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The Efforts of Taiwan to Achieve INDC Target: An Investigation on its Regional Carbon Trading System

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Outline for Today's Talk

1. Introductions
2. BaU Scenarios
3. Simulation for Taiwan's INDC
4. Conclusions and Future Work

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Introductions

Introduction to Taiwan

- Locate in **Southeast Asia**
- **Population**: 23 millions
- **Area**: 35,883 km^2 (Japan 377,915 km^2 , 10.53 times of Taiwan)
- Taiwan has a close relationship with the Japan.

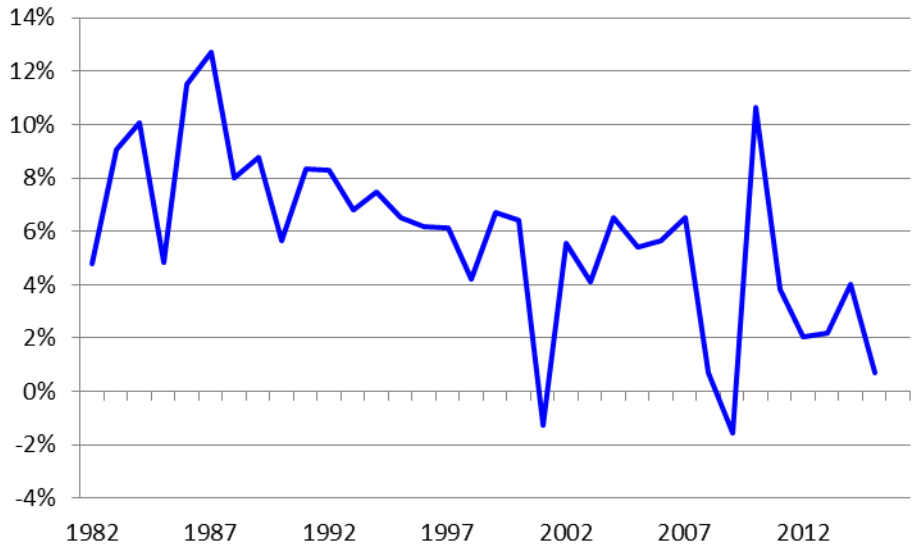
Location of Taiwan

Introductions

Introduction to GDP of TaiwanTaiwan

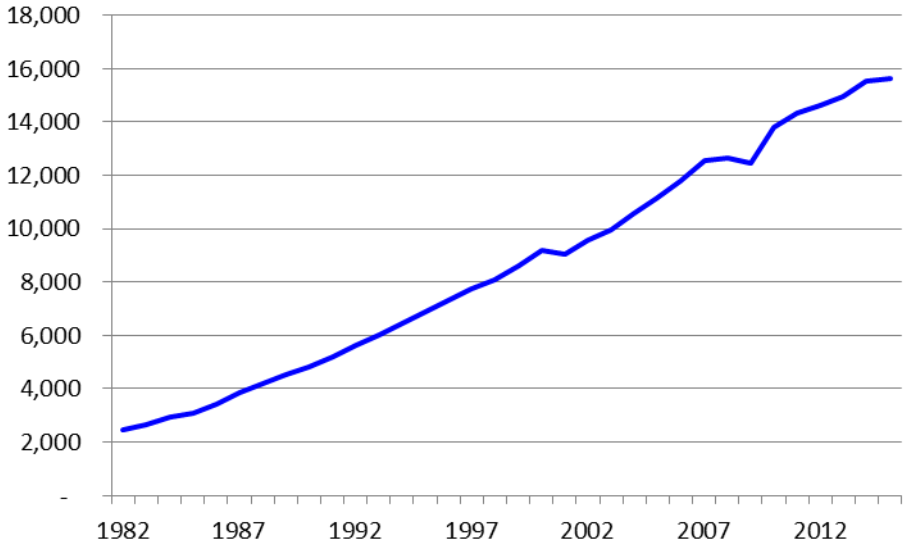
- GDP growth slows down in recent years
- GDP growth is sensitive to the U.S. economy.
- 1 US dollar equal 32 NT dollars

GDP Growth of Taiwan



GDP Growth of Taiwan

billions of NT dollars



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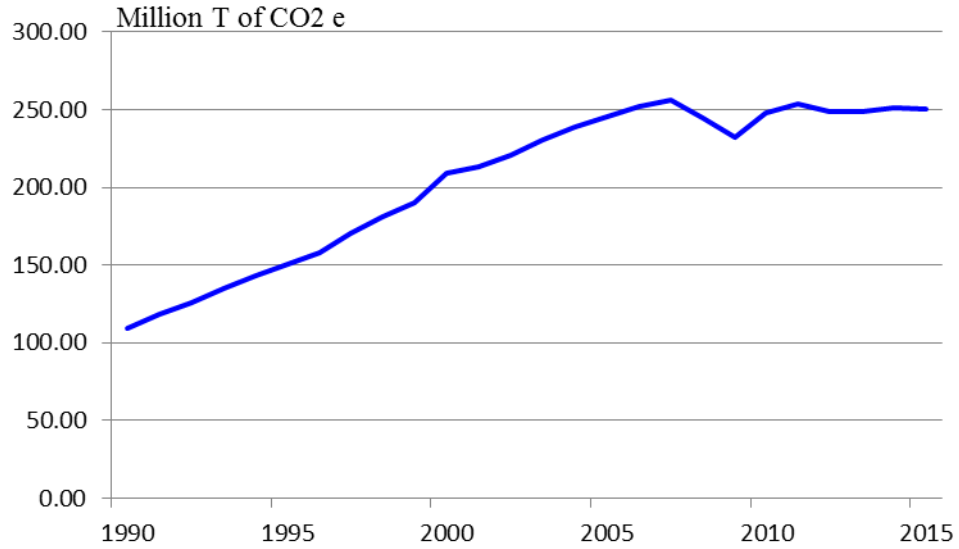
Introductions

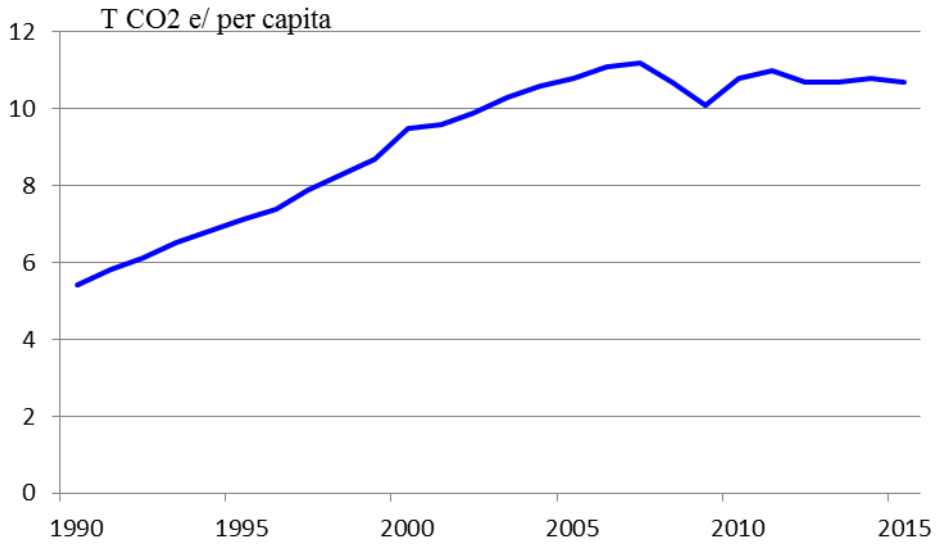
Introduction to CO_2 Emission in Taiwan

- **Total CO_2 emission** increases from 10.95 Millions **Tone of CO_2 e** in 1990 to 25.05 in 2015.
- **Per capita CO_2 emission** increases from 5.8 Tone of CO_2 e in 1990 to 10.7 in 2015.
- **CO_2 emissions** stabilize after 2010.

Total CO_2 Emissions in Taiwan



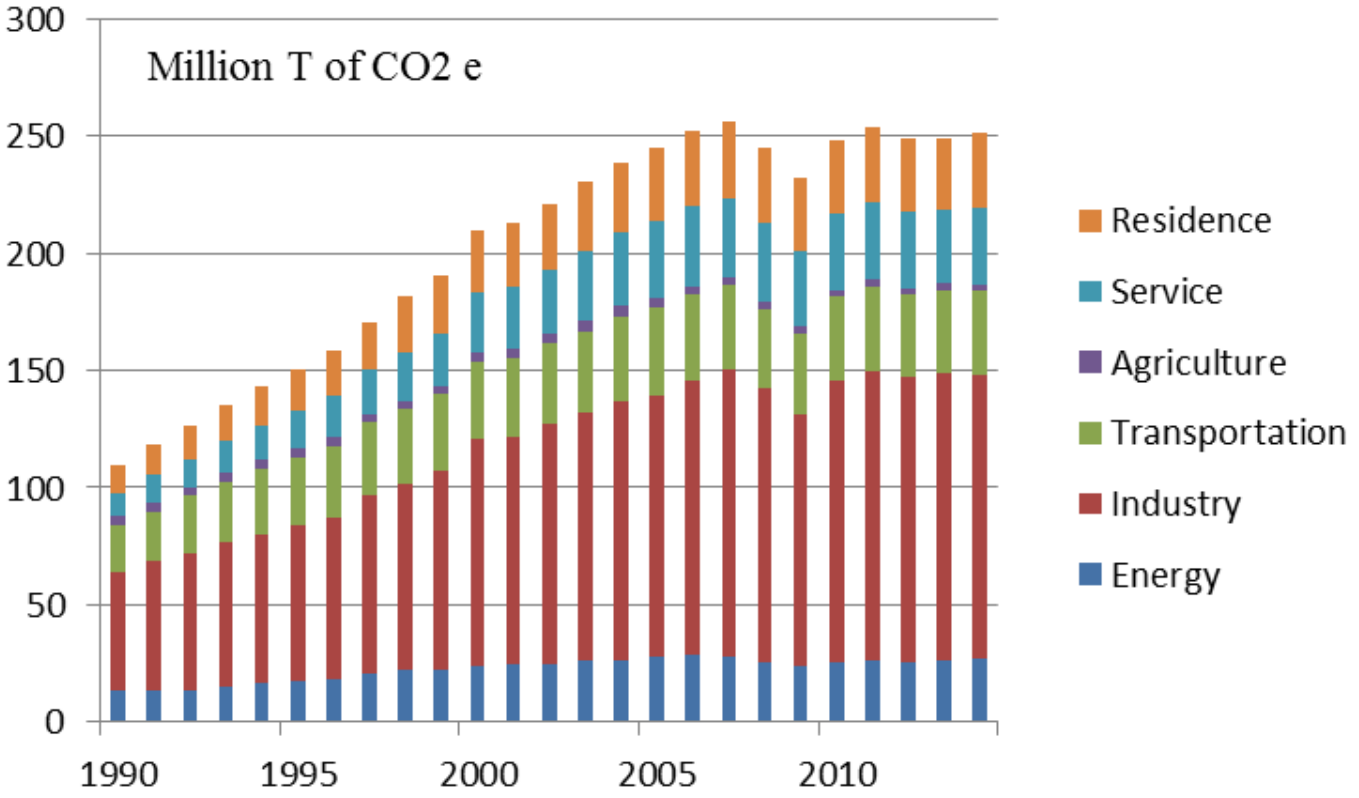
Per Capita CO_2 Emissions



Introductions

Share of Emissions by Sectors

- The largest emissions sector: **Industry** (46% in 1990 to 48% in 2015)
- Second largest sector: **Transportation** (18% in 1990 to 15% in 2015)
- Third largest sector: **Energy** (12% in 1990 to 10% in 2015)

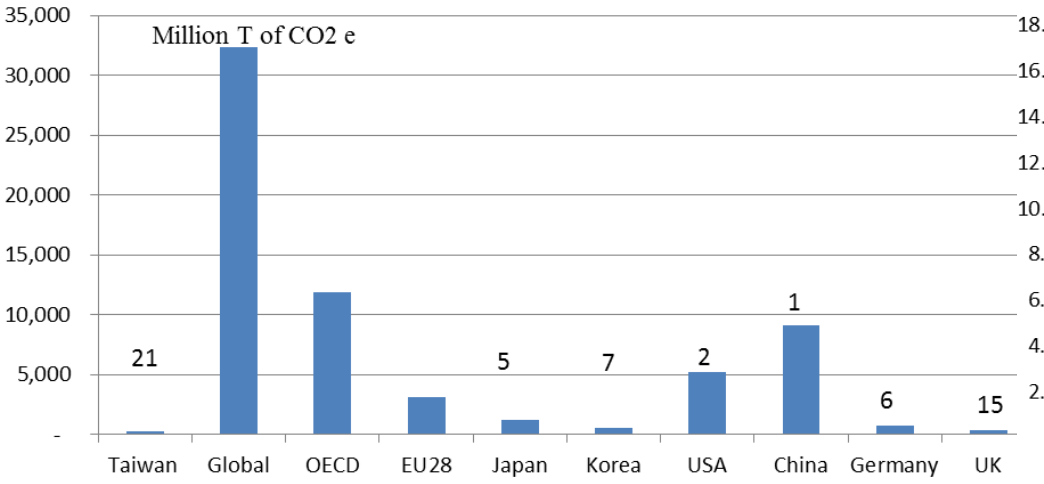


Introductions

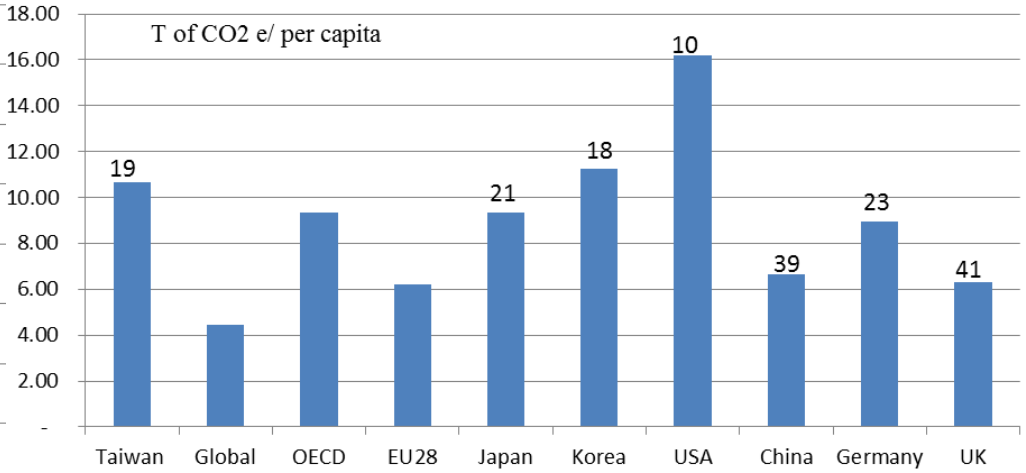
Global Comparison of CO_2 Emission in Taiwan

- Taiwan's **total CO_2 emission** ranks as 21 in the world. **China** (1), **Japan** (5), and **Korea** (7).
- Taiwan's **per capita CO_2 emission** ranks 19 in the world. **China** (39), **Japan** (21), and **Korea** (18).

2014 Global Comparison: Total CO_2 Emissions



2014 Global Comparison: Per capita CO_2 Emissions



Source: IEA (2016)

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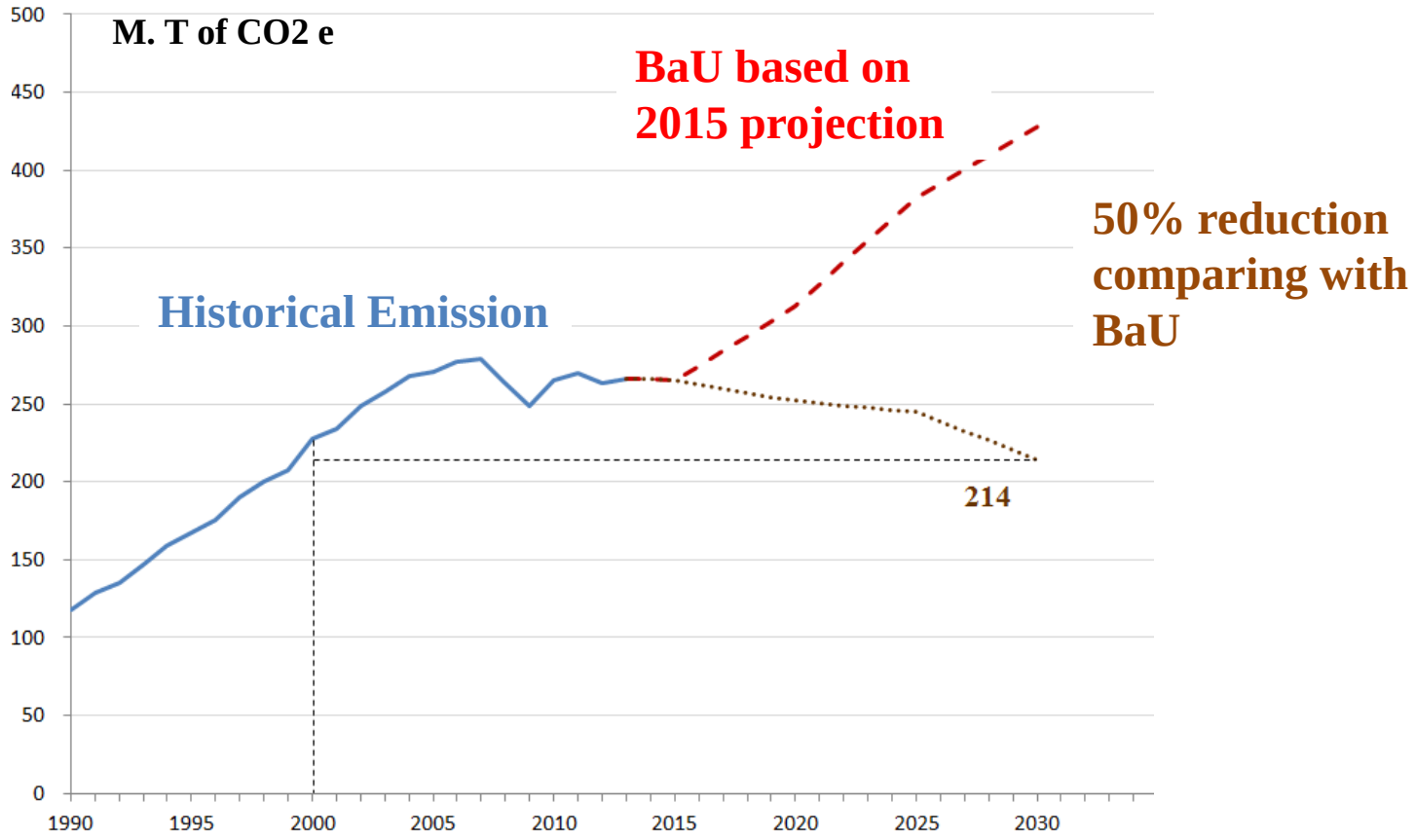
Introductions

Taiwan announced its INDC target in 2015

- The **GHG emissions** in 2030 should be reduced 50% comparing with BaU level.
- How to achieve this target, at what costs, has **not been studied**.



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Introductions

Purpose of this study

- Study **how Taiwan can achieve** INDC target, and at what cost.
- We specify several issues:
  - **Carbon cap without trade**
  - **Emission trade**
  - **How** to allocate **allowance** for lower costs

Models

- We adopt AIM model to studied such issue for Taiwan
- Built this year by **NIES** and **ITRI**

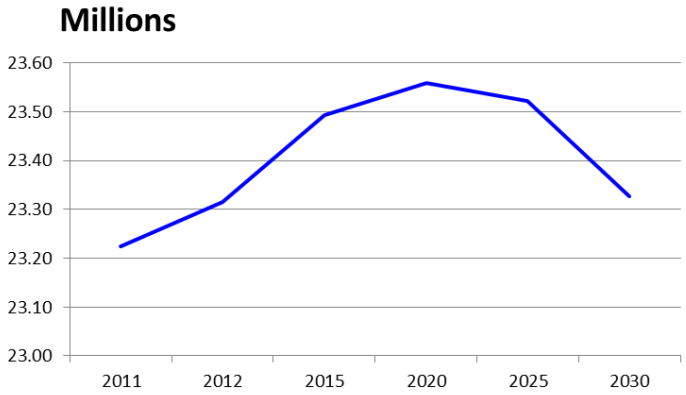
Key findings

- **INDC target** is **achievable** but with economic costs
- **More participants** in market lower **carbon price** and less **GDP loss**

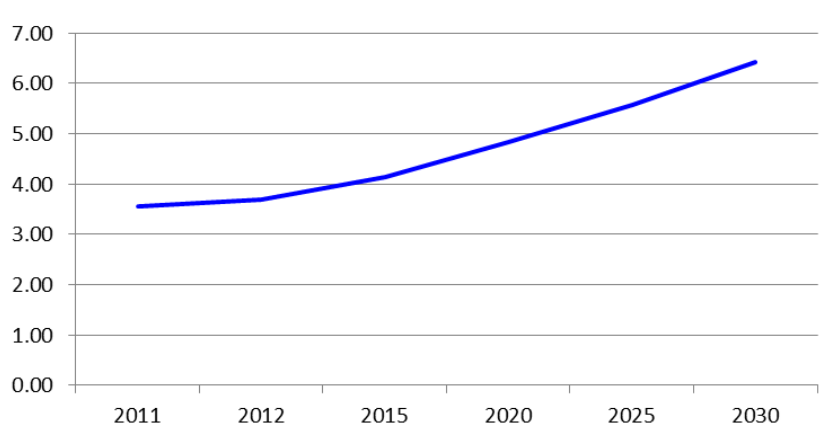
BaU Scenarios

Future Scenarios of Taiwan

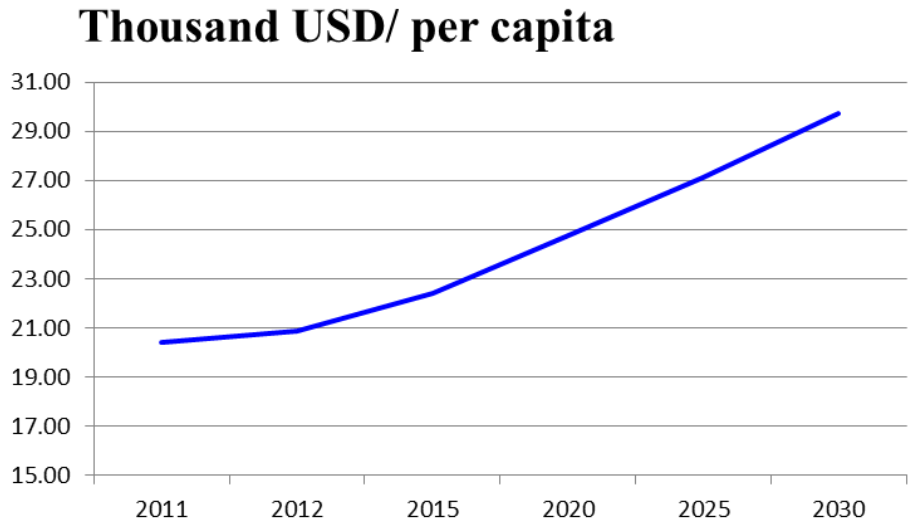
- **Population** (official projection for Taiwan) :
  - Taiwan population is expected to decline



- **Primary Energy**:
  - Primary energy is expected to reach 6.43 EJ in 2030.

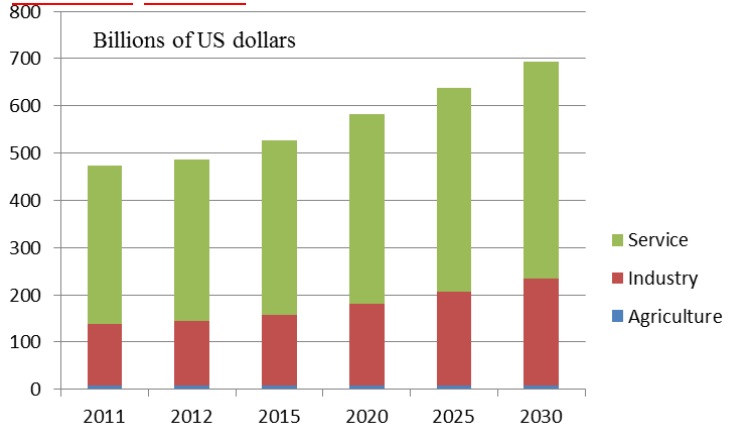


- **Per capita GDP** :
  - Use **Vector Autoregressive Model** (VAR, a econometric model) to project Taiwan's GDP.
  - We consider **Taiwan's GDP**, Taiwan's **GDP deflator**, and **OECD's GDP** for projection.
  - Taiwan's **per capita GDP** is expected to reach 29,000 US dollars in 2030.

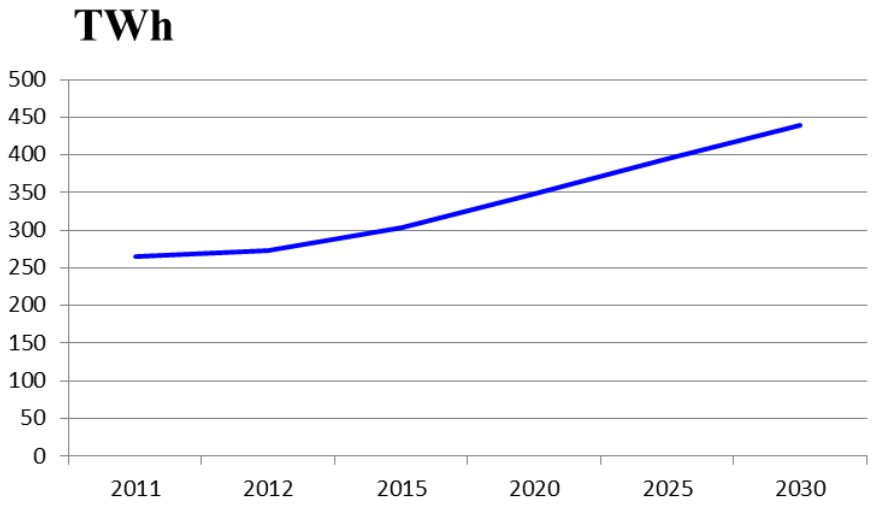


BaU Scenarios

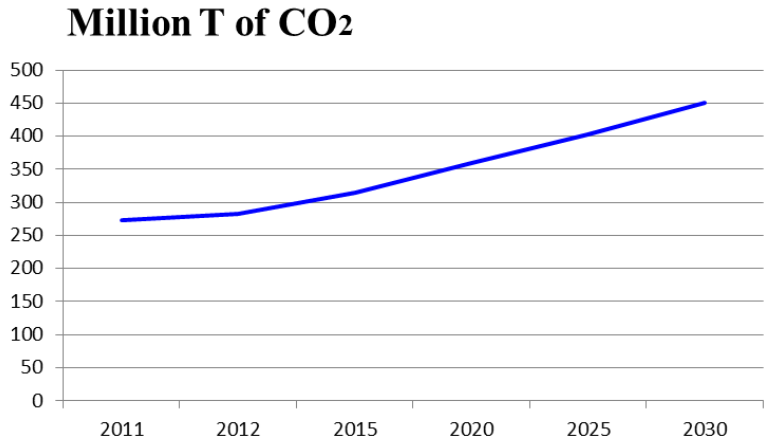
- **Trend of Taiwan's industries**
  - Value added of industry expands faster than service sector



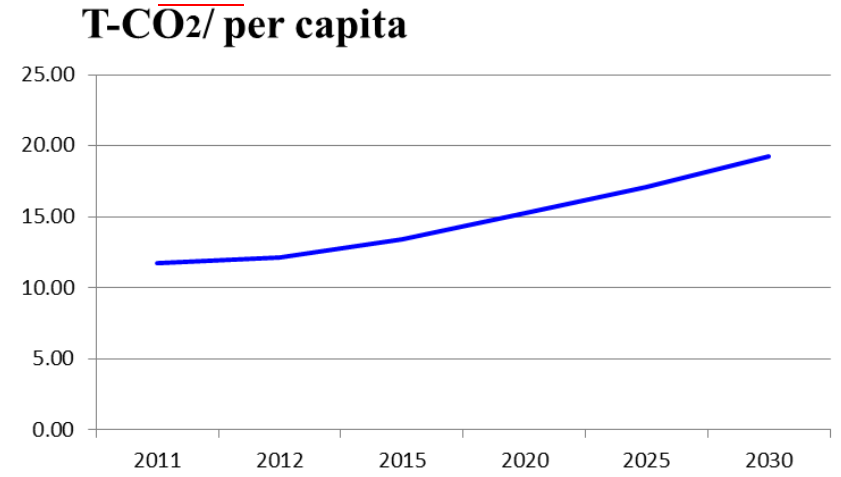
- **Trend of Power Demand**
  - increase from 265 TWh in 2011 to 439 TWh in 2030



- **Total CO_2**
  - Increase from 272 Million T in 2011 to 450 Million T in 2030



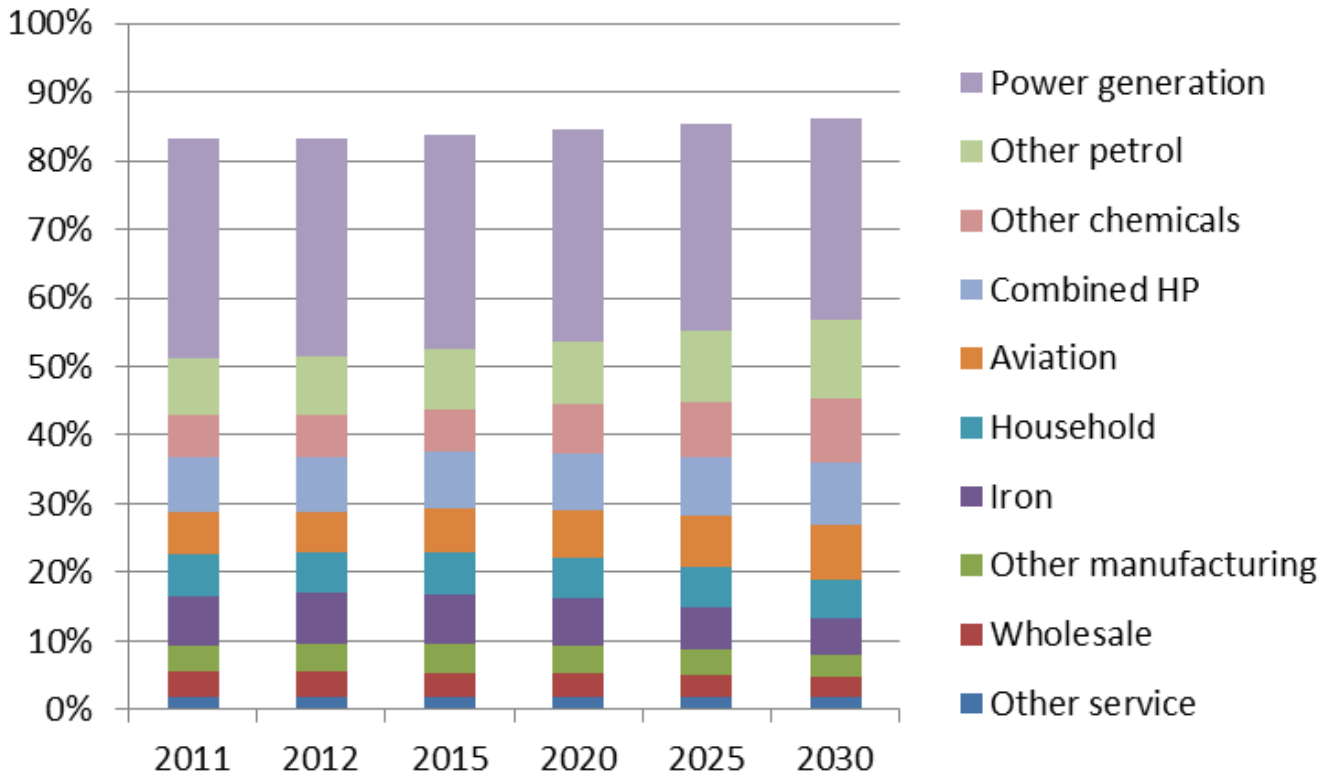
- **CO_2/ Per capita**
  - Increase from 11.73 T in 2011 to 19.29 T in 2030



BaU Scenarios

Share of Emissions

- Taiwan's **power generation** sector constitutes **a large share of emissions**, followed by **other petrol, other chemicals sectors, and combined HP.**
- **Energy** and **chemical sectors** are main sources of emissions



Simulation for Taiwan's INDC

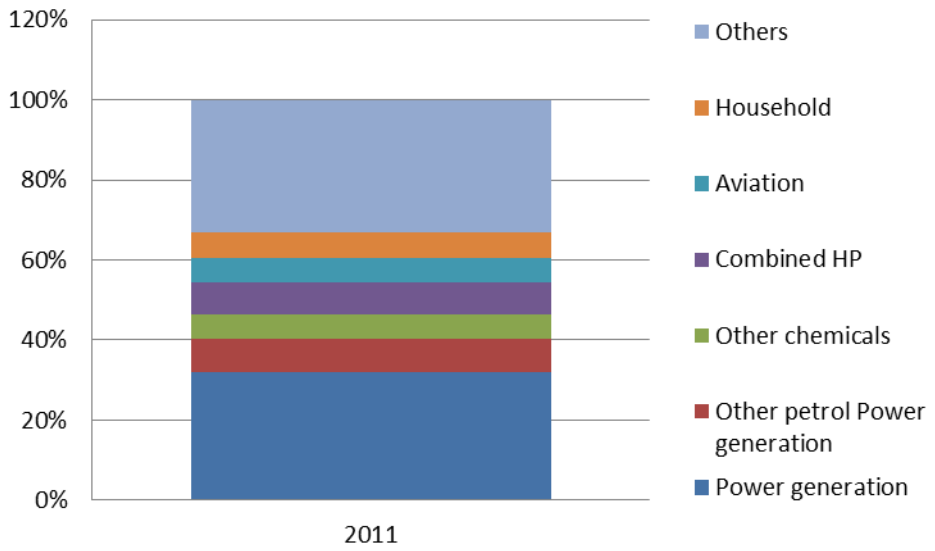
Scenario for Cap: Base Year 2011

- Base Year 2011 indicates that allowances are set according to the emissions share in Base Year 2011

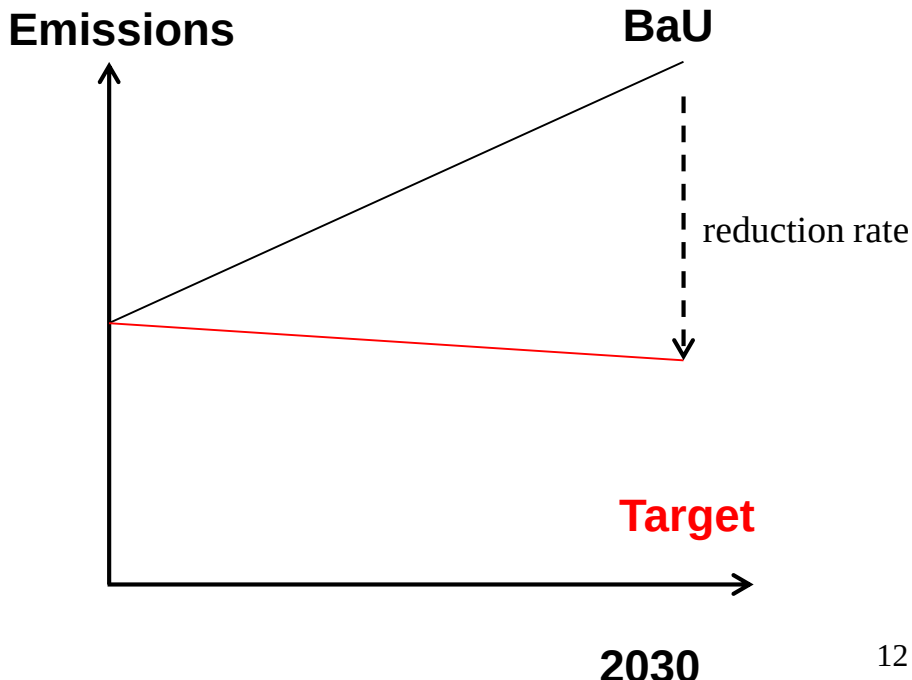
Scenario for Cap: BaU

- BaU indicates that allowances are set according to the emissions in BaU
  - Calculate the reduction rate of BaU emission to INDCtarget
  - Emissions of detail sectors are capped according to the reduction rate of BaU.

Scenario: Base Year 2011



Scenario: BaU



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Simulation for Taiwan's INDC

Cap without trade

- Just **restrict emission** of each industry. But they are not allowed to trade if there is a surplus/deficit of allowance

	Cap Reference	Capped Industries	Scenario
Carbon cap	BaU	All	Cap_BaU_All
Carbon cap	BaU	Partial	Cap_BaU_Partial
Carbon cap	Base Year 2011	All	Cap_2011_All
Carbon cap	Base Year 2011	Partial	Cap_2011_Patial

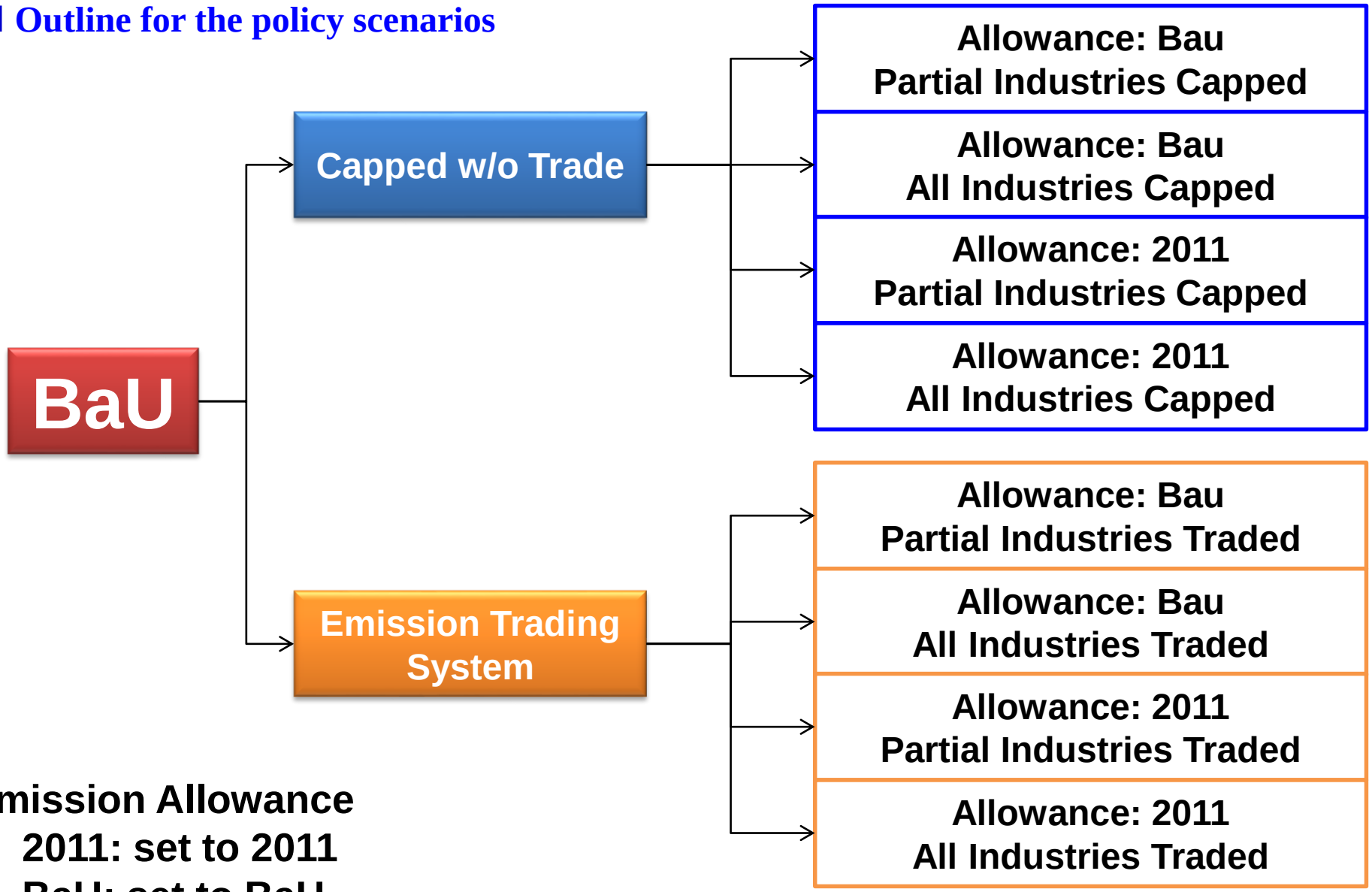
Cap and trade

- Industries are allowed to trade if there is a surplus/deficit of allowance

	Cap Reference	Capped Industries	Scenario
Carbon Trade	BaU	All	Trade_BaU_All
Carbon Trade	BaU	Partial	Trade_BaU_Partial
Carbon Trade	Base Year 2011	All	Trade_2011_All
Carbon Trade	Base Year 2011	Partial	Trade_2011_Partial

Simulation for Taiwan's INDC

Outline for the policy scenarios



Emission Allowance

- 2011: set to 2011
- BaU: set to BaU

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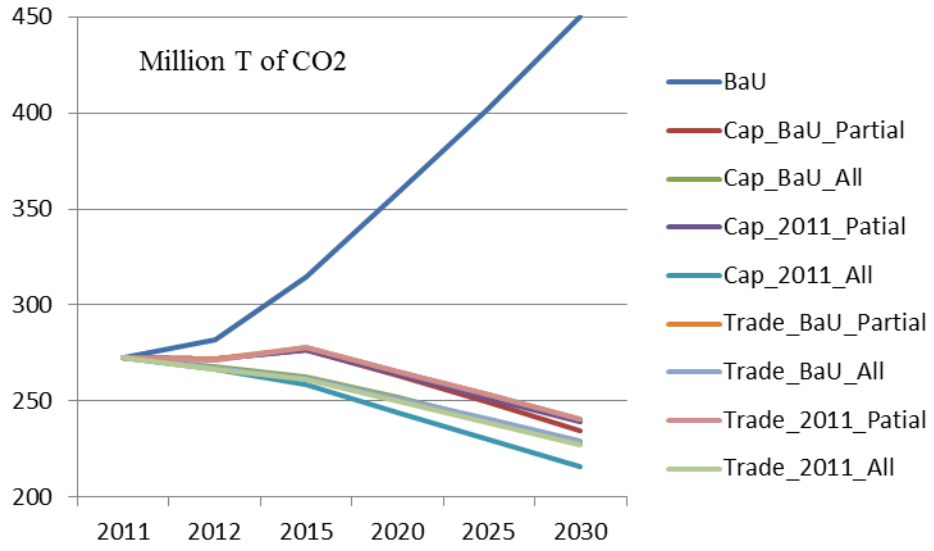
Simulation for Taiwan's INDC

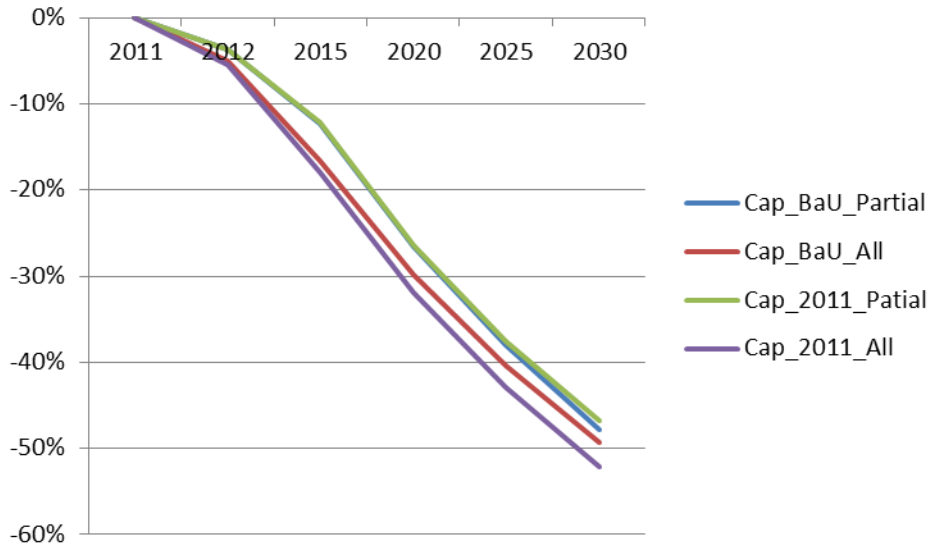
Pathways for Cap and Emission Trade

- All pathways **achieve** the INDC target
- The pathways are **slightly different**, **depending on** the scenarios

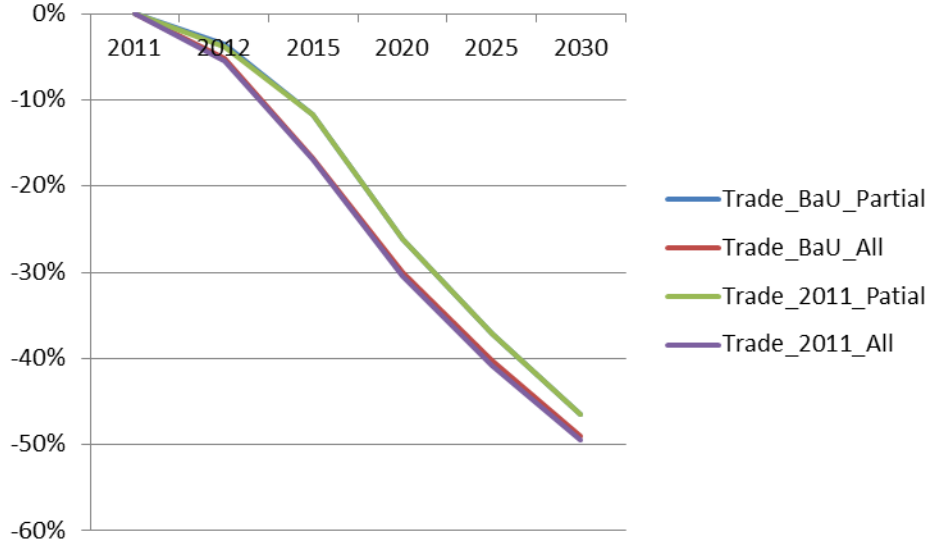
Total CO_2 Emissions in all Scenarios



Capped without Trade v.s. BaU (%)



Emission Trade v.s. BaU (%)

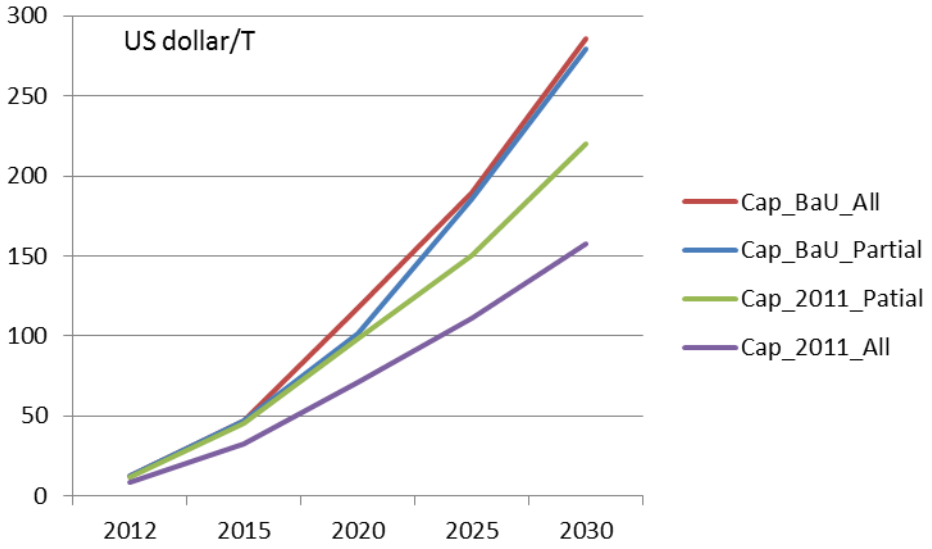


Simulation for Taiwan's INDC

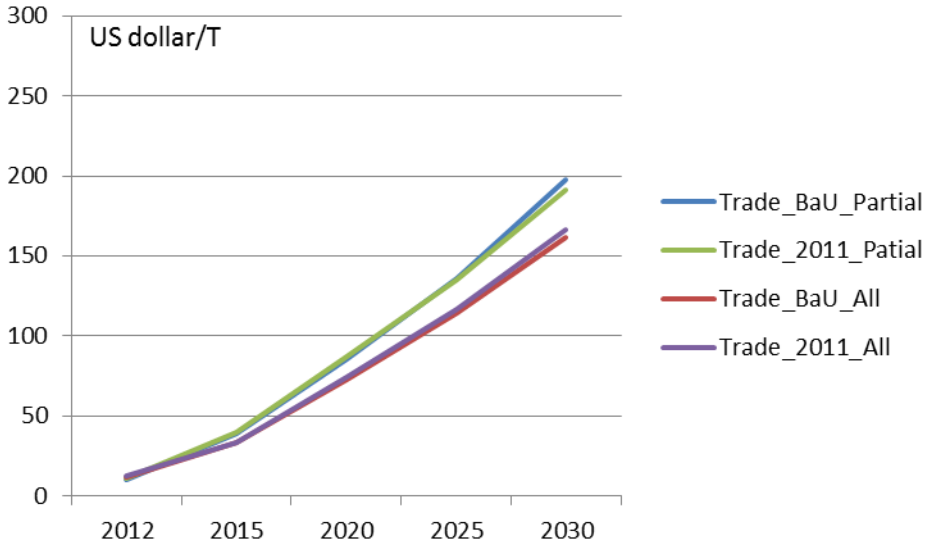
Carbon Price: Cap v.s. Emission Trade pathway

- **Carbon cap without trade** induces relative higher **implicit carbon price**. (shadow price, but not the market price)
- **With emission trade**, the **implicit carbon price** could be relative lower. (More tradable allowance in the carbon market)
- With **all sectors participating** the trade market, carbon prices are lower relative to partial trade.

Implicit Carbon Price: Capped without Trade



Implicit Carbon Price: Emission Trading



Simulation for Taiwan's INDC

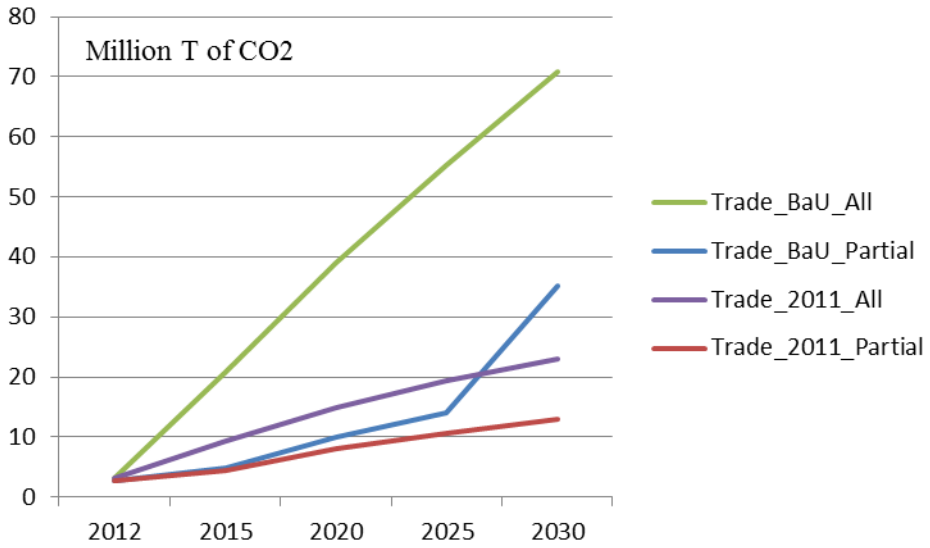
Emission Trade pathway

- **Carbon traded volume**:
  - **All sectors tradable** implies higher **traded volume**, relative to **partial trade**

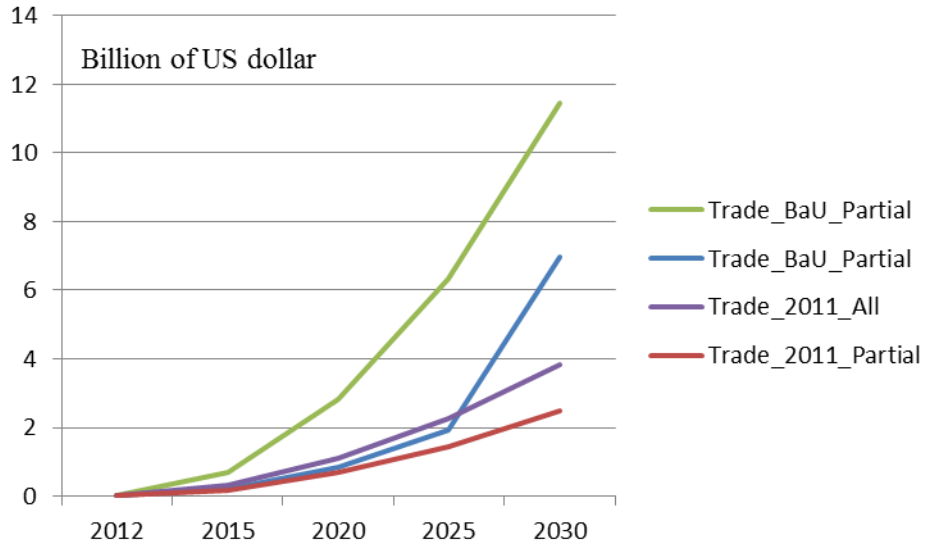
Market values of trade

- Market values:
  - **All sectors tradable** has large **market value of trade**

Trade Volume



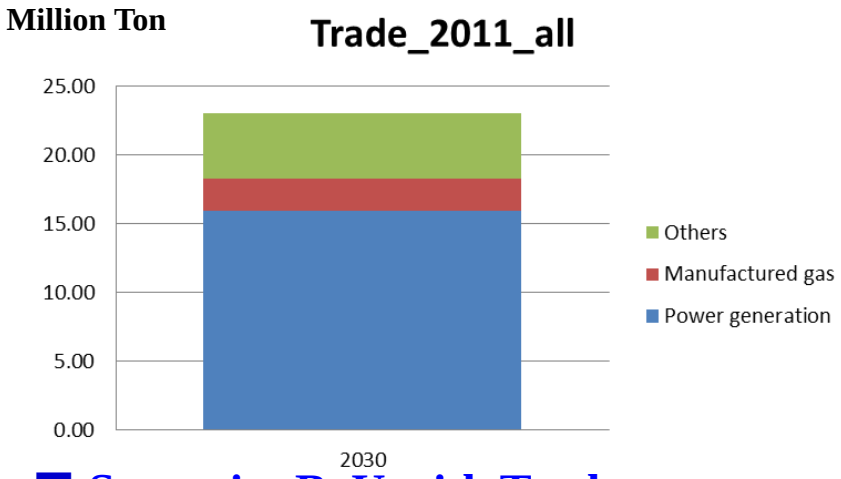
Market values



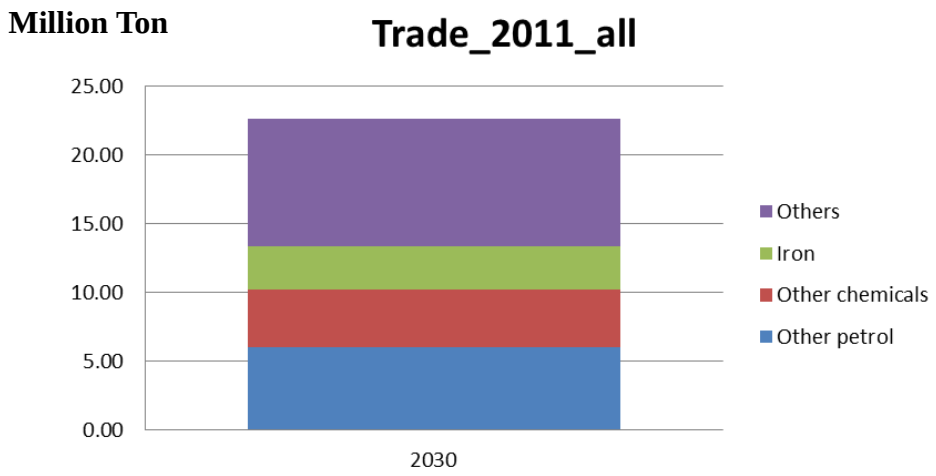
Simulation for Taiwan's INDC

Scenario: Base year 2011 with Trade

Major Buyer: Power generation sector

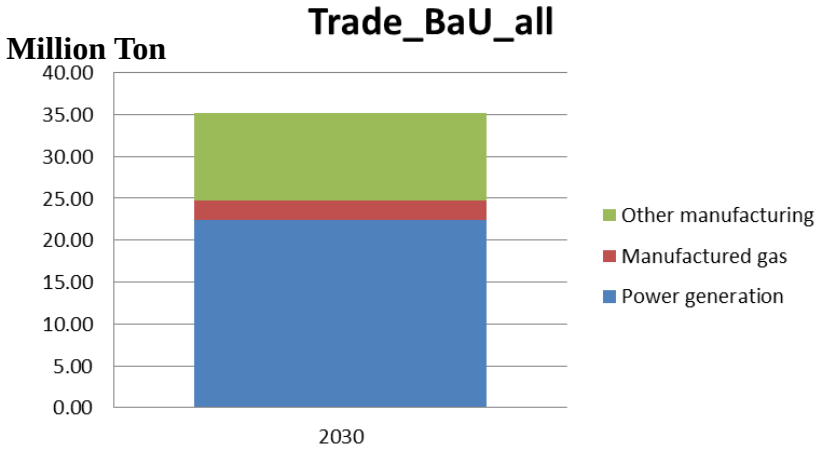


Major Seller: Other Petrol

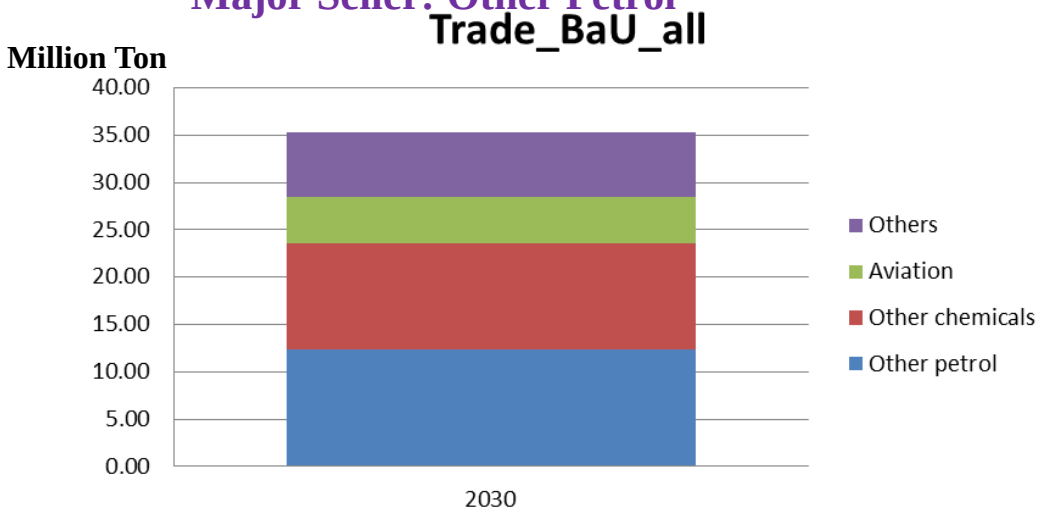


Scenario: BaU with Trade

Major Buyer: Power generation sector



Major Seller: Other Petrol

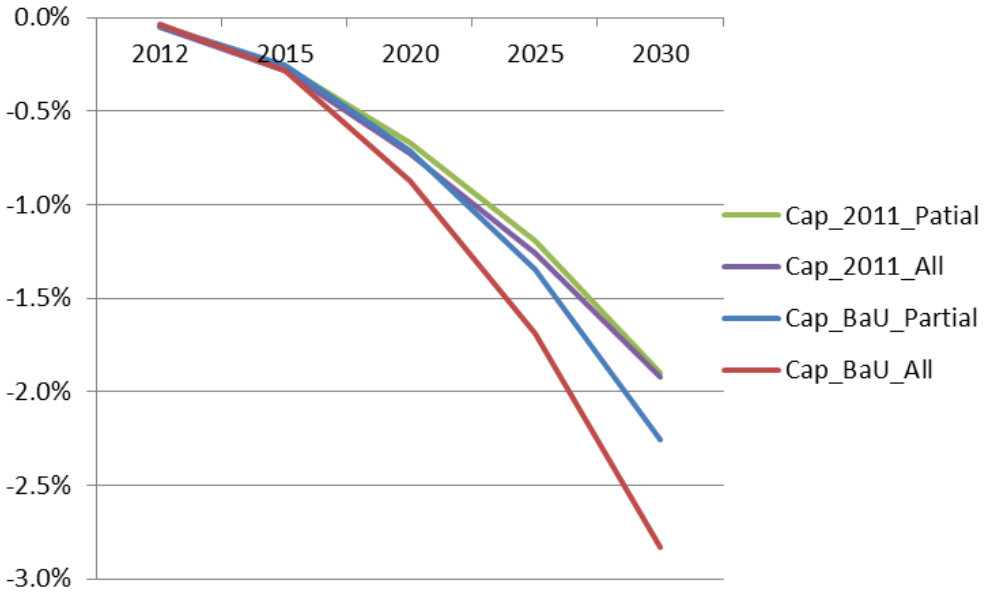


Simulation for Taiwan's INDC

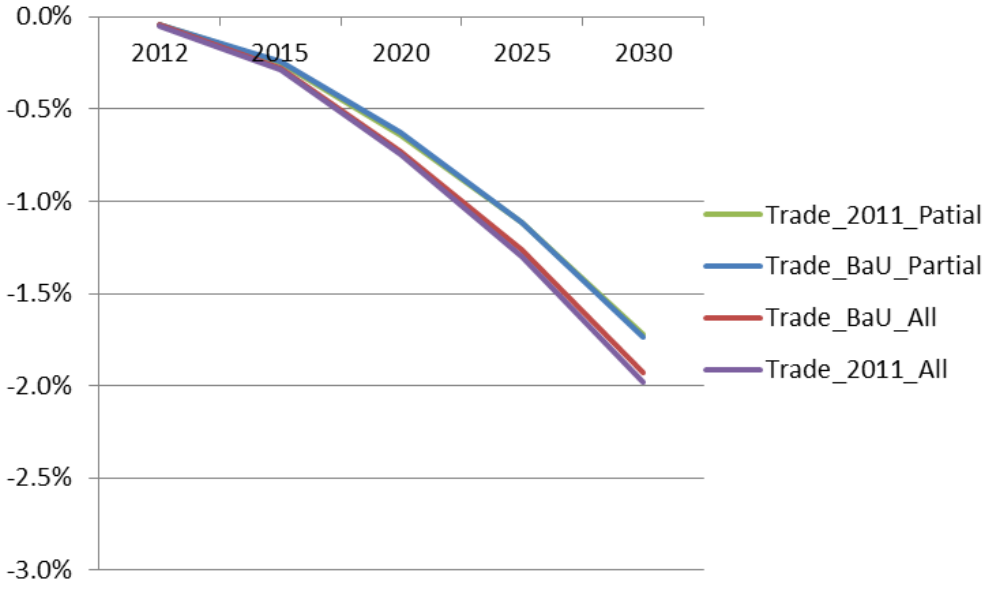
GDP loss

- **Capped without trade** induces larger GDP loss, relative to **Emission Trading System**
  - A sector with **lower emission** can **sell** its allowance in the market.➔Trade
  - **Without trade**, a sector **affordable for extra emissions** has to **reduce output**
  - **Market system** helps reduce GDP loss

Capped without Emission Trade



Emission Trade

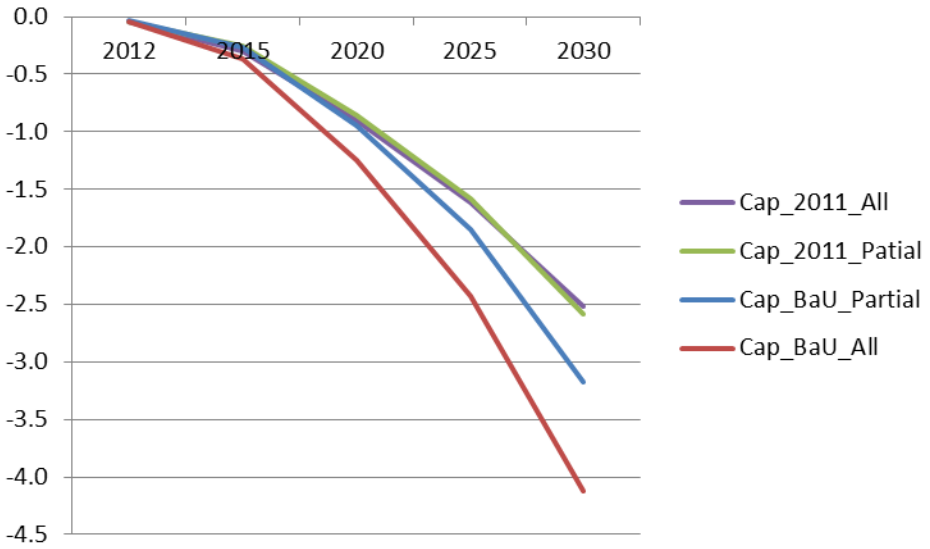


Simulation for Taiwan's INDC

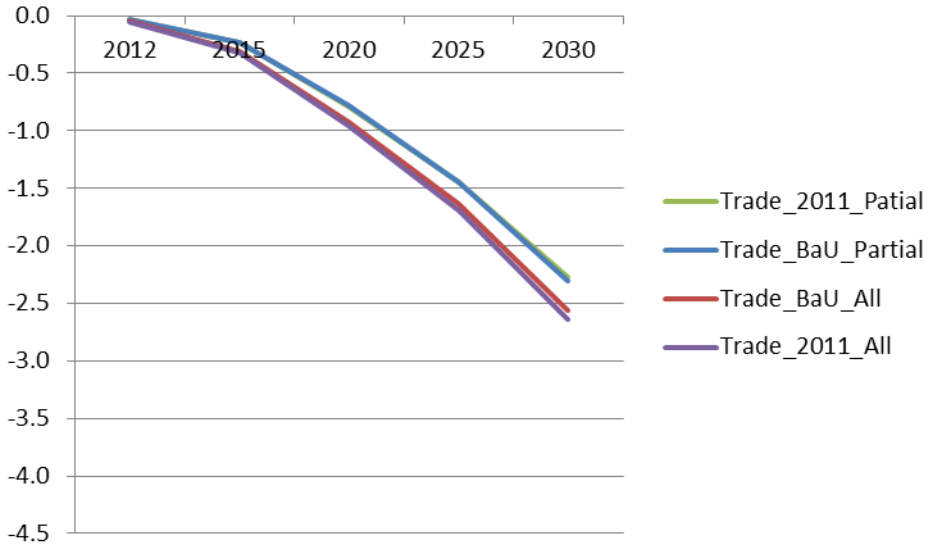
Welfare loss (Measured by private consumption)

- **Capped without trade** induces larger welfare loss, relative to **Emission Trading System**
  - Market system helps reduce welfare loss

Capped without Emission Trade



Emission Trade



Conclusions

We build an AIM/CGE for Taiwan

- We study the consequence of launching **Cap Without trade** V.S. **Emission Trading System**
  - Taiwan's largest emission sectors are **power generation sector**, followed by **other petrol, other chemicals sectors, and combined HP**.
- **Trading system** mitigates the negative impact on economy
  - Enlarge the trading market mitigates the negative impact on economy

Future work

- We will try to study the contribution of Taiwan's effort to global warming reduction, using AIM/CGE
- Consider what would happen if Taiwan is allowed to trade allowance with other regions/countries