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# Carbon Pricing Efficacy: Cross-Country Evidence

Rohan Best, Paul J. Burke & Frank Jotzo

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# Energy mix persistence and the effect of carbon pricing†

Rohan Best ✉, Paul J. Burke

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# Background

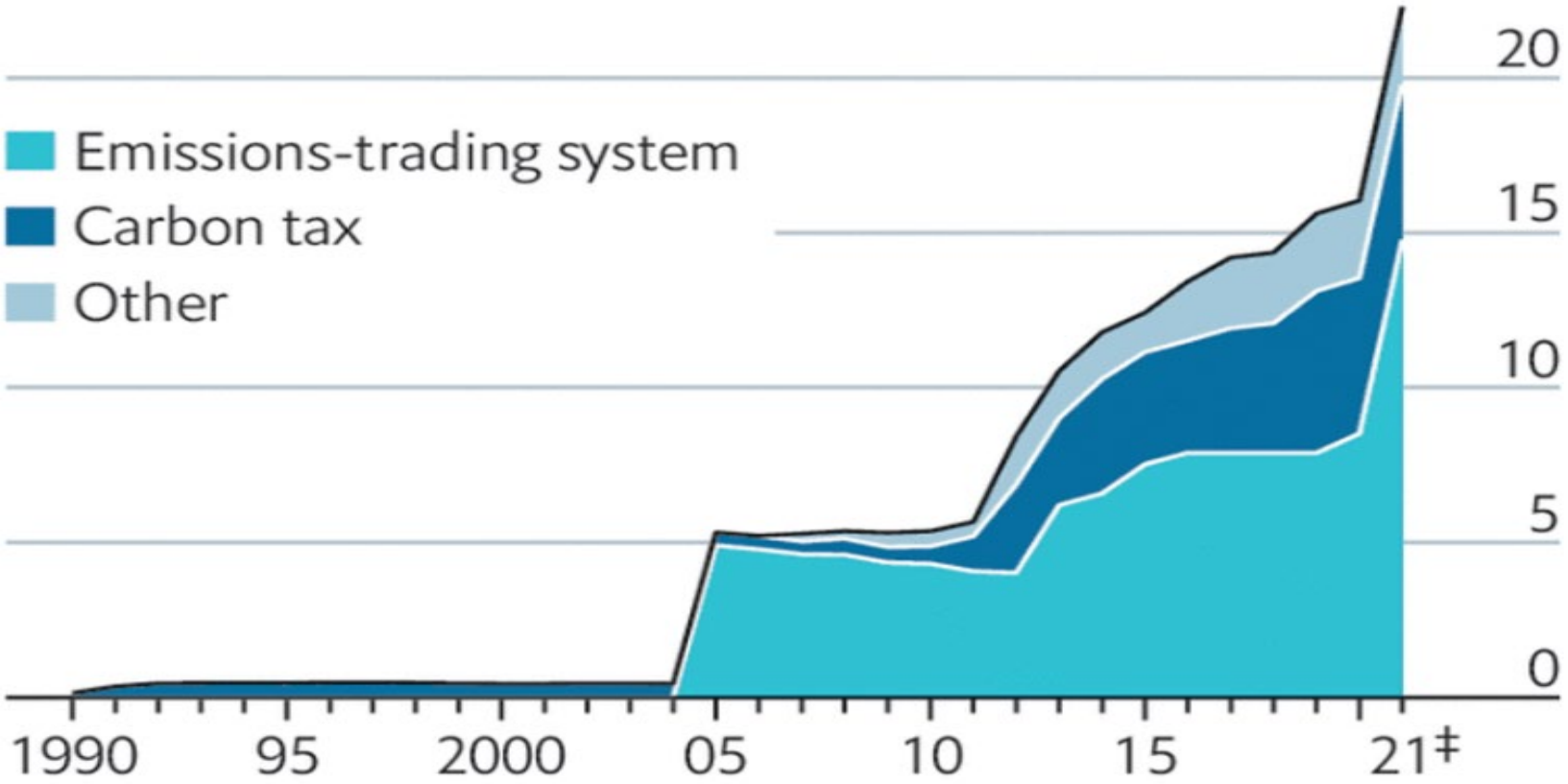
- In theory, carbon pricing is a low-cost way of reducing emissions
- Carbon pricing has been implemented or is under consideration in many countries but coverage remains low
  - Around 16% of emissions are covered by implemented schemes
  - This is higher at 22% when including scheduled schemes
- Some empirical case studies estimate effects of carbon prices on emissions for single countries
- Some theoretical papers model carbon price impacts on emissions
- Our paper quantifies the empirical effect of carbon prices on emissions across a global sample of countries
- We focus on explicit carbon dioxide prices:
  - Taxes
  - Emissions trading systems

# Carbon price independent variables

- Binary, based on the 'State and Trends of Carbon Pricing' report
  - All countries with any carbon pricing schemes
  - Only countries with national-level carbon pricing schemes
  - Duration-adjusted binary variable
    - Countries that introduced carbon prices during a growth period have a proportional value
- *Effective* continuous price in 2012 euro per tonne of $CO_2$, which is adjusted for emissions coverage, from the OECD
- Composite numerical measure for carbon price coverage and monitoring from the RISE measures from the World Bank.

# Carbon-pricing initiatives*

% of annual global greenhouse-gas emissions covered†




*Regional, national and subnational
†Emissions are given as a share of global GHG emissions in 2012 ‡Forecast

Source: World Bank

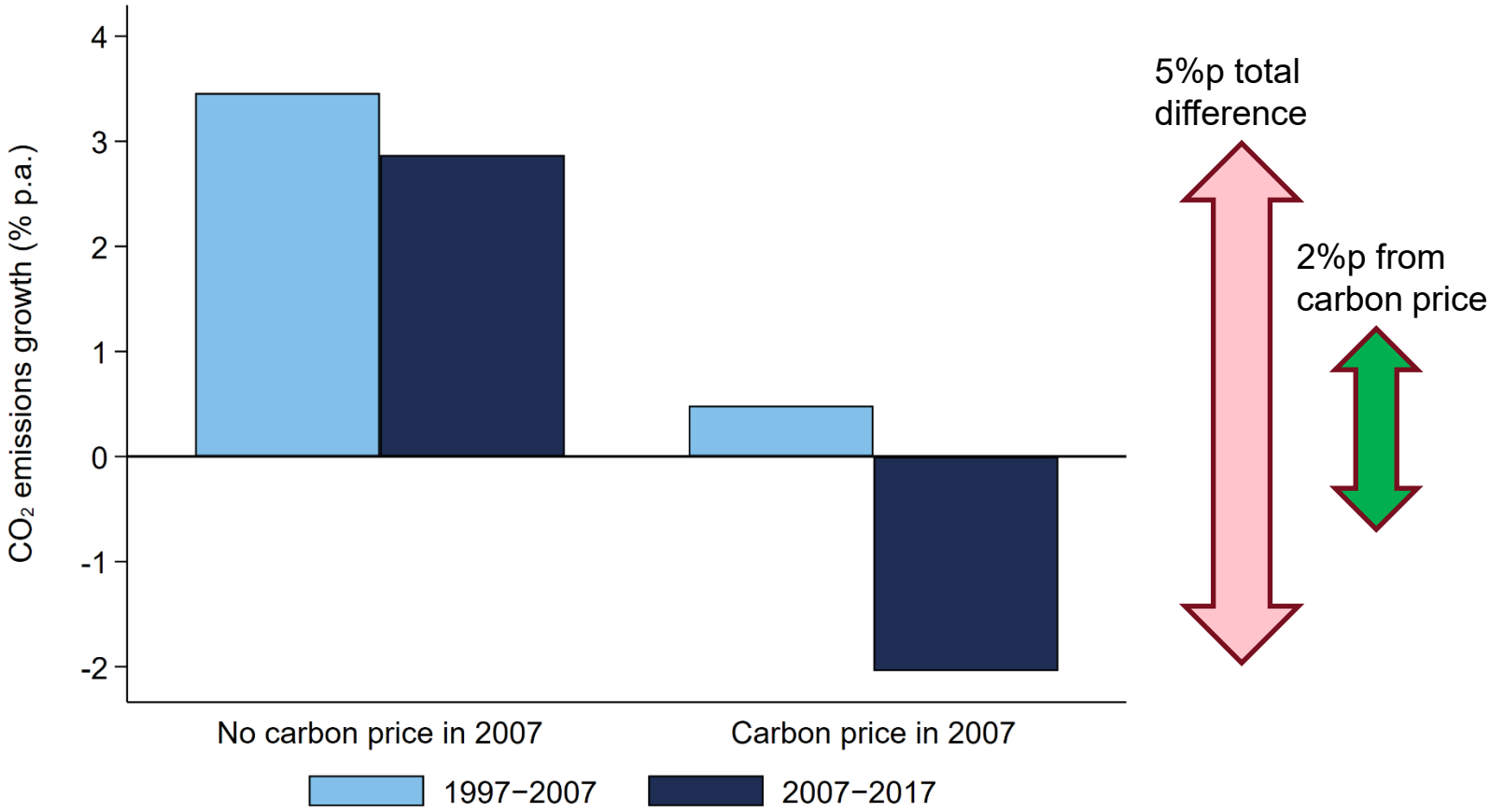
The Economist

# Countries with a carbon price in 2011

| | | | | | |
|---|---|---|---|---|---|
| Austria | Czech Republic | Greece | Latvia | Norway | Spain |
| Belgium | Denmark | Hungary | Lithuania | Poland | Sweden |
| Bulgaria | Estonia | Iceland | Luxembourg | Portugal | Switzerland |
| Canada | Finland | Ireland | Malta | Romania | Ukraine |
| Croatia | France | Italy | Netherlands | Slovak Republic | United Kingdom |
| Cyprus | Germany | Japan | New Zealand | Slovenia | United States |

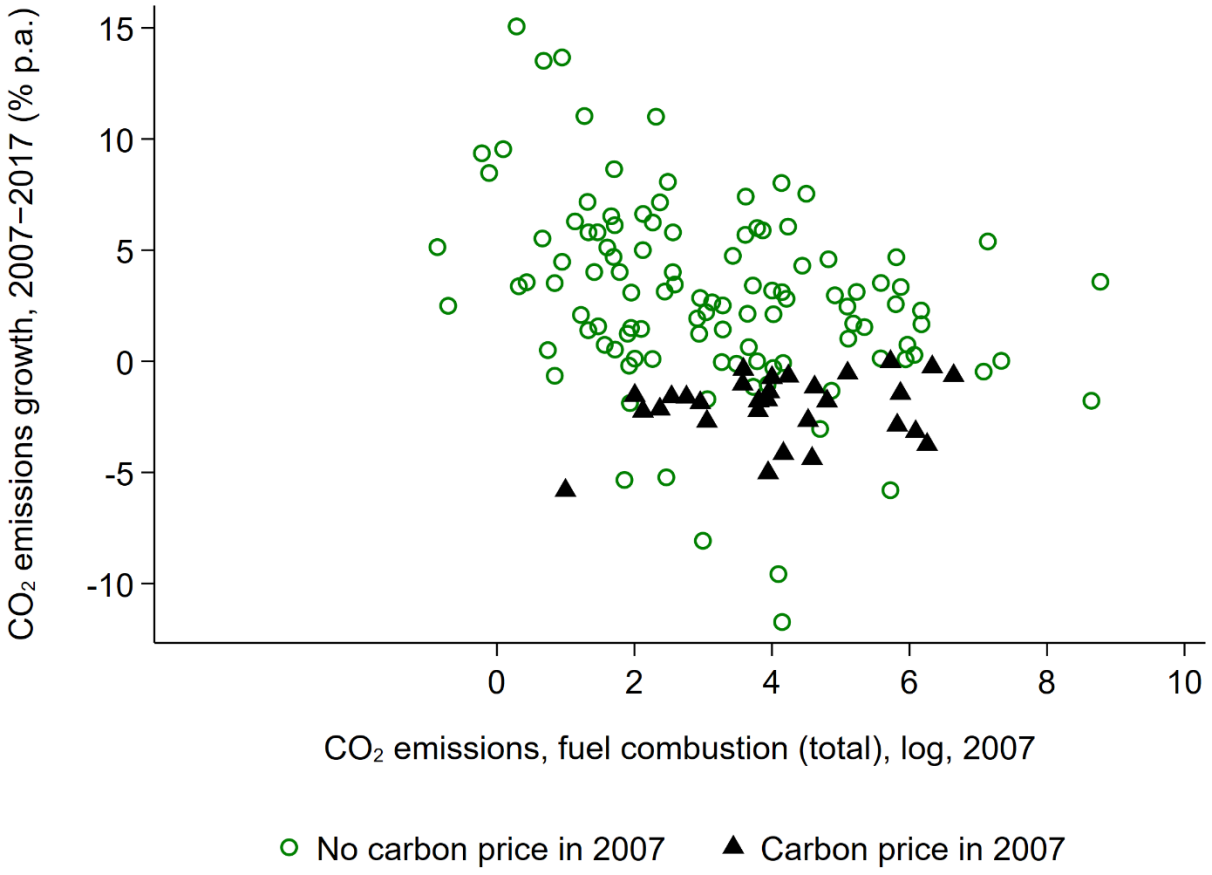
# $CO_2$ emissions growth (average annual)

## COUNTRIES WITHOUT CARBON PRICES AND WITH CARBON PRICES



# $CO_2$ emissions growth (average annual)

## CONVERGENCE



# Study details

- Cross-sectional and panel regression of large samples of countries
  - Emissions data are available for approximately 142 countries from the International Energy Agency
  - Regression samples include between 104 and 137 countries depending on availability of all variables in our study
    - This covers 92-96% of the global population
- The study covers the entire length of time that carbon pricing has existed in at least one country (since 1990)
  - We also focus on the five year period 2012-2017 in some results

# Dependent variables

- Carbon dioxide emissions growth
  - Growth over the 5 years to 2017 for a cross-sectional approach
  - Growth over periods of 1-3 years using a panel regression approach
- Levels of carbon dioxide emissions per capita (log)

# Control variables

- Other policies:
  - Fossil fuel subsidies
  - Net gasoline tax
  - Feed-in tariffs (binary)
  - Renewable portfolio standards (binary)
  - Renewable energy policies (numerical index)
  - Energy efficiency policies (numerical index)
- Initial emissions
- Prior emissions growth
- Population level and growth
- GDP per capita level and growth (controls for the Global Financial Crisis)

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# Results: cross-sectional $CO_2$ growth (2012-2017)

## SELECTED COEFFICIENTS

| Dependent variable: Average annual $CO_2$ growth: (2012-2017), *** = 1% significance | | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Effective carbon price | -0.003*** | | -0.003*** | | -0.002** | |
| | (0.001) | | (0.001) | | (0.001) | |
| Effective carbon tax | | -0.002*** | | -0.003*** | | -0.002** |
| | | (0.001) | | (0.001) | | (0.001) |
| Effective ETS rate | | -0.006** | | -0.004 | | -0.003 |
| | | (0.003) | | (0.003) | | (0.003) |
| Net gasoline tax | | | -0.011 | -0.010 | -0.016 | -0.016 |
| | | | (0.010) | (0.011) | (0.011) | (0.011) |
| Fossil fuel subsidies | | | 0.029 | 0.029 | 0.028 | 0.028 |
| | | | (0.025) | (0.025) | (0.025) | (0.025) |
| Efficiency policies | | | 0.036 | 0.037 | 0.028 | 0.028 |
| | | | (0.024) | (0.024) | (0.024) | (0.025) |
| Renewable policies | | | -0.044 | -0.044 | | |
| | | | (0.027) | (0.027) | | |
| Observations | 126 | 126 | 104 | 104 | 104 | 104 |
| $R^2$ | 0.518 | 0.522 | 0.586 | 0.587 | 0.583 | 0.583 |

# Carbon pricing impacts

- Using a continuous carbon-pricing variable:
  - for a one euro increase in carbon price there is lower average annual growth of $CO_2$ emissions by 0.3 percentage points
- Using a binary carbon-pricing variable:
  - average annual growth of carbon dioxide emissions is lower by approximately 2 percentage points
- Impacts of carbon prices in the non-road sector are larger than in the road sector (but less precisely estimated)
- Based on our estimates it appears that carbon pricing works, after controlling for what we have been able to.
- There is also evidence that carbon pricing supports the transition from fossil fuels to renewable energy.

Australian National University

# The effect of carbon pricing on emissions: evidence from an international study

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## Question

How effective has carbon pricing been in reducing $CO_2$ emissions from the energy sector?

## Method

Regressions using an international dataset with many controls

## Result

A noticeable link between carbon pricing and slower emissions growth rates

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# EU emissions trading scheme (ETS)

Launched in 2005

Covers ~45% of EU greenhouse gas emissions

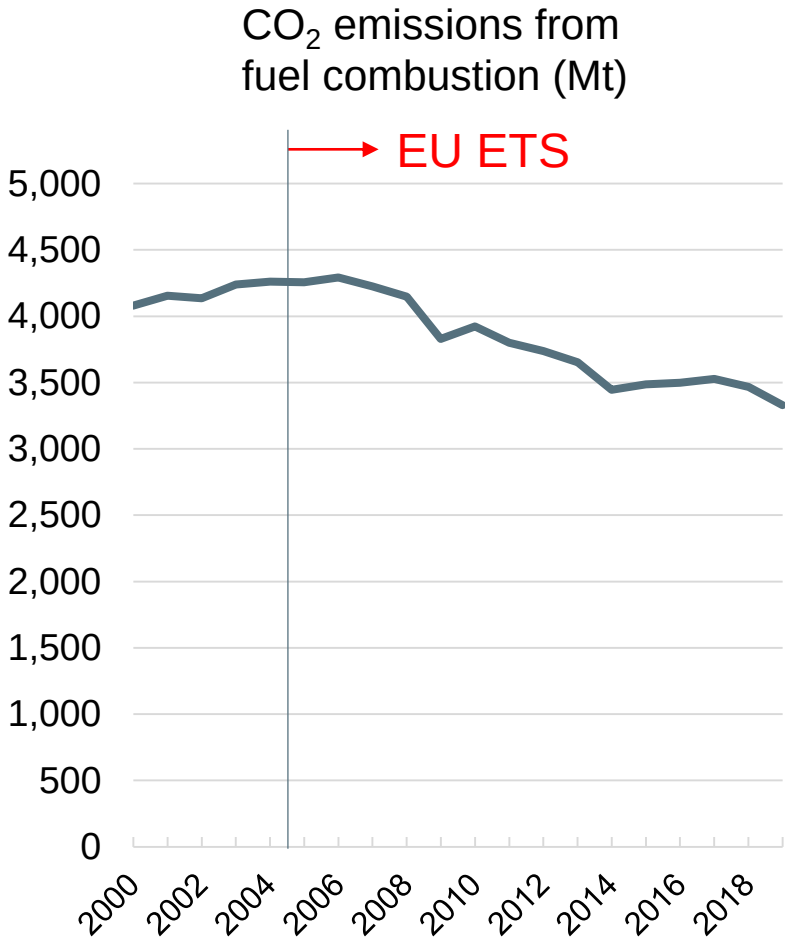
Emissions cap is currently tightened by 1.74% p.a.

In 2021 the annual rate of tightening will increase to 2.2% p.a.

Current permit price = €27/tCO2

Operates in 31 countries (27 EU countries + UK, Norway, Iceland, Liechtenstein)

EU is considering the introduction of a border tax adjustment mechanism




Source: BP

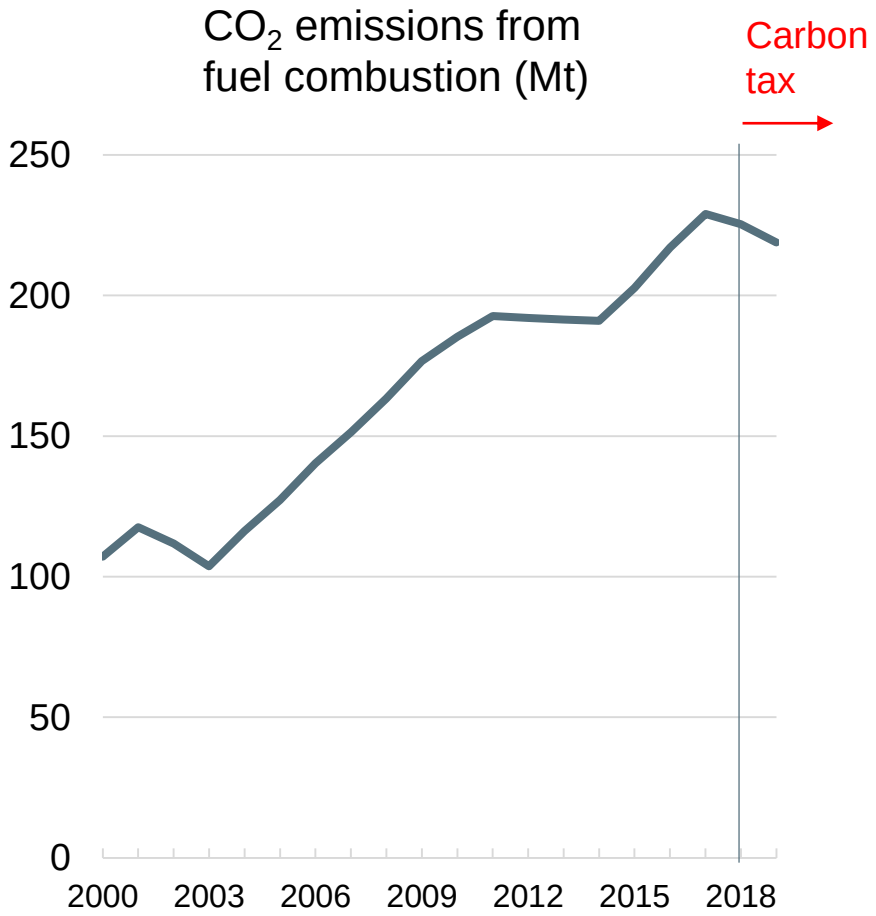
# Singapore's carbon tax

Commenced on 1 January 2019 at S$5/t$CO_2$ (US$3.7/t$CO_2$)

Covers ~80% of national greenhouse gas emissions

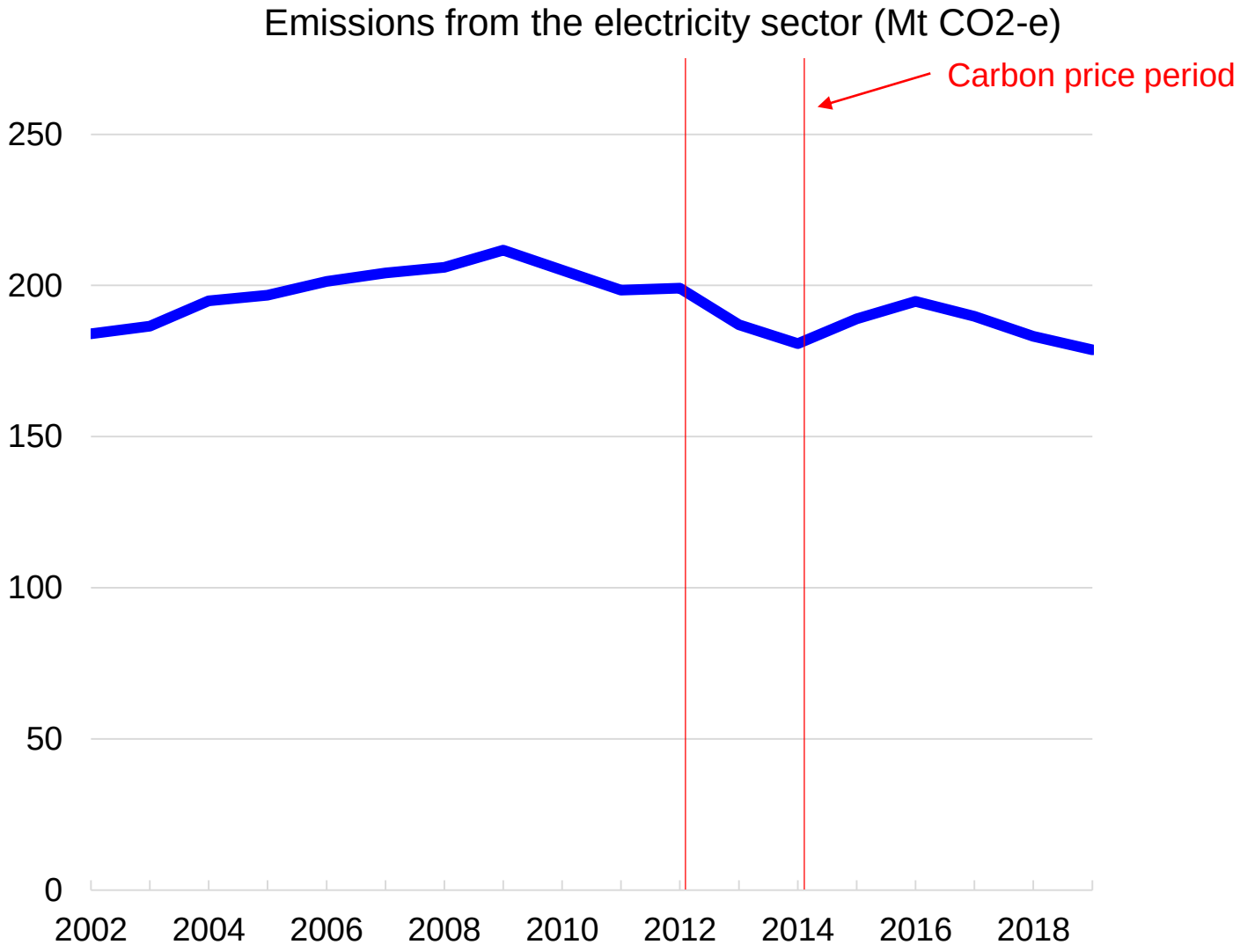
Tax rate is expected to be reviewed in 2023

Singapore's $CO_2$ emissions from fuel combustion fell by 2.8% in 2019




Source: BP

# Australia's carbon price




Source: National Greenhouse Gas Inventory. Data are for the financial year

# Opportunities to adopt a carbon price

Vietnam

- 45 countries have some type of carbon price at the national or sub-national level
- China's national ETS is on the way. It will cover ~1,700 emitters in the power sector
- Vietnam is considering an ETS
- A number of other countries are considering carbon pricing
- A carbon tax is the simpler way to go
- Scheme design is highly important. A higher price delivers larger emissions reductions

# Australia's emissions reduction policy

- Emissions Reduction Fund
- Safeguard mechanism
- Technology Investment Roadmap


The Technology Investment Roadmap prioritises:

- Clean hydrogen
- Energy storage
- Low carbon steel & aluminium
- Carbon capture and storage
- Soil carbon

However Australia is lacking a strong technology deployment mechanism

Carbon pricing would still be a useful reform

# Conclusions

Carbon pricing associated with:

- Faster transitions to clean energy
- Emissions reductions

On average, a country with a carbon price has a 2-pp lower annual emissions growth rate, holding other observable differences constant

Carbon pricing is not the only policy approach to reduce emissions, but appears to be an effective one when used

## Looking forward to the discussion

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Photo: https://solarbay.com.au/september-record-month-rooftop-solar-australia/