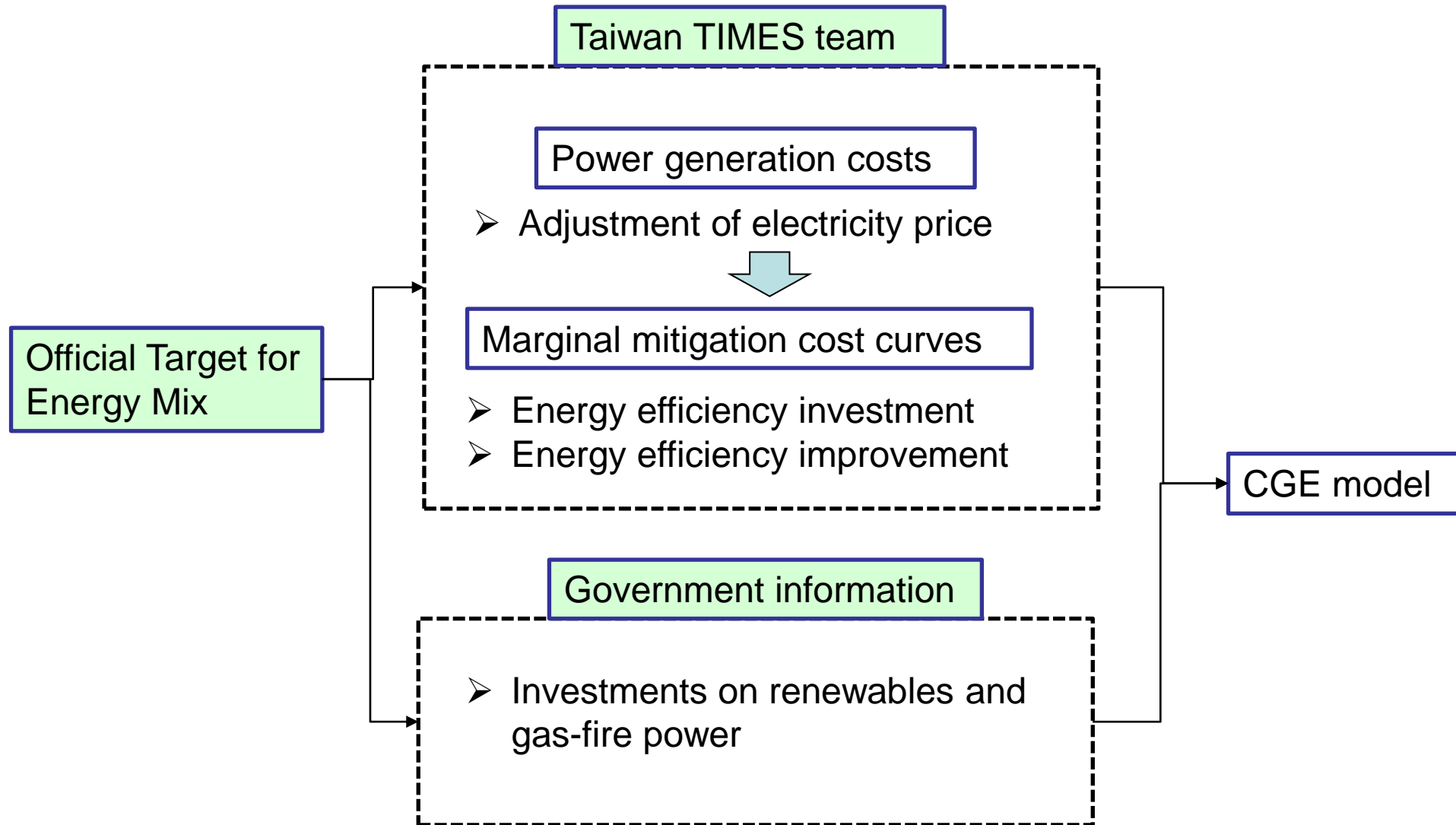
Tax base

2022-2024: High emission industries only
2025-2035: All industries and households

Model Soft-link

Soft-link with TIMES model

TIMES links with a CGE model



Scenario settings

Power supply mix in Taiwan

- ◆ The official goal is to expand the renewables in the future
- ◆ We expect higher power generation costs regarding more renewables

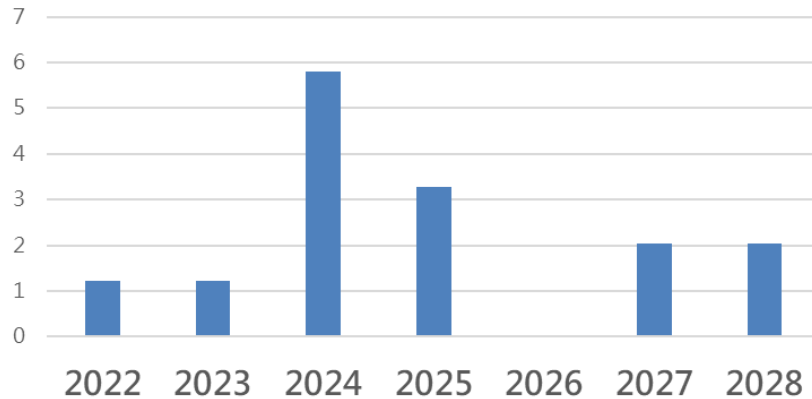
BAU	Policy Scenario
<ul style="list-style-type: none">➤ 2025<ul style="list-style-type: none">✓ Fired power(95.3%)✓ Renewables(3.8%)✓ Nuclear power(0.9%)➤ 2035發電占比<ul style="list-style-type: none">✓ Fired power(96.5%)✓ Renewables(3.5%)✓ Nuclear power(0 %)	<ul style="list-style-type: none">➤ 2025<ul style="list-style-type: none">✓ Fired power(78.8%)✓ Renewables(20%)✓ Nuclear power(1.0 %)➤ 2035<ul style="list-style-type: none">✓ Fired power(69.7%)✓ Renewables(30.3%)✓ Nuclear power(0 %)

Scenario settings

Input for CGE model

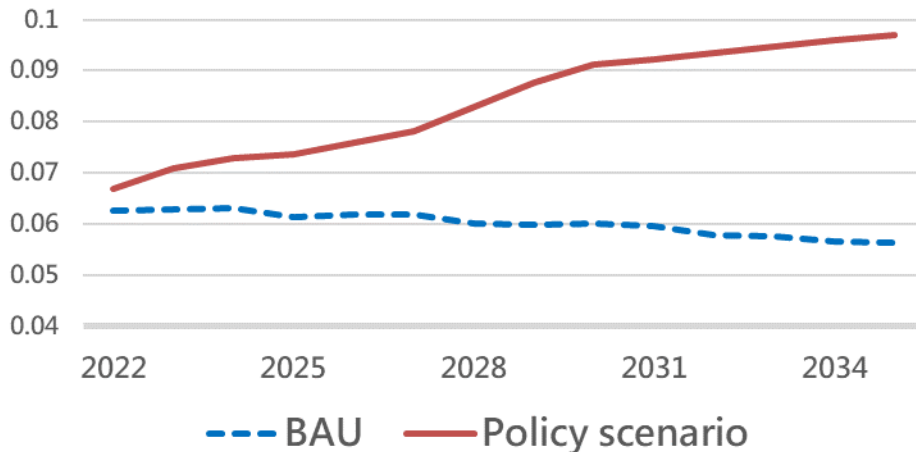
Investment on gas-fired power

Trillion USD



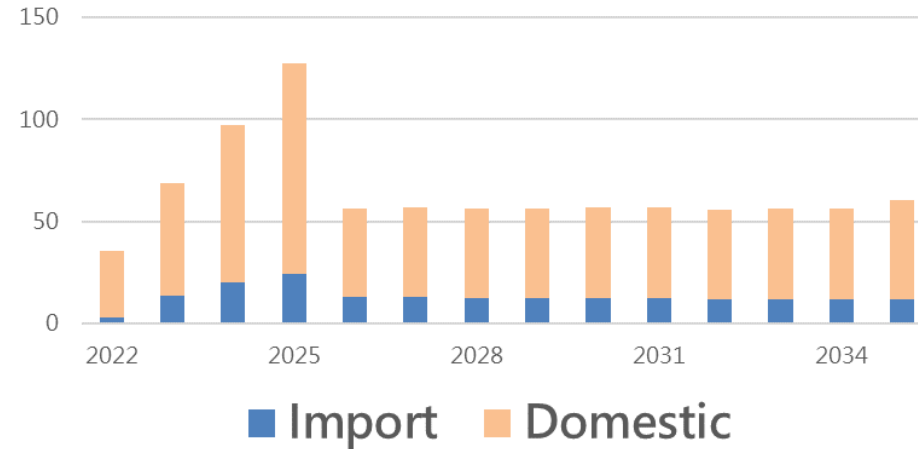
Power generation costs

USD/KWh



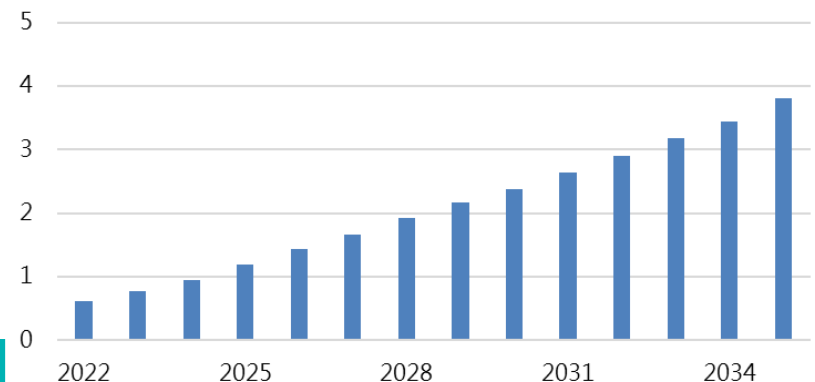
Renewable Investments

Million USD



Induced investments in energy efficiency

Trillion USD

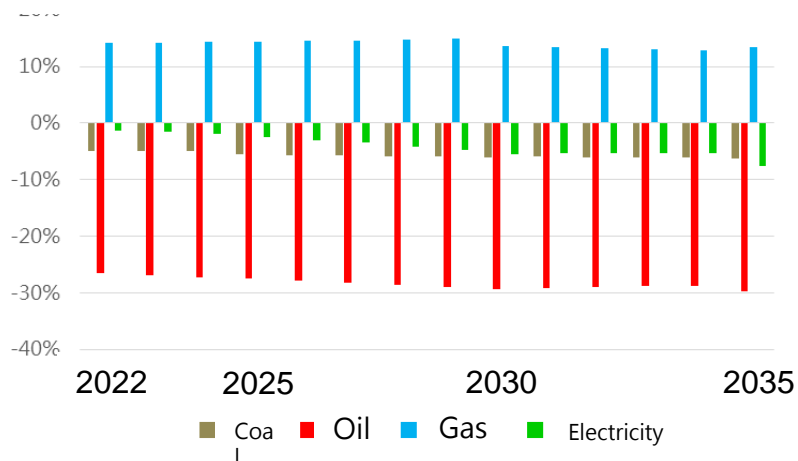


Scenario settings

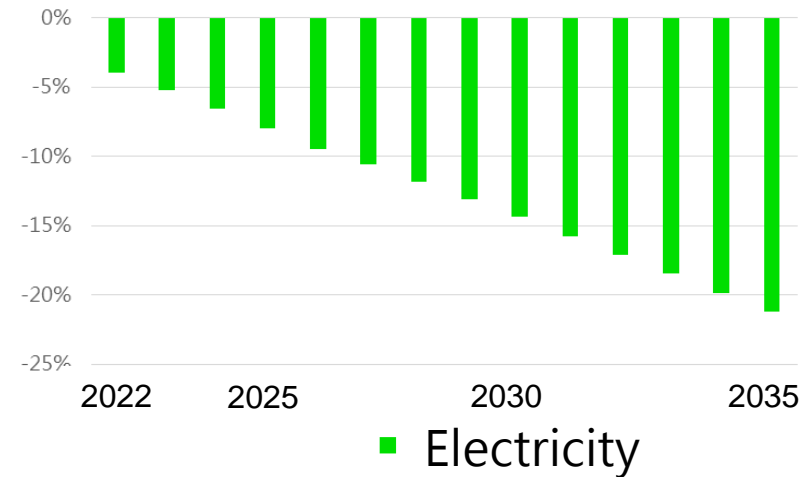
Input for CGE model

- ◆ **Change of energy demand** in face of **higher** electricity price
 - Use **MACC** to identify which technology is going to be applied in face of **higher electricity price**
 - Calculate the **investment costs** and energy demand reduction **rate** relative to BAU
 - These two data are input for CGE

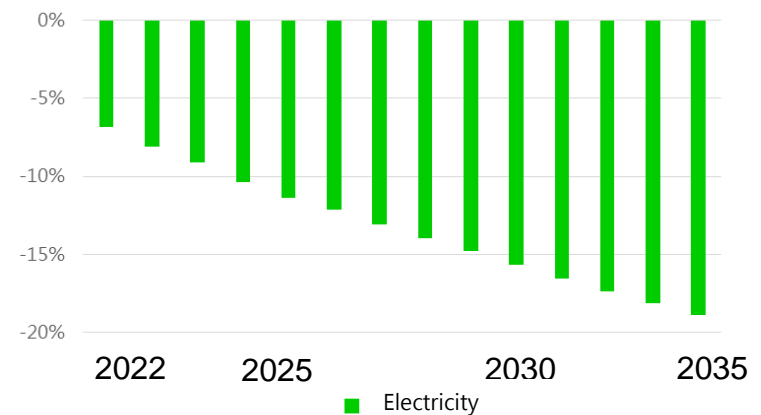
Industrial Sector



Residential Sector



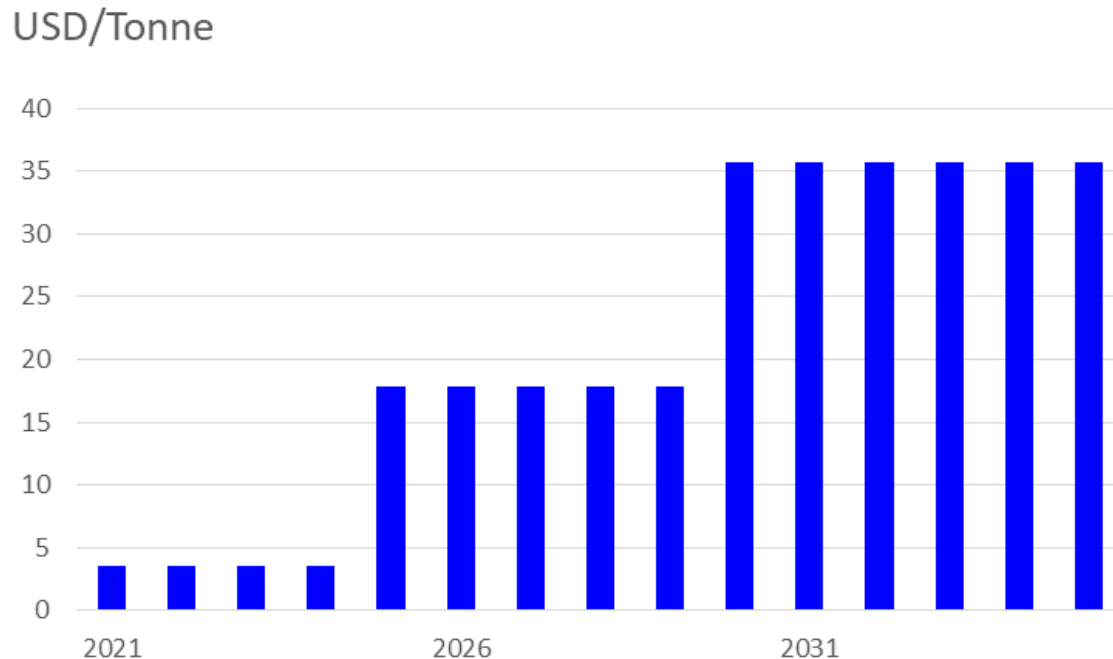
Service Sector



Policy Action and Scenarios

Carbon Tax Design

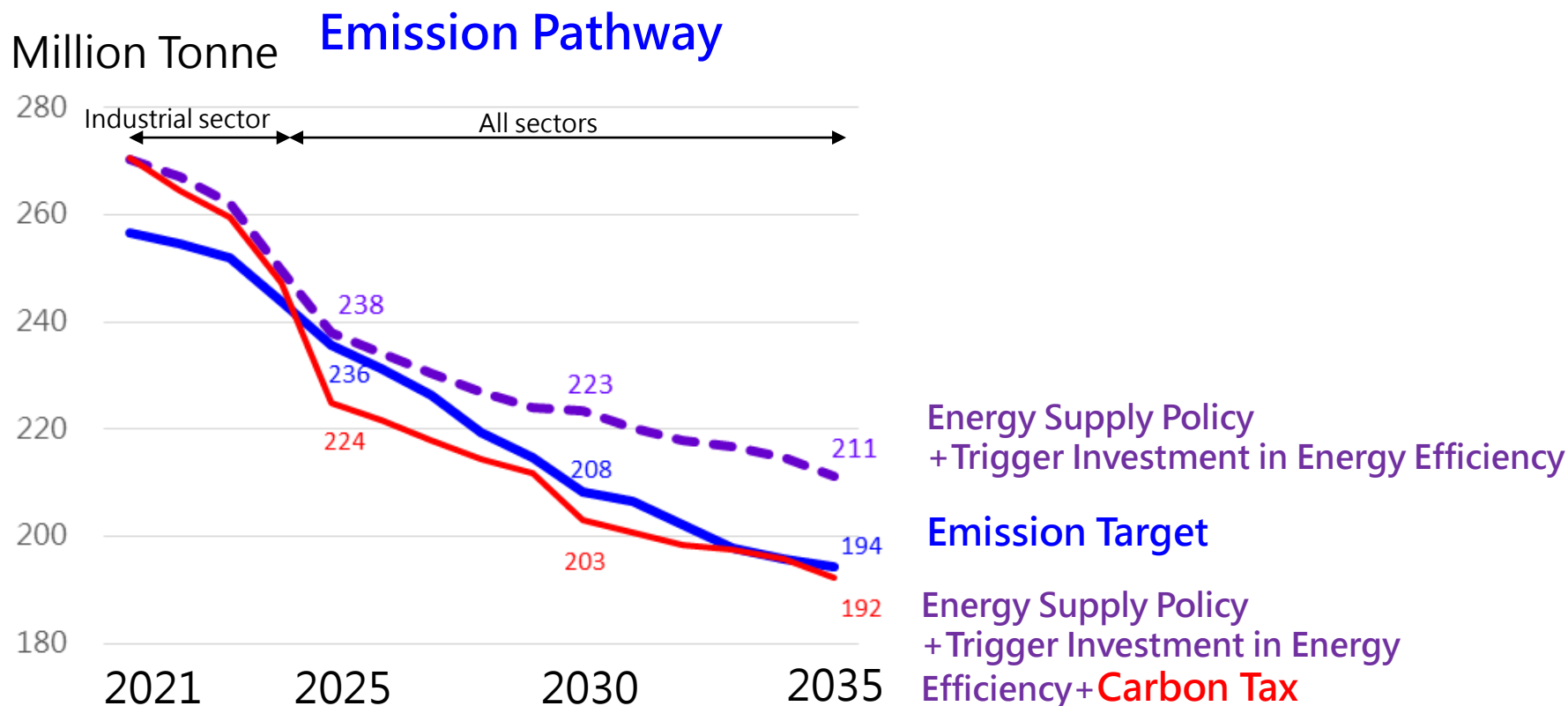
- ◆ Carbon tax rate increases in 5-year interval
 - Taiwan will review its emission reduction achievement every 5 year.
- ◆ We set up an ad-hoc tax rate, increasing it up to 35 USD/tonne in 2035
 - Environmental Protection Administration (EPA) in Taiwan proposed 3 USD/tonne (similar to the case in Singapore)
 - The punishment for those which fail to obey the abatement requirement will be fined up to 50 USD/tonne



Simulation Results

1. Impacts on CO₂ Emissions

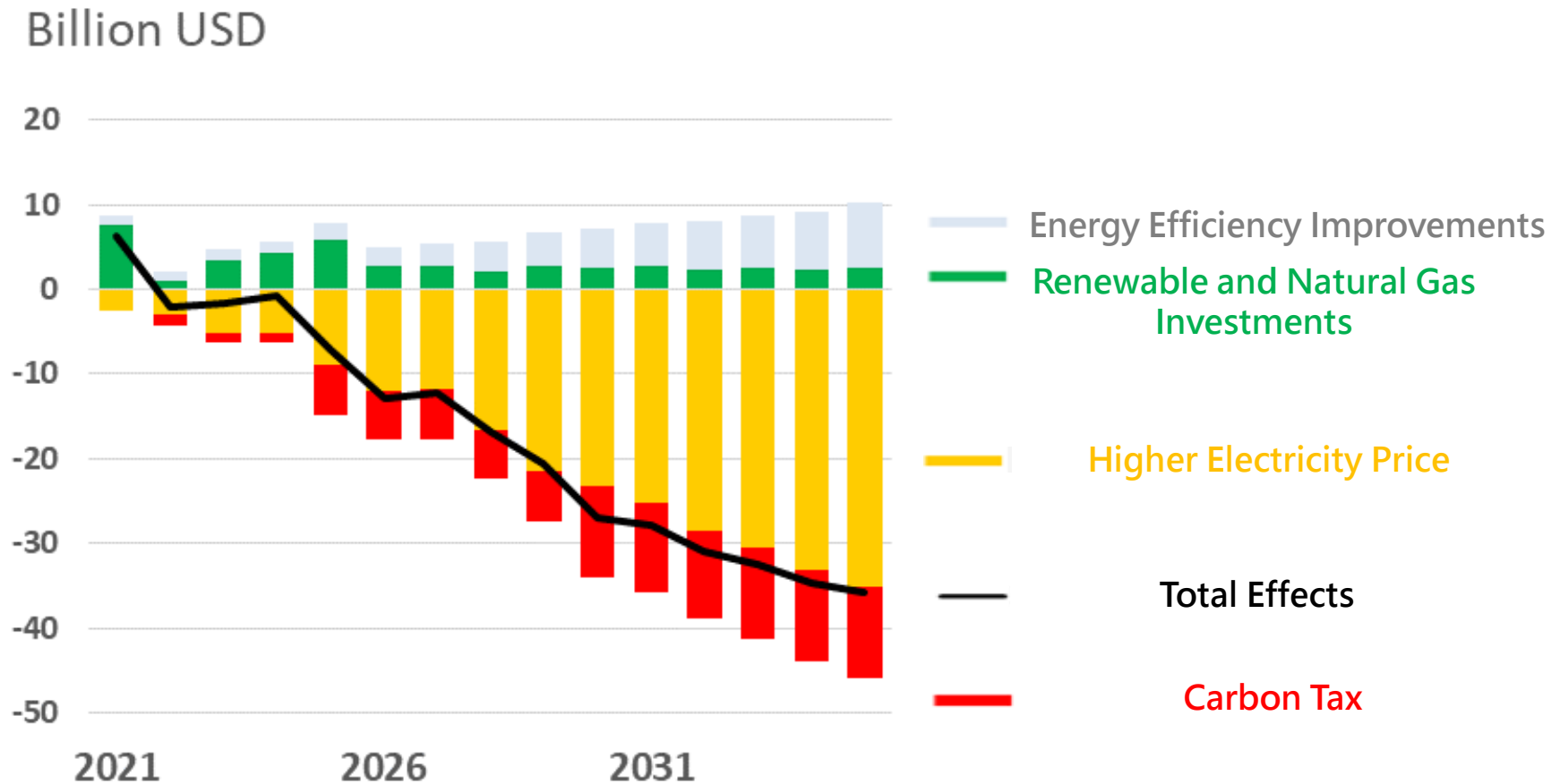
◆ The target is **not** achievable **without** a carbon tax



Simulation Results

2. Impacts on GDP

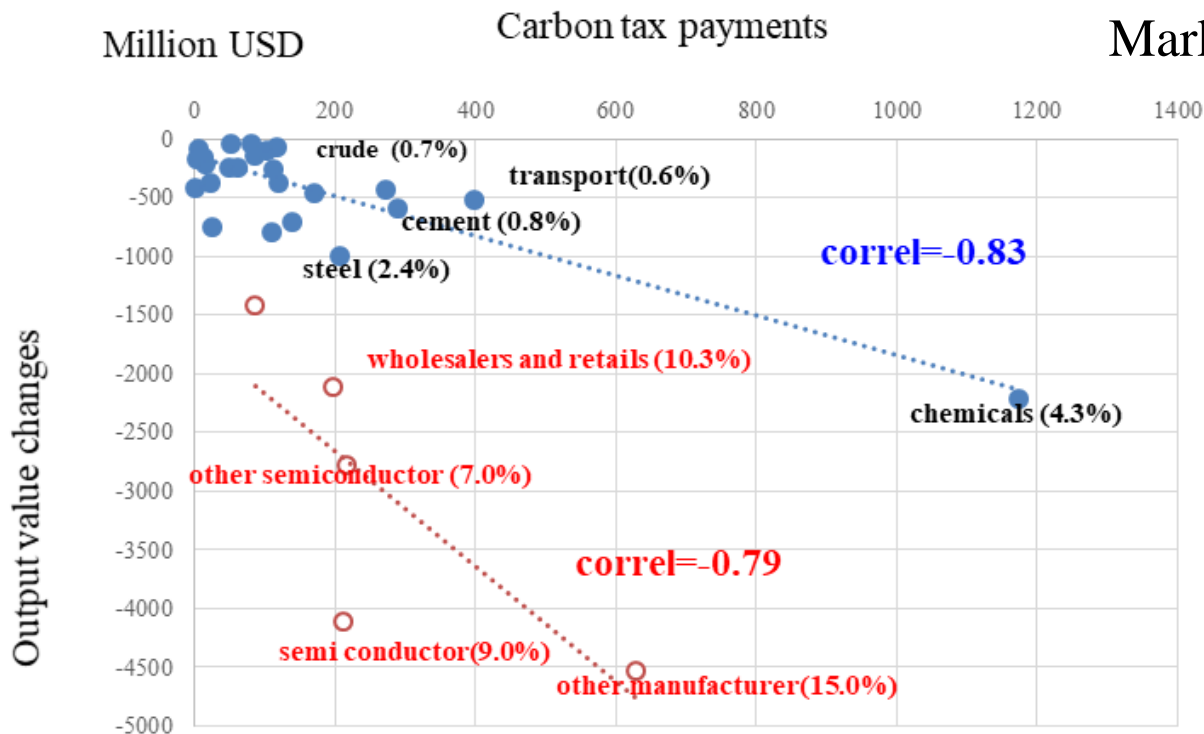
- ✓ **Positive Effects:** Renewable and natural gas investments, energy efficiency improvements
- ✓ **Negative Effects:** higher electricity price and carbon tax



Simulation Results

3. Impacts on Industries

- ◆ Numbers in bracket indicates the market share of an industry
- ◆ Low market share group (blue) v.s. High market share group (red)
 - ✓ Relatively lower impact in former group, regarding the same carbon tax payment
 - ✓ A industry with a large market share would suffer more output losses, due to the close connection with other industries



$$= \frac{\text{output value of } i}{\text{total output values}}$$

Conclusions

- ◆ Carbon price is a powerful tool to achieve emission reduction
- ◆ However, a **single policy** to achieve the emission target might result in **large** economic losses
- ◆ An industry with a large market share could reduce output values **by a large extent** with respect to **carbon tax**

Thank You for Your Attentions

Appendix

- ◆ Target for more renewables and less coal fired power plants
 - Electricity Carbon Emission Factor↓→big effects on carbon reduction
- ◆ Electricity Price ↑+Energy Efficiency Improvements→Furthe reduce the emissions
- ◆ Still need the carbon tax to reach the target

Million Tonne

