

## Lecture 21: Market-based Environmental Regulations in Practice

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Environmental Economics  
Econ 475

## Part 1: Market-Based Instruments in Practice

# Market-Based Instruments in Practice

## Outline:

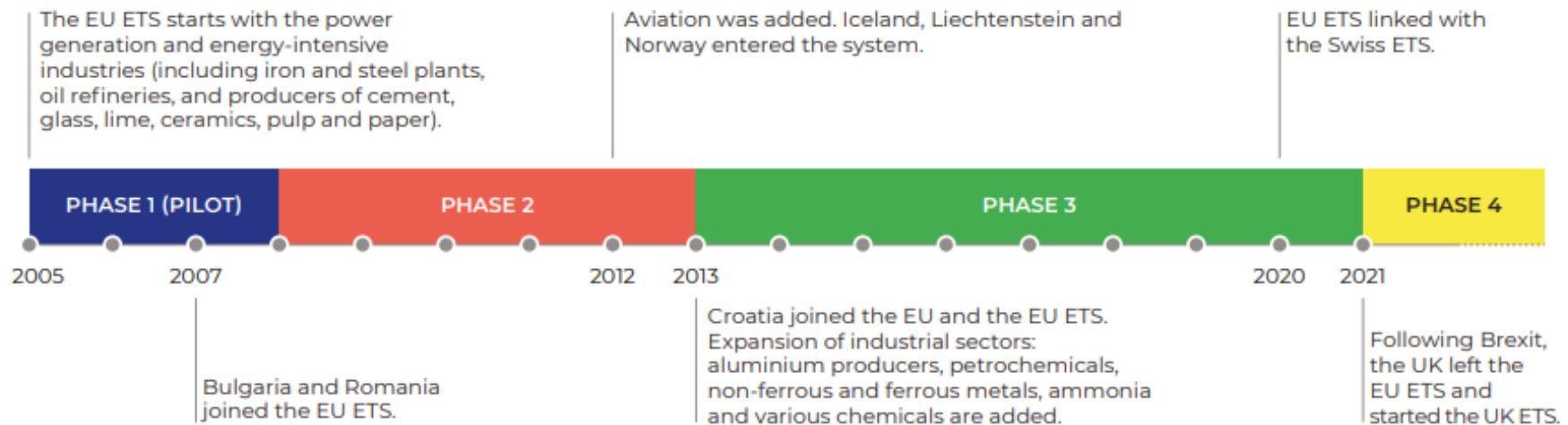
- 1) EU Emissions Trading System
- 2) Other Market-based GHG Policies
- 3) Differences Across Policies at Complete GHG Elimination

# EU Emissions Trading Market

Largest GHG cap-and-trade in the world (before 2021).

- Four phases.
- 27 countries
- 40% of EU GHGs
- 12,000 entities

**Figure 4: Main changes to the coverage of the EU ETS**



Source: [Carbon Market Watch](https://www.carbonmarketwatch.com/).

# General Features

- Carbon neutrality by 2050, 55% net reduction by 2030.
- Partly auction (57% as of Phase 3), partly free allowances.
- Allowances targeted to protect against leakage.
  - Heavy industries like steel receive allowances (close to 95% of emissions in heavy industry).
  - Aviation receives allowances and flights to non-EU states do not count towards total
  - Electricity generally not eligible for free allowances

# Concerns with EU ETS

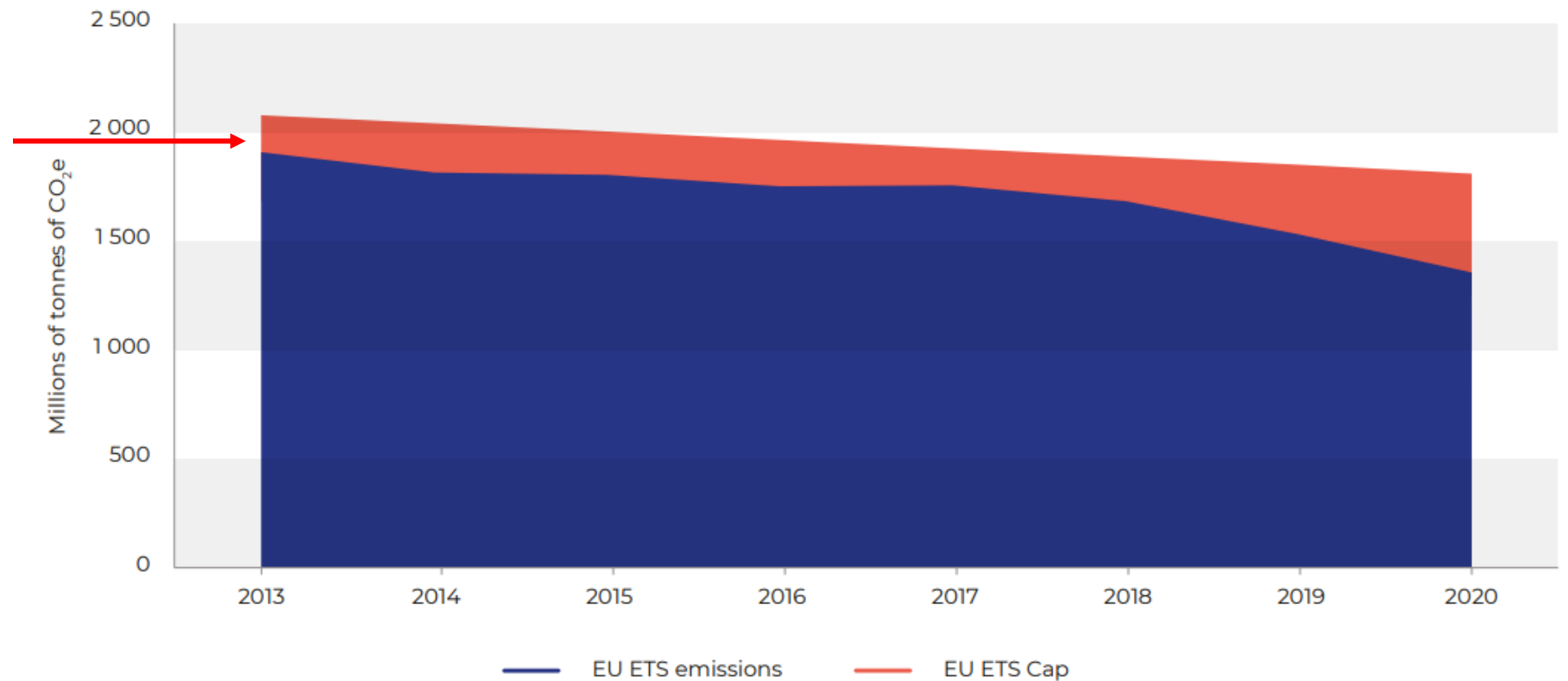
Early hiccups and other concerns:

- Over-allocation of allotments
- International offsets
- Fraud and misreporting
- Windfall profits

# Overallocation of Allotments

Figure 5: EU ETS emissions vs. the cap

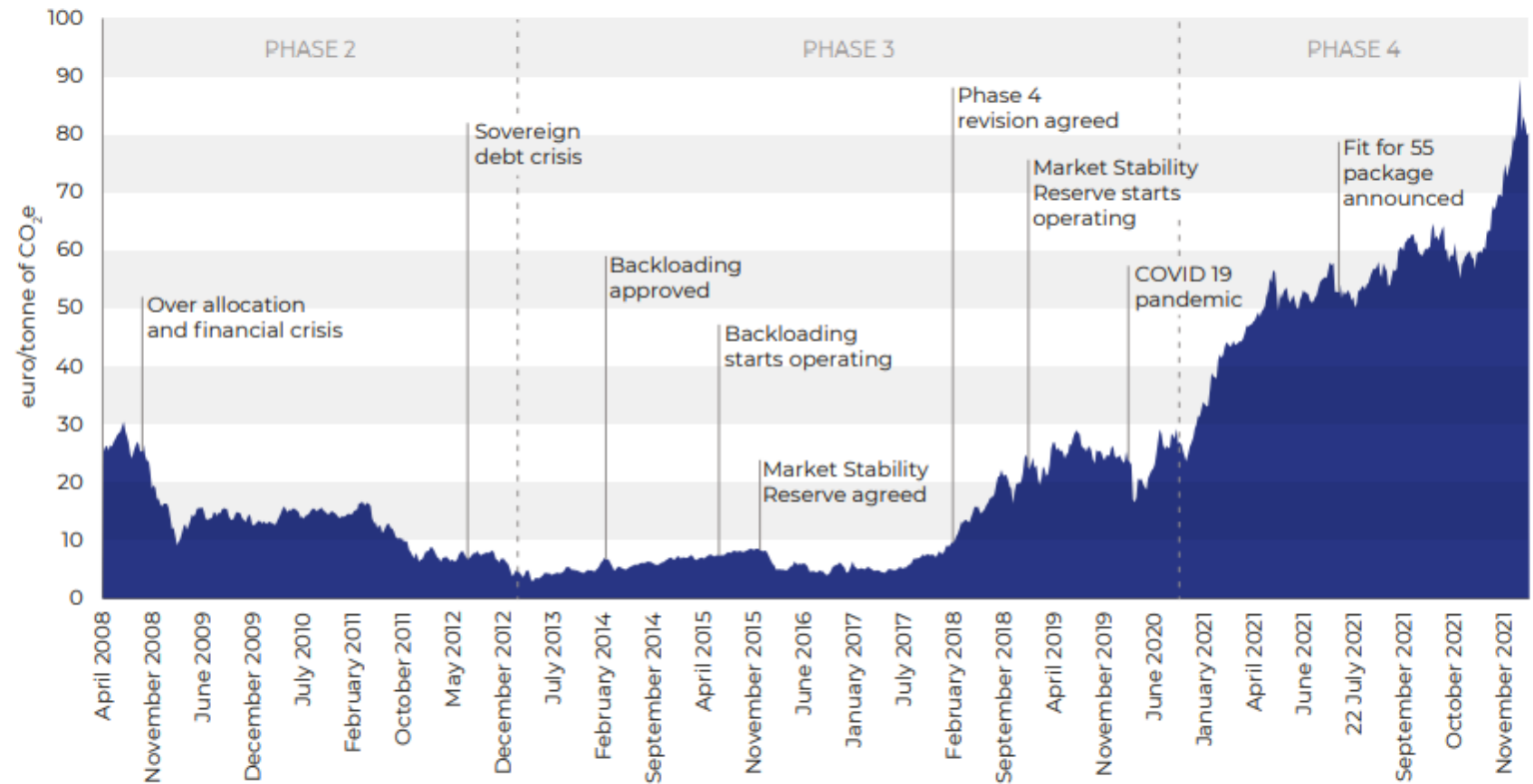
Excess credits



Source: [Carbon Market Watch](#).

# EU Emissions Trading Market Allowance Prices over Time

Figure 8: EU carbon prices since the start of Phase 2



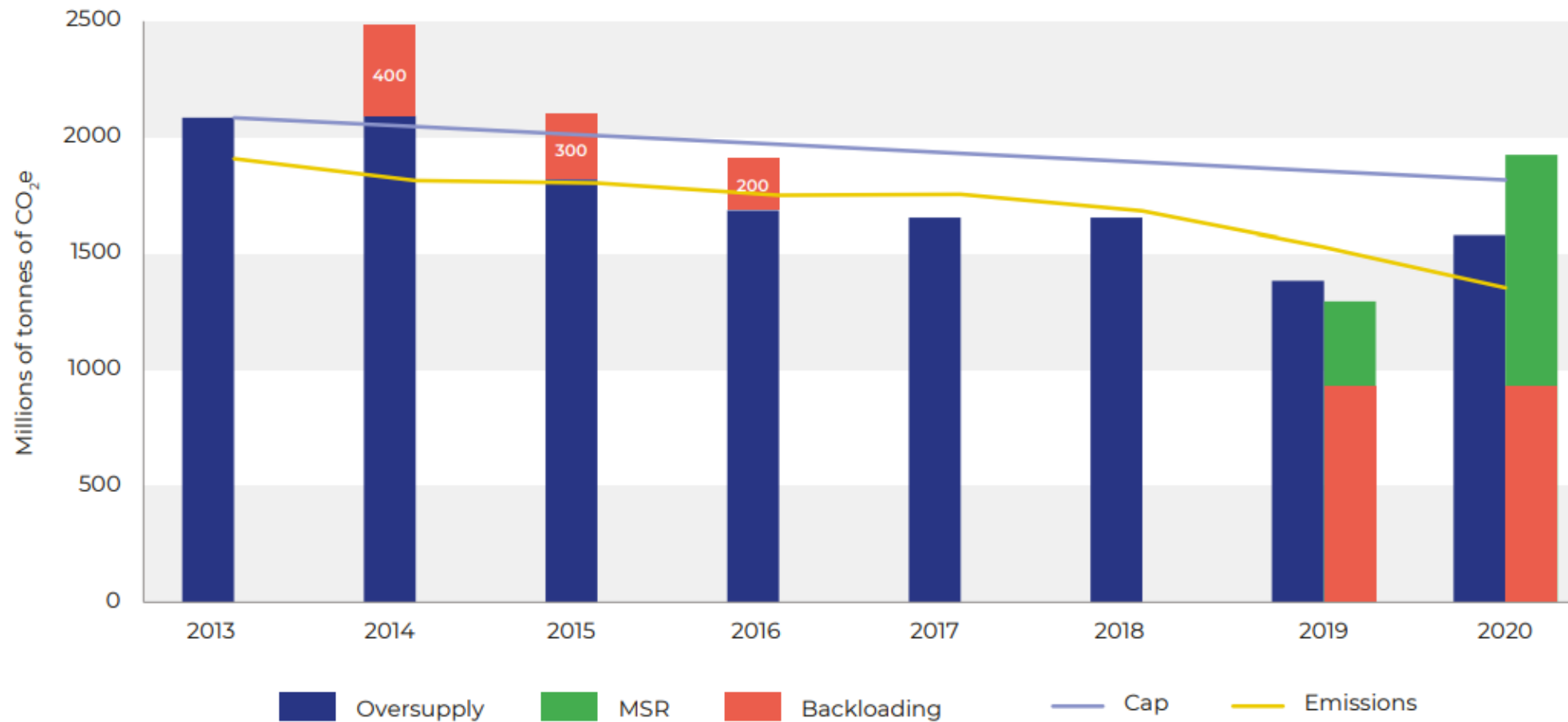
Over-allocation impacts on prices clearly visible.

Offsets, financial crisis lowering output, high cap led to near collapse of prices in 2014.

Source: [Carbon Market Watch](https://carbonmarketwatch.com/).



**Figure 9: Oversupply in the EU ETS during Phase 3**



Source: [Carbon Market Watch](#).

# Problems with Offsets

Over 1 billion international offset credits entered the market by 2012. Limited to 500m by 2020.

Why a concern?

- Additionality
- Permanence
- Verification



[Great summary of issues with carbon offsets by John Oliver.](#)



Above: John Liu's work  
(see "[Regreening the desert](#)" documentary.)

Right:  
[Zai in Kenya](#)



## Aside: Planting Trees?

Trillion Trees Initiative & Great Green Wall in the Sahara?

- 80% of planted trees have died.
- Monoculture tree forests susceptible to disease
- Ultimately [not enough mitigation](#) in trees
  - 7.6 billion tons absorbed by trees of 36 billion tons CO<sub>2</sub>e

More success with permaculture:

- [Zai](#), swales, step irrigation, [bunds and water farming in Rajasthan](#).

Also, paying indigenous cultures to maintain land.

# EU ETS Market Stability Reserve

MSR started operation in 2018. Keeps over-supply in check by purchasing allowances:

- Some backloaded allowances (that had been pushed from 2013 to later in the decade) purchased by MSR.
- Reduces allowances in circulation by a specific share from the prior year excess; will start to retire these in 2023.

International offsets scaled back from 2013-2020 and then prohibited in 2021.

2012	2013	2014	2015	2016	2017	2018	2019	2020
-1.94%	2.20%	-4.93%	-0.61%	-2.88%	0.23%	-4.10%	-9.09%	-11.44%

Source: [Carbon Market Watch](#).

# EU ETS Other Concerns

## Value-added tax fraud:

- Companies buy carbon allowances in one country without a VAT, sell in another with the tax (pocket difference).
  - [5B EUR in damages from VAT fraud.](#)

## Under-reporting:

- [30M in under-reported emissions at a Bulgarian coal plant.](#)



# Windfall Profits

In Phase 1 & 2, electricity generators passed opportunity cost of freely-acquired allowances on to consumers in the form of higher prices ([Sigmund et al., 2006](#)).

**Table 3: Industry windfall profits by sector in million EUR 2008-2019**

Sector	Windfall profits from surplus	Windfall profits from international offsets	Windfall profits from average cost pass-through	Total windfall profits
Refineries	-1800	630	12,460	11,300
Petrochemicals	600	320	4010	5000
Cement	3000	310	6630	10,300
Iron and steel	-710	850	16,000	16,100

# EU ETS Other Features

10% increase in low-carbon patents in industries covered by C&T

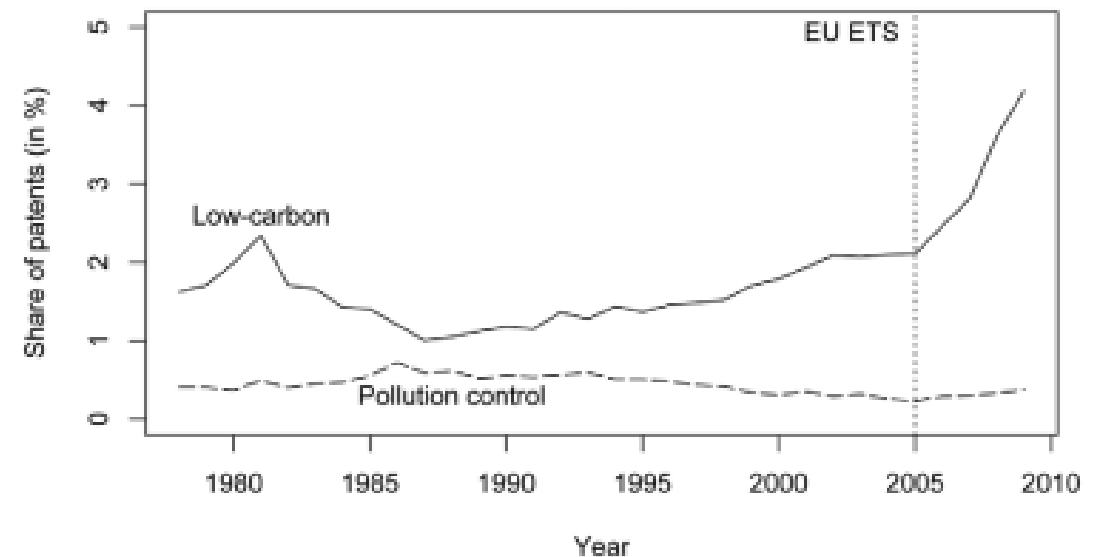
Innovation Fund:

- Collects 20B EUR from auctions for subsidizing development of low-carbon technologies.

Modernization Fund:

- Collects 25B EUR from auctions for modernizing the electricity sector and upgrading the grid in lower-income EU member states.

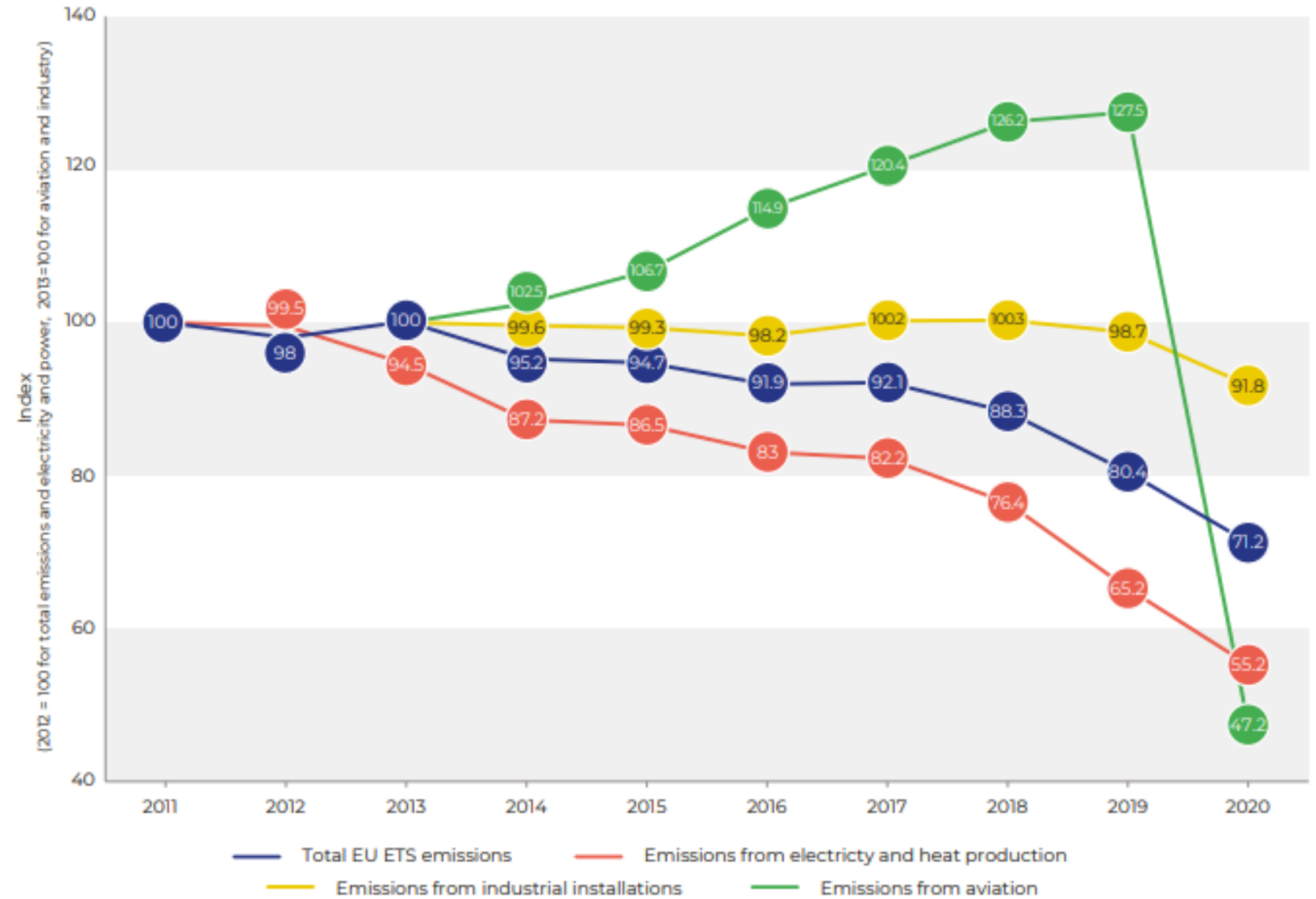
FIGURE 1.—SHARE OF LOW-CARBON PATENTS, 1978–2009



Source: [Calel and Dechezlepetre \(2016\)](#).

Is it working?

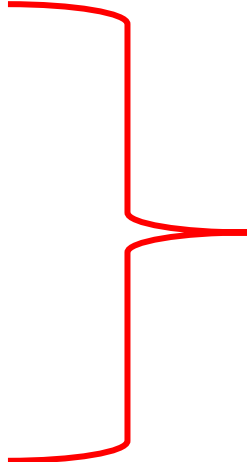
Figure 6: Sectoral emission trends



Source: [Carbon Market Watch](#).

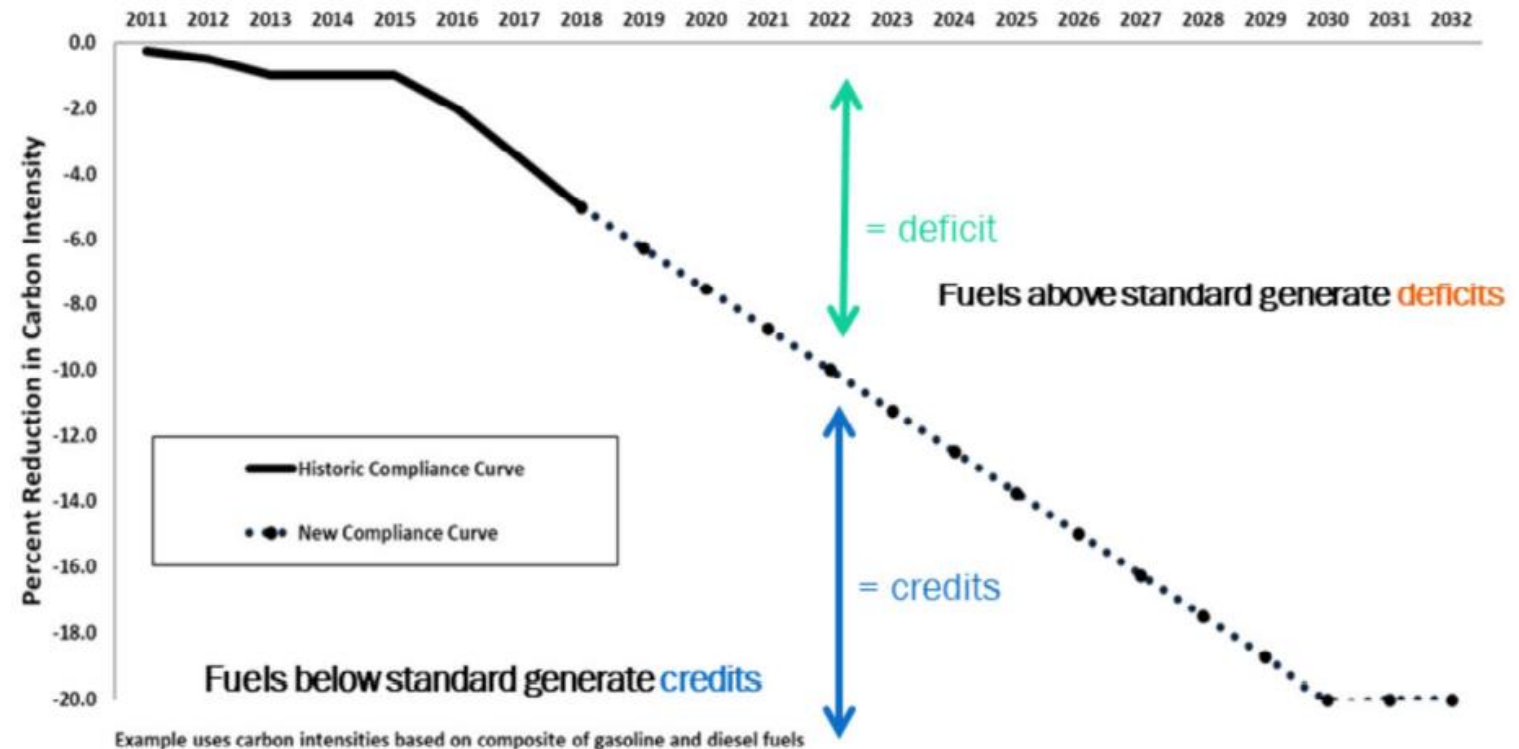


# Carbon Market-based Policies in Borenstein and Kellogg (2022)

- Carbon pricing
    - Carbon tax
    - Cap and trade
  - Intensity Standard
    - Emissions intensity standard
    - Clean energy standard
  - Subsidizing Clean Energy
    - Zero-emissions energy subsidies
    - Zero-emissions capital subsidies
- 

# Emissions Intensity Standard

- Set target annual carbon intensity standard for gasoline, diesel, and replacement fuels.
  - Intensity is measured in grams of CO<sub>2</sub> per megajoule.
- Firms buy and sell until carbon intensity standard is met.
- Acts as a tax on higher, and subsidy on lower fuel intensities.



# Renewable Portfolio Standards

$$\frac{\text{renewables}}{\text{fossil fuel} + \text{renewables}} > RPS$$

## Renewables Portfolio Standard

A requirement on retail electric suppliers...  
To supply a minimum percentage or amount of their retail load...  
With eligible sources of renewable energy

*Typically*

Backed with penalties of some form

*Often*

Accompanied by a tradable renewable energy certificate (REC) program to facilitate compliance

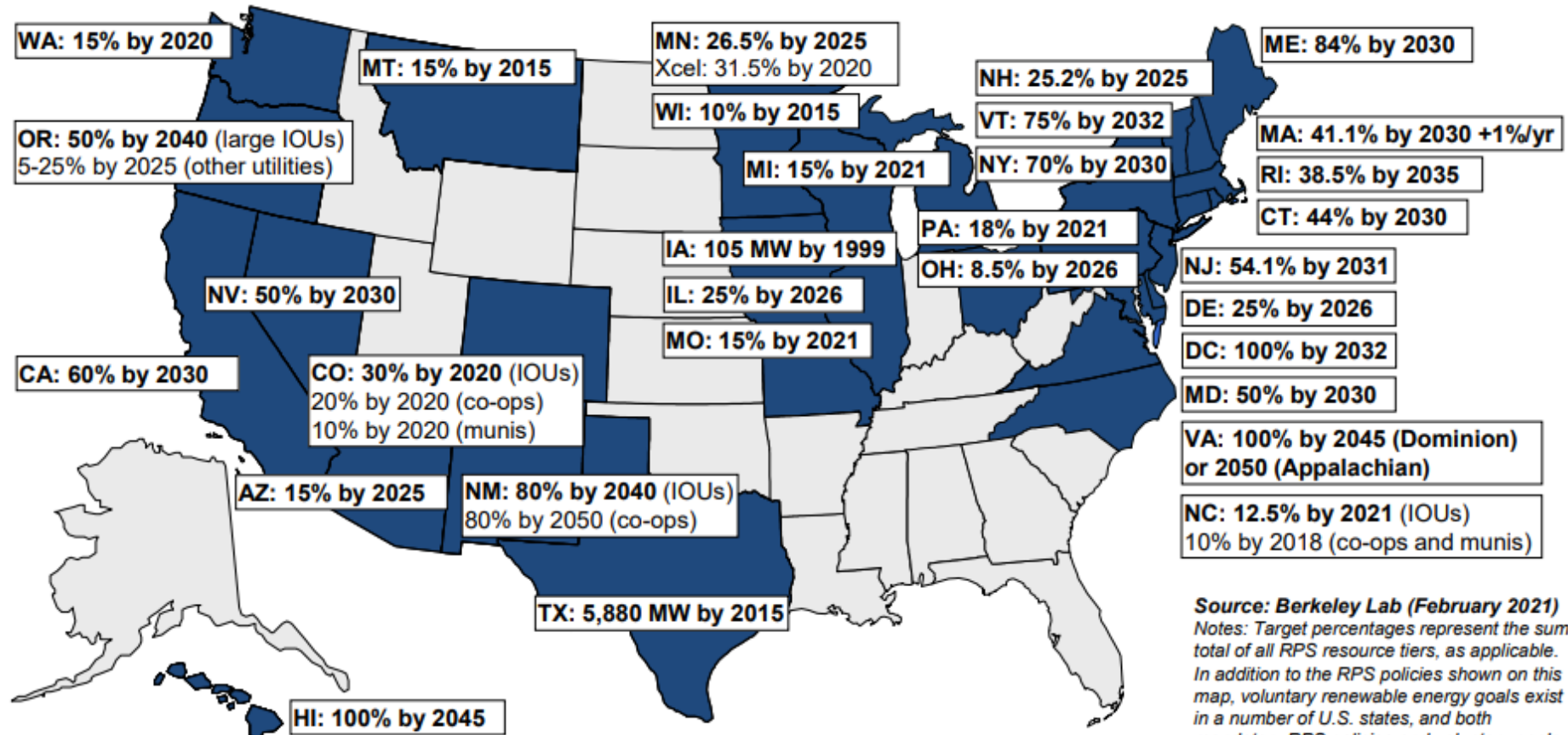
*Never*

Designed the same in any two states

Source: [Berkeley Lab \(2021\)](#).

# RPS Policies Exist in 30 States and DC

## Apply to 58% of Total U.S. Retail Electricity Sales

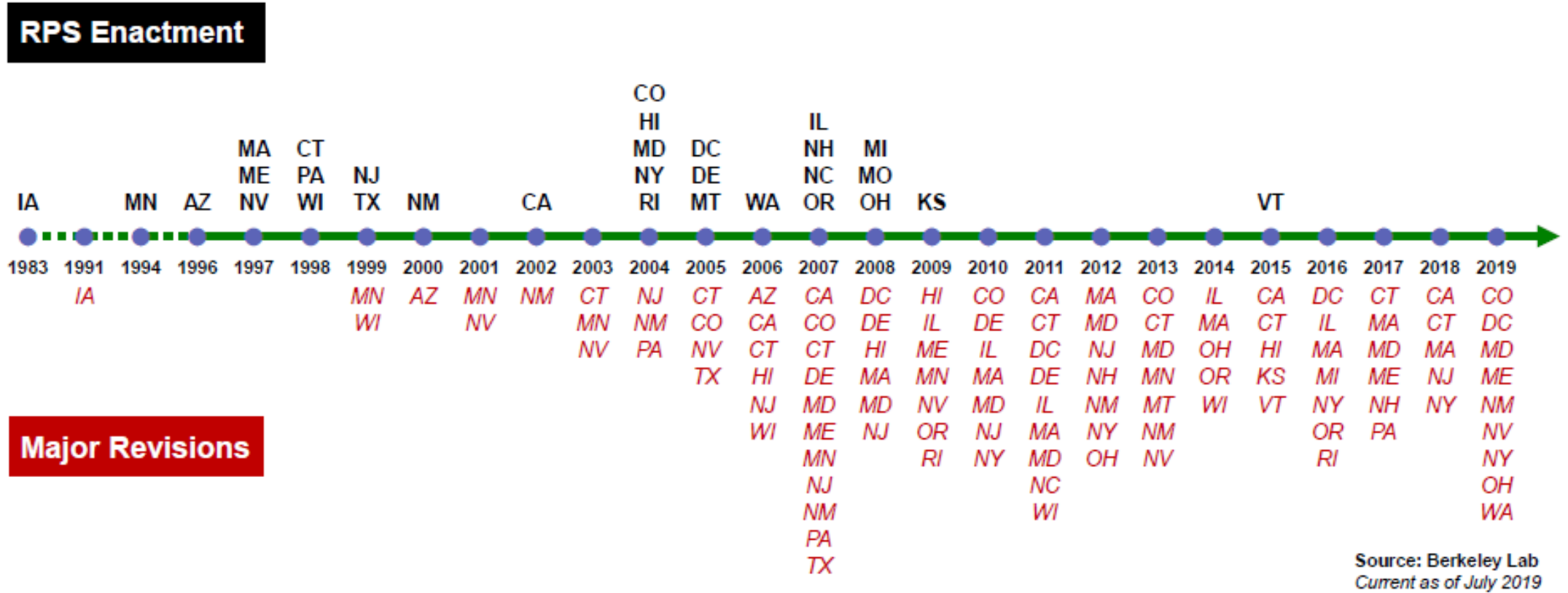


**Source: Berkeley Lab (February 2021)**  
*Notes: Target percentages represent the sum total of all RPS resource tiers, as applicable. In addition to the RPS policies shown on this map, voluntary renewable energy goals exist in a number of U.S. states, and both mandatory RPS policies and voluntary goals exist among U.S. territories (American Samoa, Guam, Puerto Rico, US Virgin Islands).*



# Most RPS Policies Have Been on the Books for a Decade or More

But states continue to make regular and significant revisions



Source: [Berkeley Lab \(2021\)](#).

# Renewable Portfolio Standards

After passage RPSs, reduce emissions 10-25% seven years after revisions to RPS standards.

- Electricity prices increase 11%
- Cost per ton of abatement is \$50-298, generally above \$100.
- Most costs come from extending transmission lines across states.
  - i.e., likely more expensive than traditional C&T.

Source: [Greenstone and Nath \(2020\)](#).

# Comparing Intensity Standards

- Emissions Intensity Standard vs. Clean Energy Standard:
  - Clean energy standard differentiates between “clean” and “dirty” but not within these categories
    - Determining which generators produce within category reflects private marginal cost of each generation (not carbon emissions)
  - EIS has lower emissions but higher prices effect than CES

# Comparing Intensity Standards

Pros and cons compared to other carbon strategies:

- Lower electricity prices than with carbon pricing, but higher than no standard
  - Revenue neutral – trading of compliance credits subsidizes cleaner generators and taxes dirtier generators
- Higher electricity generation than under carbon tax
- Less price volatility but more quantity volatility than an emissions cap, and more price volatility but less quantity volatility than a carbon tax.



# Subsidizing Clean Energy

- Types of subsidies:
  - Zero-emission energy subsidy (MWH production tax credit)
  - Zero-emission capital subsidy (investment tax credit)
- Production tax credit vs. investment tax credit
  - Investment tax credit only subsidizes capital, which does not incentivize the most cost-efficient input mix of capital and labor.
    - Investment tax credit will be costlier than production tax credit for the government.

# Subsidizing Clean Energy

Pros and Cons compared to other market-based policies:

- Zero emission energy production tax credit standard differentiates between “clean” and “dirty” but not within these categories
  - Like clean energy standard but no budget neutrality
- ZES has higher generation and higher emissions, but lower electricity prices than CES

# Some Caveats

Carbon pricing may not end up being that much more efficient than other market-based policies:

- Retail price faced by consumers is substantially higher than wholesale electricity prices due to markups
  - Since residential prices already exceed total SMC, further electricity price increases induced by carbon pricing would exacerbate the DWL for consumers.
- Electricity is increasingly a substitute fuel for transportation
- Regressivity of taxes complicates picture

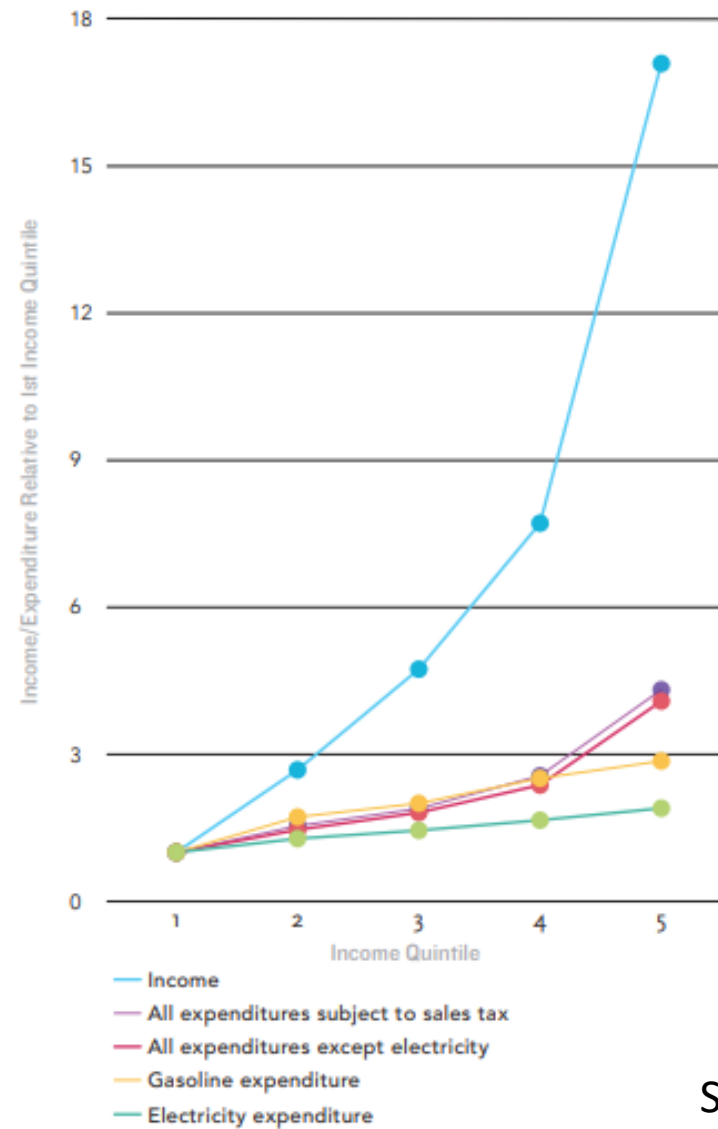
# Are Pollution Taxes Regressive?

Pollution regulations, and carbon taxes in particular, likely regressive:

1. Cost of living as proportion of income is higher
2. Goods that use energy more expensive
3. Abatement is capital intensive, affecting capital-labor share of production

Really depends on how the revenue from market-based instruments is used.

**FIG ES-3** Average Expenditures and Income per California Household by Income Quintile Relative to Lowest Quintile



Source: [Borenstein, Fowlie, Sallee \(2021\)](#).

## Part 2: Policies under Complete Elimination of GHGs

# Complete Elimination of GHGs

At complete elimination of GHGs, or 100% renewables:

- C&T, intensity standard and clean electricity standards all have the same:
  - Electricity price
  - Electricity generation
  - Government revenues (\$0)
- Subsidies have lower electricity price and higher electricity generation

# Complete Elimination of GHGs

Policy	GHG emissions intensity	Electricity price	Electricity generation	GHG emissions	Government revenue
<b>Carbon pricing</b>					
Carbon tax (CT)	zero	highest	lowest	zero	zero
Cap-and-trade	zero	same as CT	same as CT	zero	zero
<b>Intensity standards</b>					
Emissions intensity standard (EIS)	zero	same as CT	same as CT	zero	zero
Clean energy standard (CES)	zero	same as CT	same as CT	zero	zero
<b>Subsidizing clean energy</b>					
Zero-emissions energy subsidies (ZES)	zero	lower than CT	higher than CT	zero	negative
Zero-emissions capital subsidies (ZCS)	zero	same as ZES	same as ZES	zero	more negative than ZES



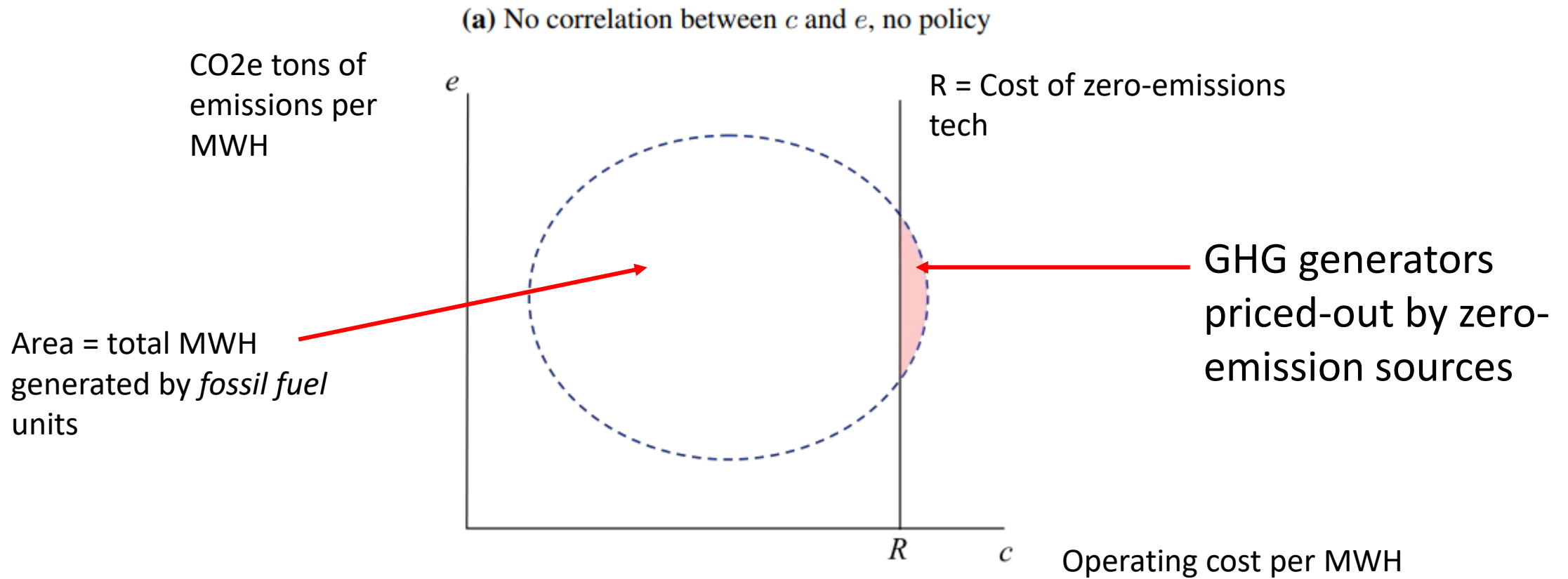
# Complete Elimination of GHGs Transition Path

We just saw that carbon pricing and intensity standards may be equally efficient at the point of complete elimination of GHGs.

But what about the level of emissions during transition?

- Clean energy standard should have higher emissions during transition
- Zero-emissions subsidy also has higher emissions, is costlier to the government, lower electricity price and higher consumption

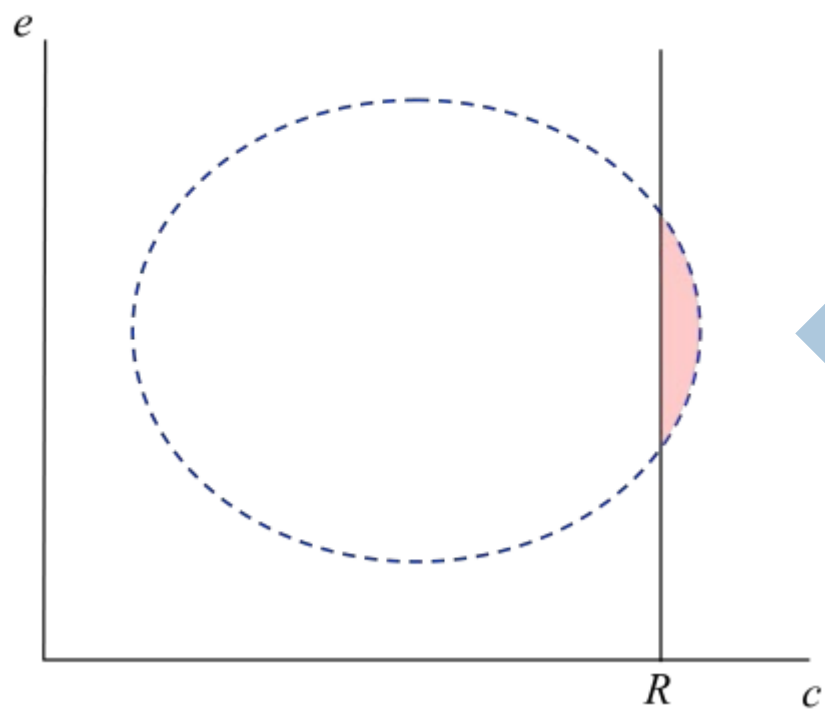
# Baseline Conditions



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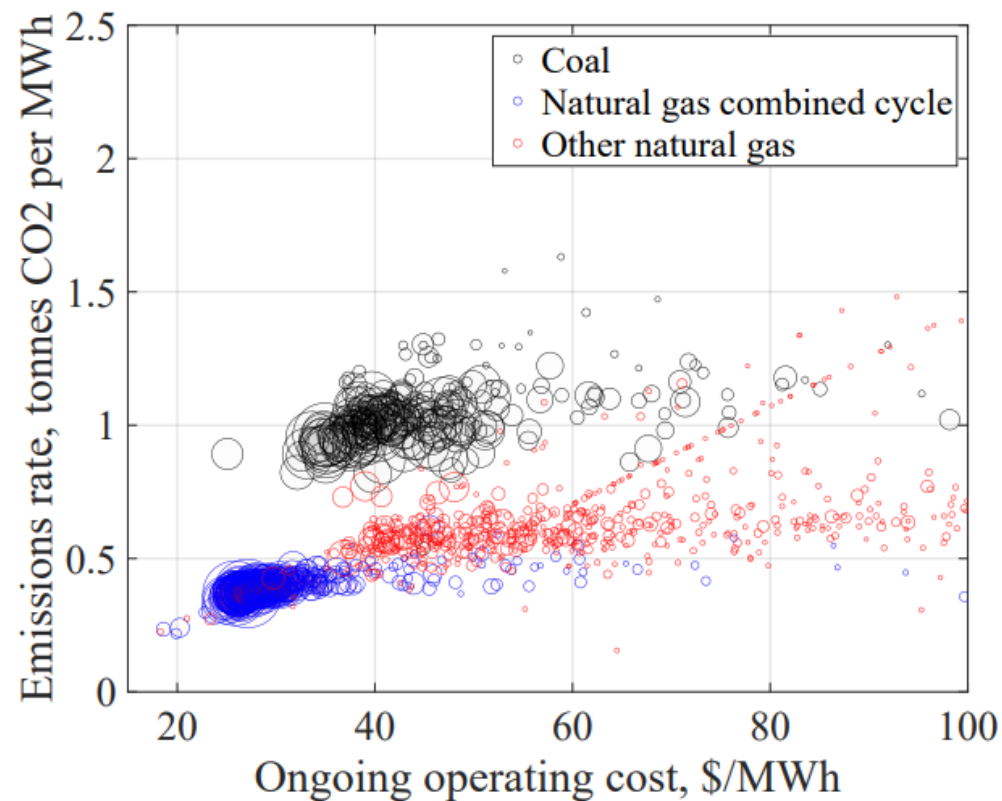
CO<sub>2</sub>e  
tons of  
emissions  
per MWh

(a) No correlation between  $c$  and  $e$ , no policy

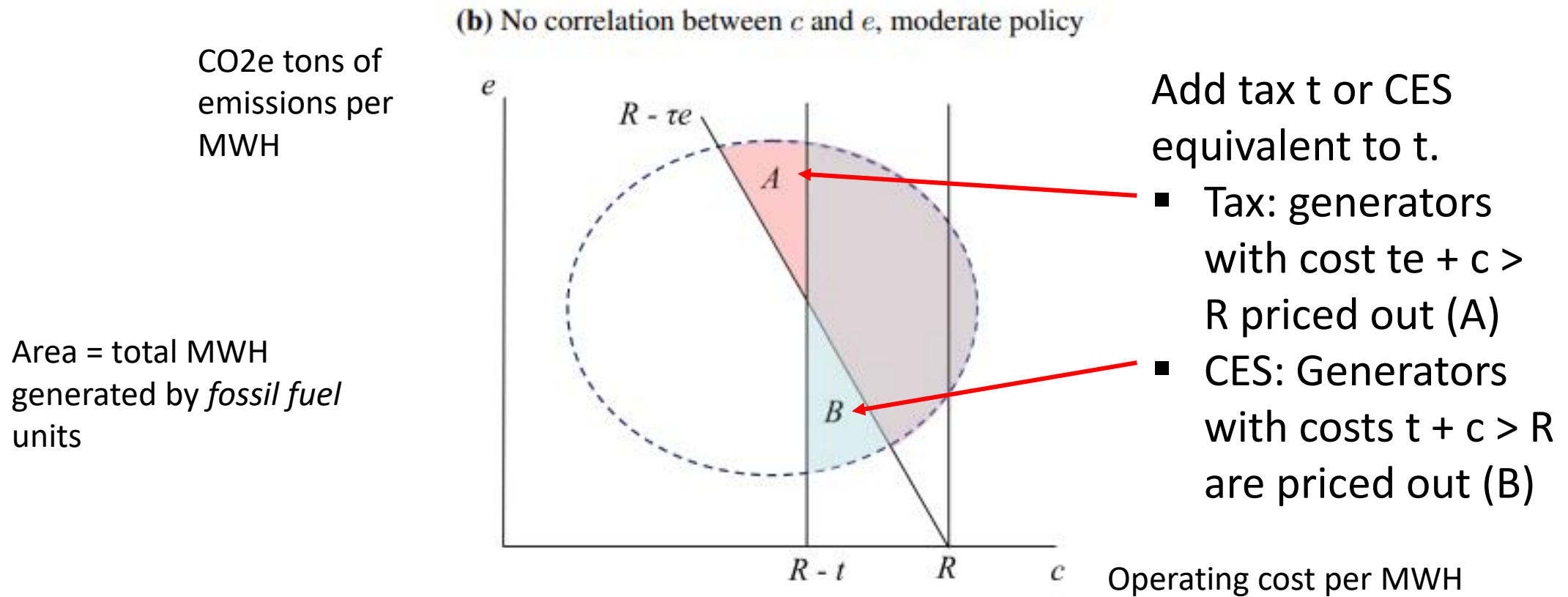


Operating cost per MWh

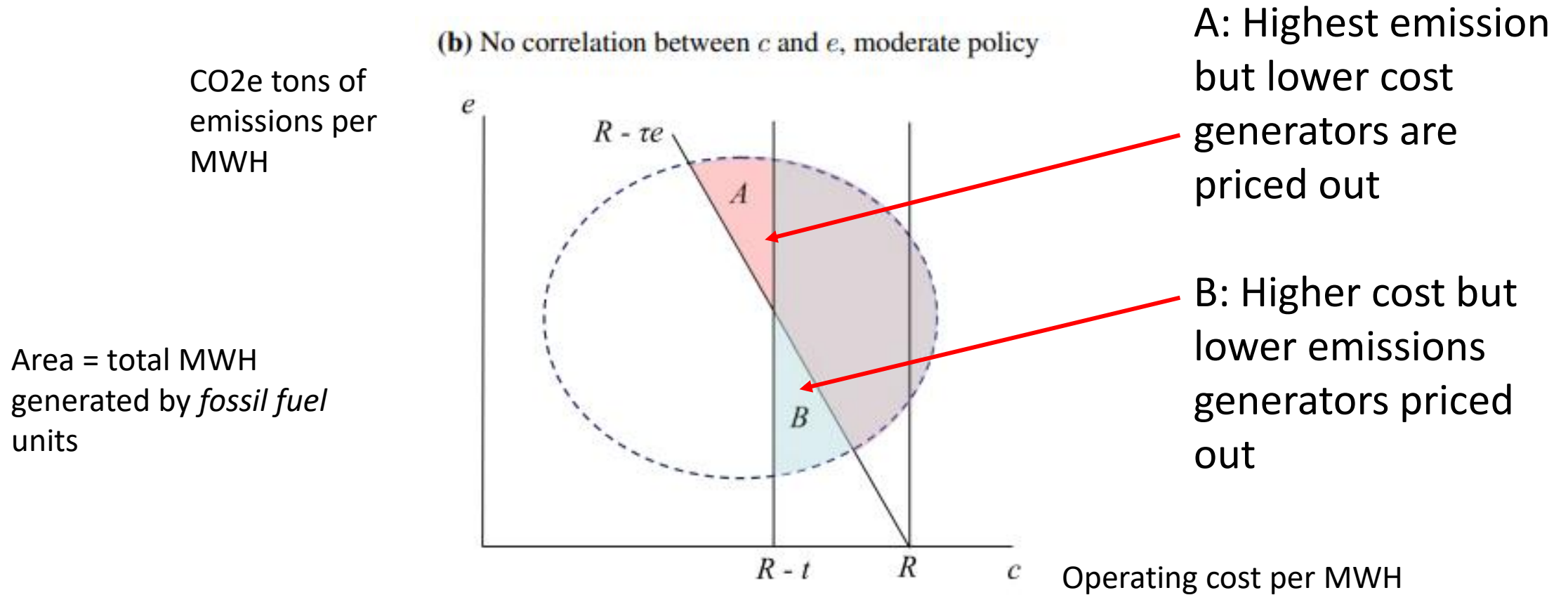
(a) Gas price = \$2.89/mmBtu



# Tax vs. Clean Energy Standard



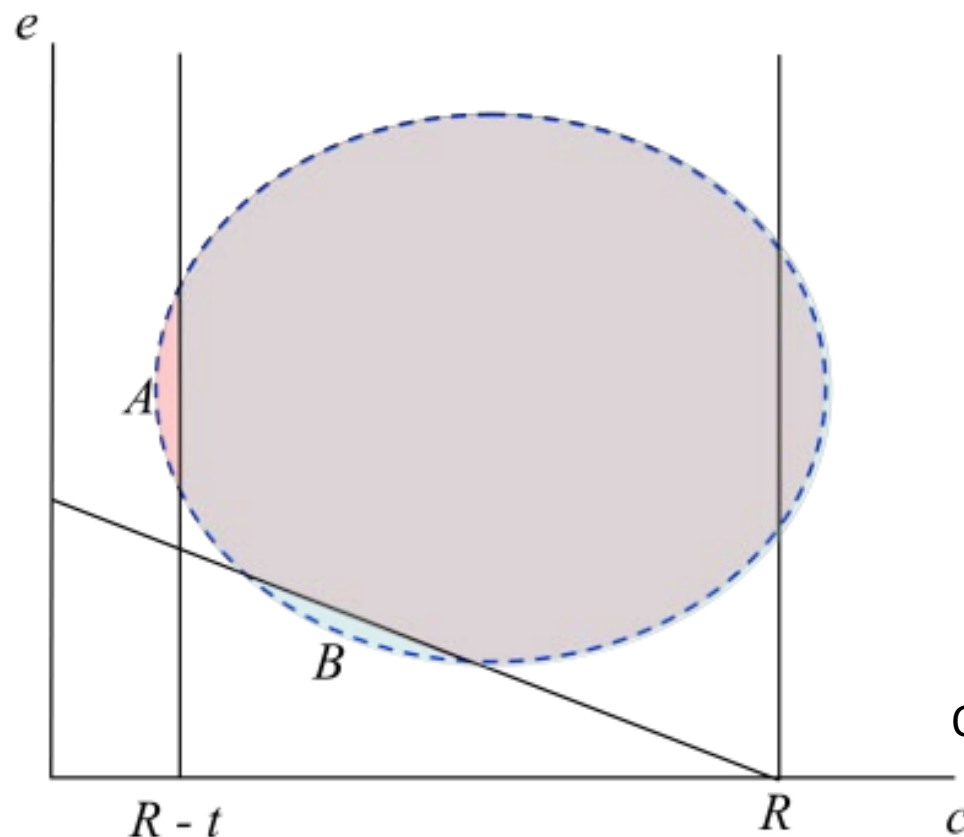
# Tax vs. Clean Energy Standard



# Tax vs. Clean Energy Standard

(c) No correlation between  $c$  and  $e$ , stringent policy

CO<sub>2</sub>e tons of  
emissions per  
MWH

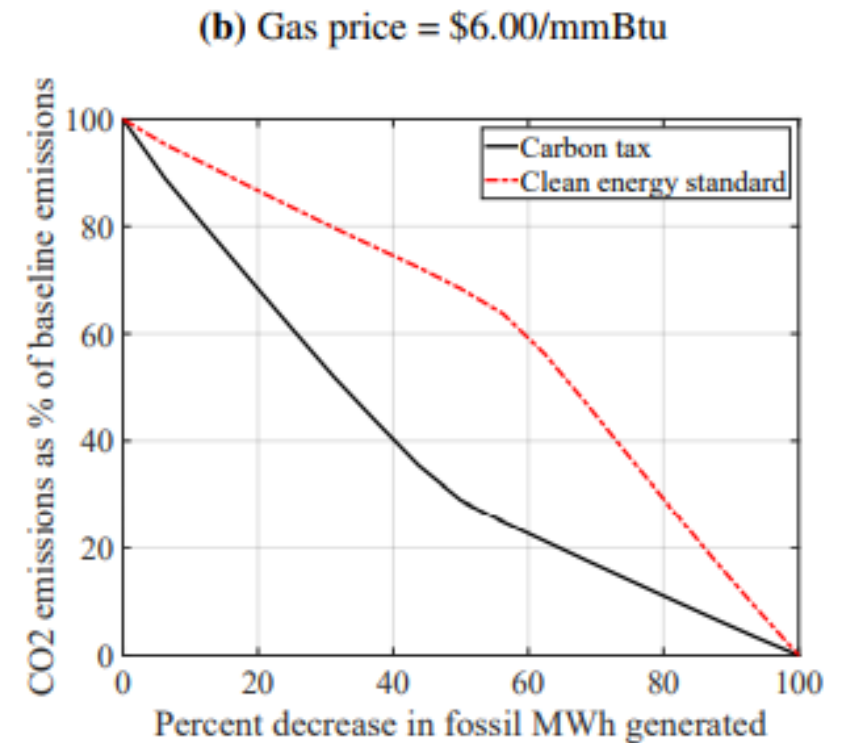
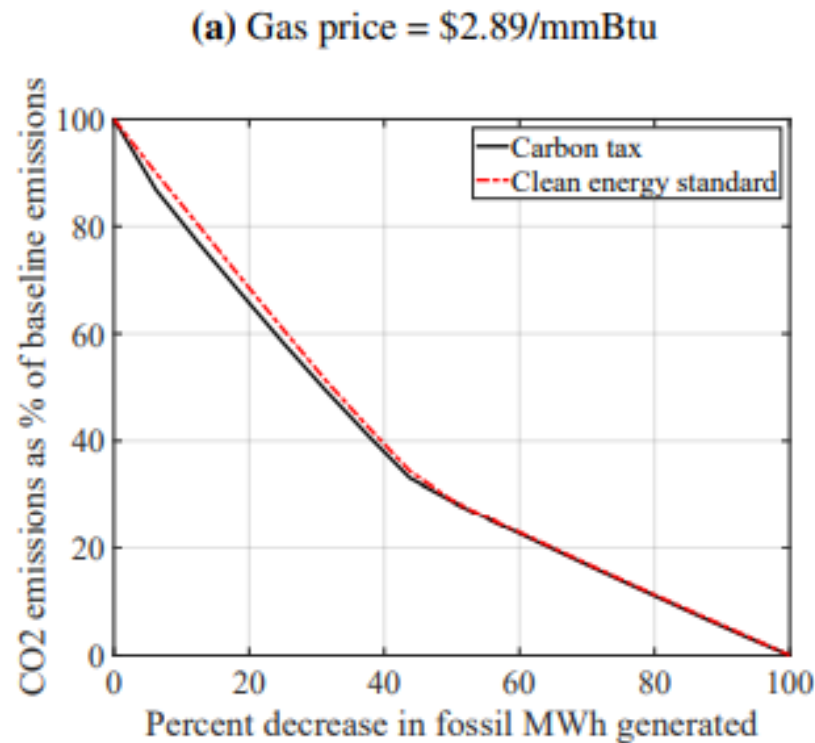


With strictest  
policies, less  
difference between  
tax and CES.

Operating cost per MWH

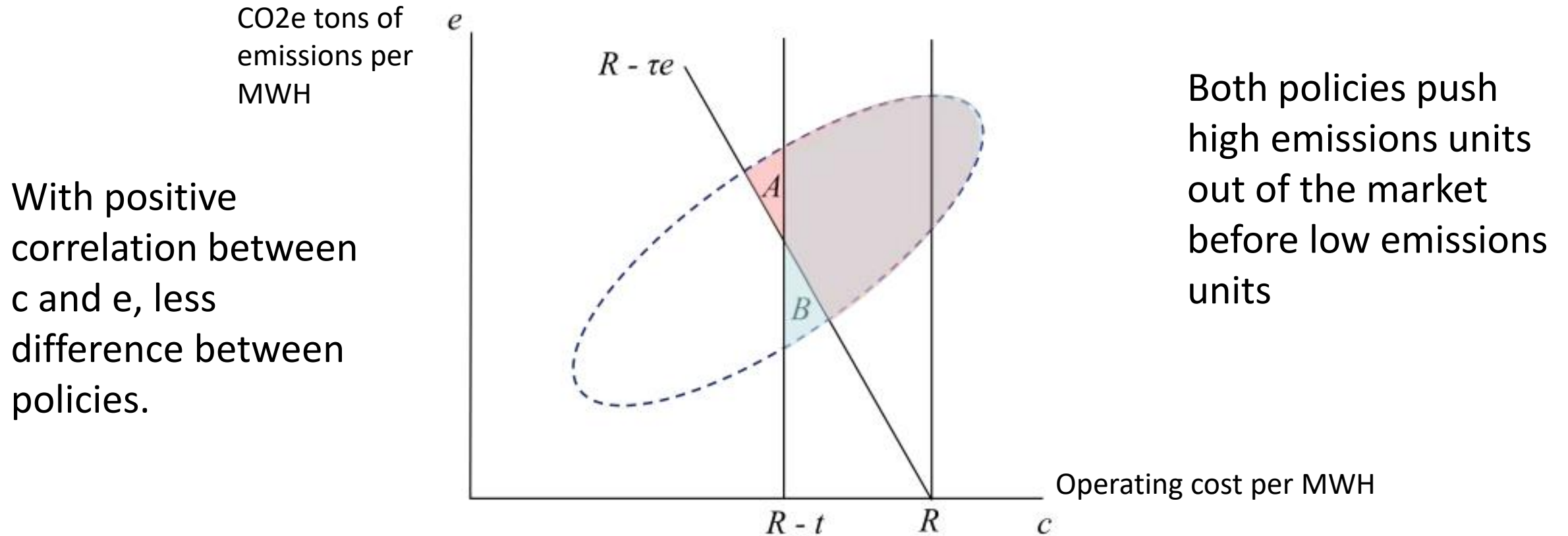
# Tax vs. Clean Energy Standard

With lower gas prices, fairly minimal difference between CES and carbon tax. Why?



# Tax vs. Clean Energy Standard

(d) Positive correlation between  $c$  and  $e$ , moderate policy





# Borenstein and Kellogg (2022)

## Conclusions:

- With carbon equivalent at zero emissions, tax, cap and trade, and intensity standards have the same efficiency implications.
- Relatively low excess emissions of clean energy standard at current gas prices, and yet lower prices.
- Lower prices could be efficiency enhancing with high mark-ups.
  - What about equity?

# Next class

Have a nice Thanksgiving. Our next class is one week from today, Monday, November 28<sup>th</sup>.

Your assigned materials for this lecture are two recent videos in the Resources for the Future seminar series.

- [WV vs. EPA Video](#)
- [IRA Video](#)