Energy Market Game – Carbon Tax

BC Econ 3391

How would a carbon tax = SCC change this market?

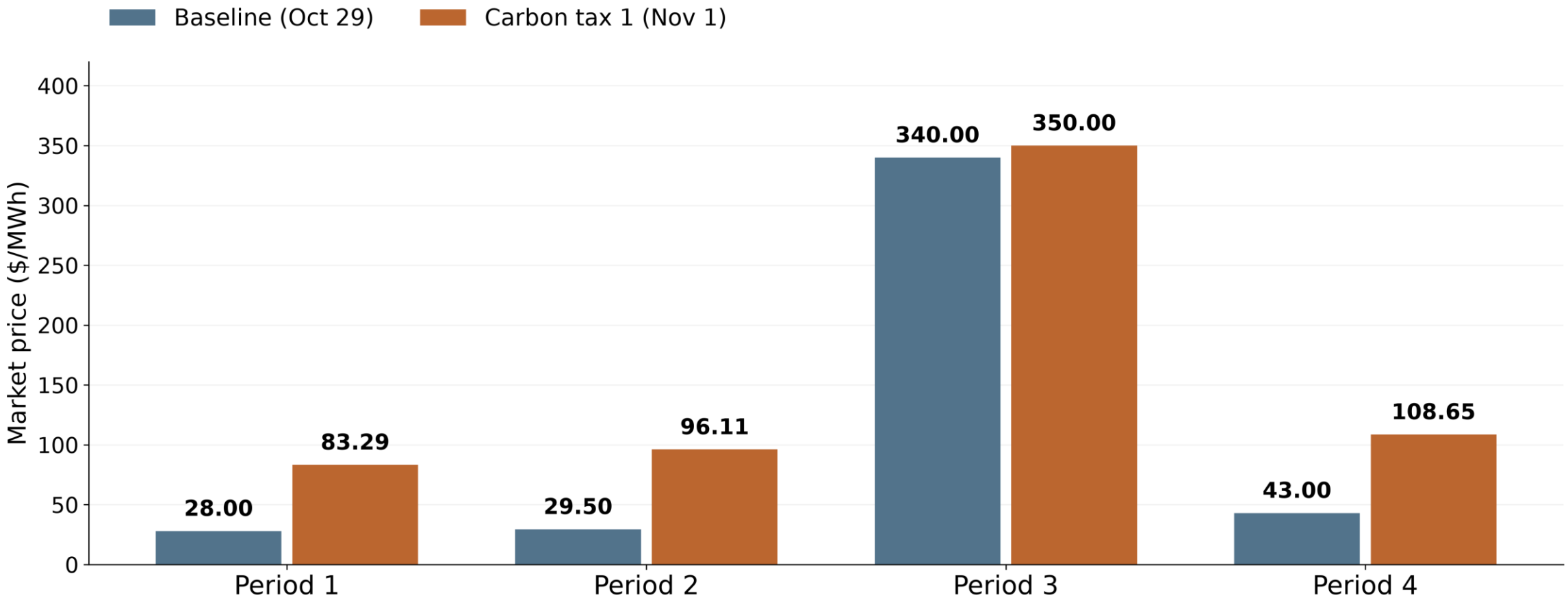


Recap on the past few days of game

- What was your team’s strategy under the carbon tax? Did you do anything different?

Section 1 · Prices by electricity period

Baseline and completed carbon-tax rounds · market price in each period

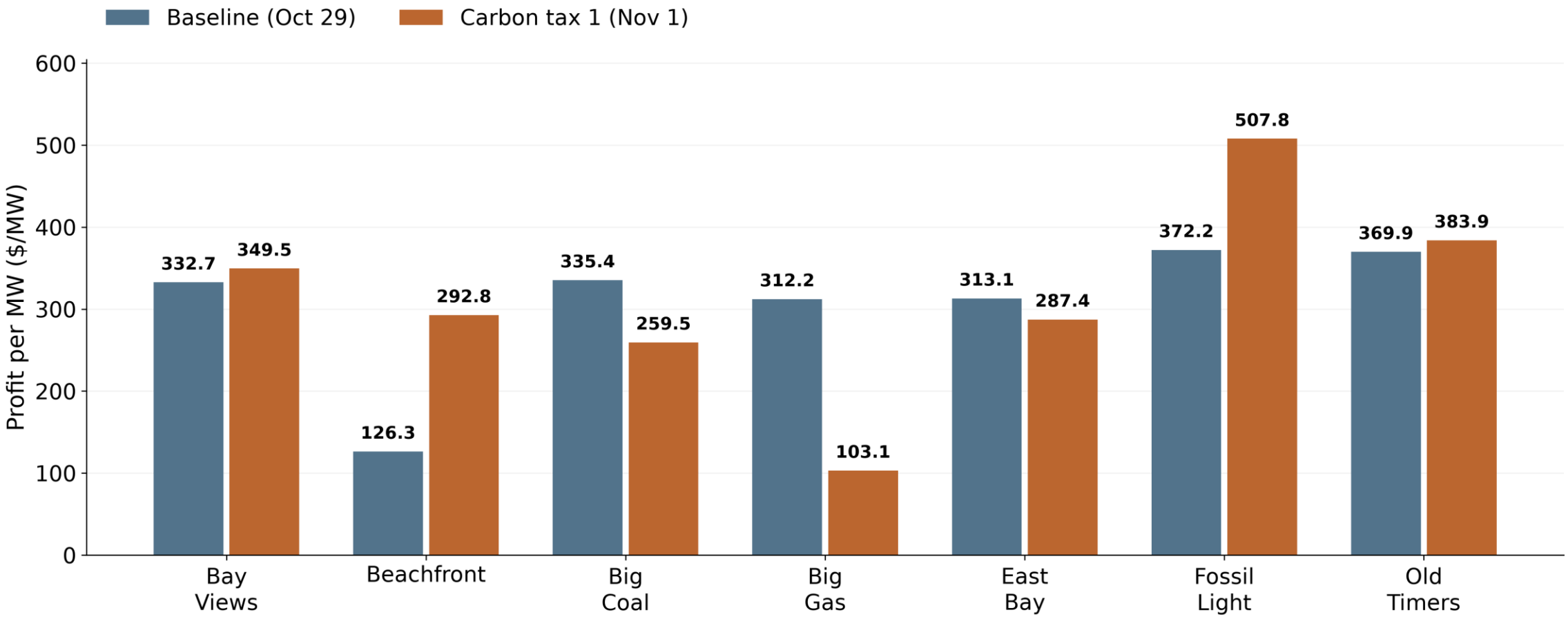


North and South have identical prices in every period shown.

Prices in $/MWh. Rounds use different seeds; these are observed market outcomes.

Section 1 · GENCO profit per MW

Baseline and completed carbon-tax rounds · cumulative game profit per MW of nominal capacity



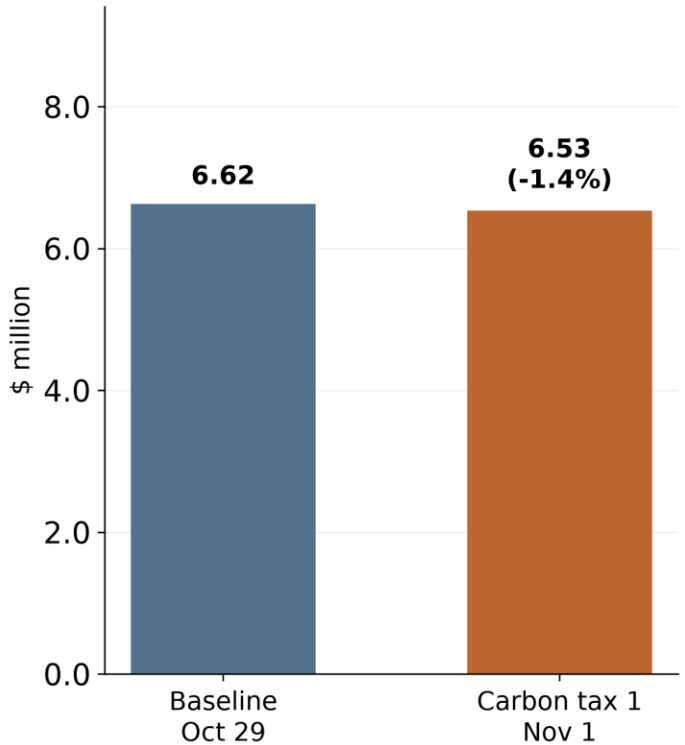
Profit per MW = each GENCO’s cumulative game profit / its total nominal plant capacity (MW).

Nominal capacity is used regardless of period-specific availability. Rounds use different seeds.

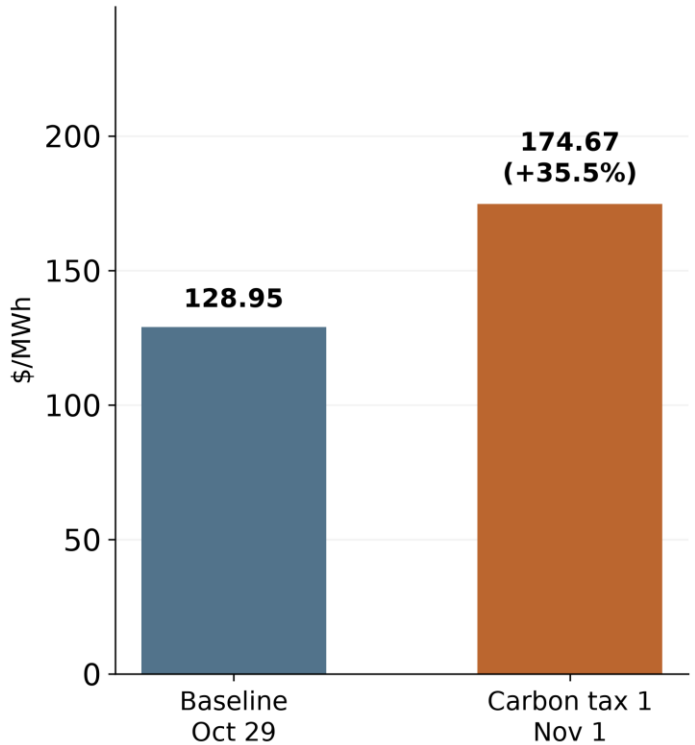
Section 1 · Baseline and carbon-tax rounds

Daily totals across all seven GENCOs and 4 electricity periods

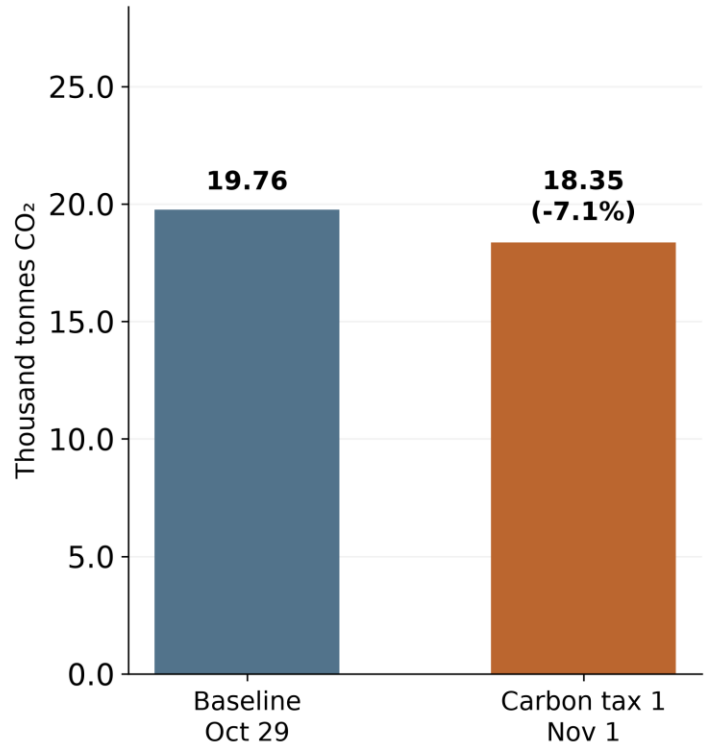
Total GENCO profits



Quantity-weighted price



Total emissions

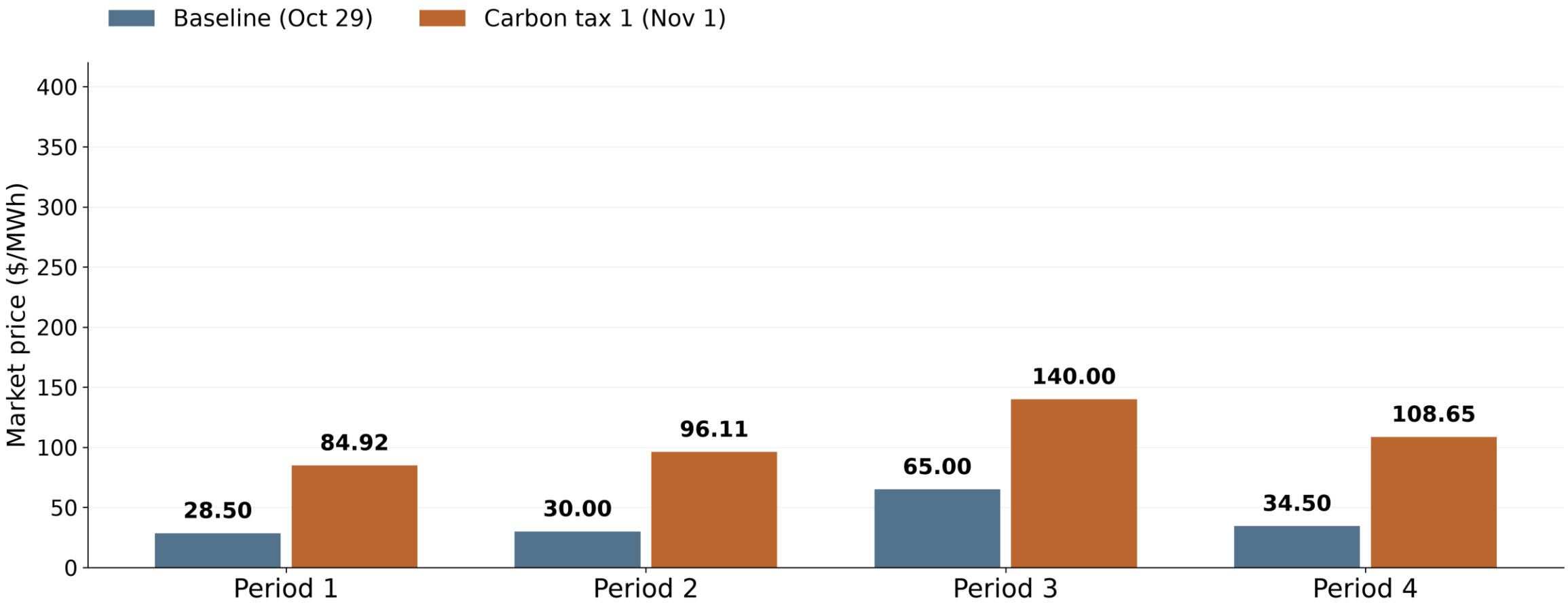


Percentages show changes from this section’s baseline. Price is weighted by dispatched MWh.

Rounds use different seeds; these are observed outcomes, not an isolated estimate of the tax effect.

Section 2 · Prices by electricity period

Baseline and completed carbon-tax rounds · market price in each period

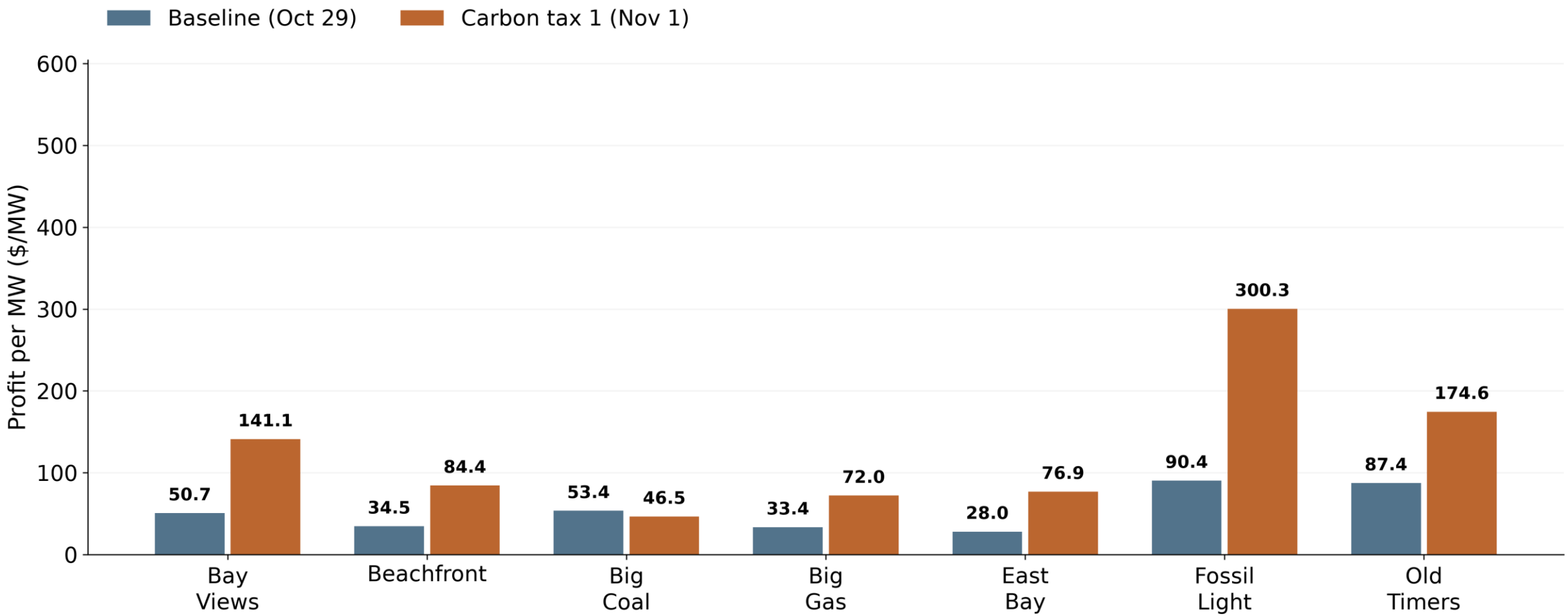


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Section 2 · GENCO profit per MW

Baseline and completed carbon-tax rounds · cumulative game profit per MW of nominal capacity



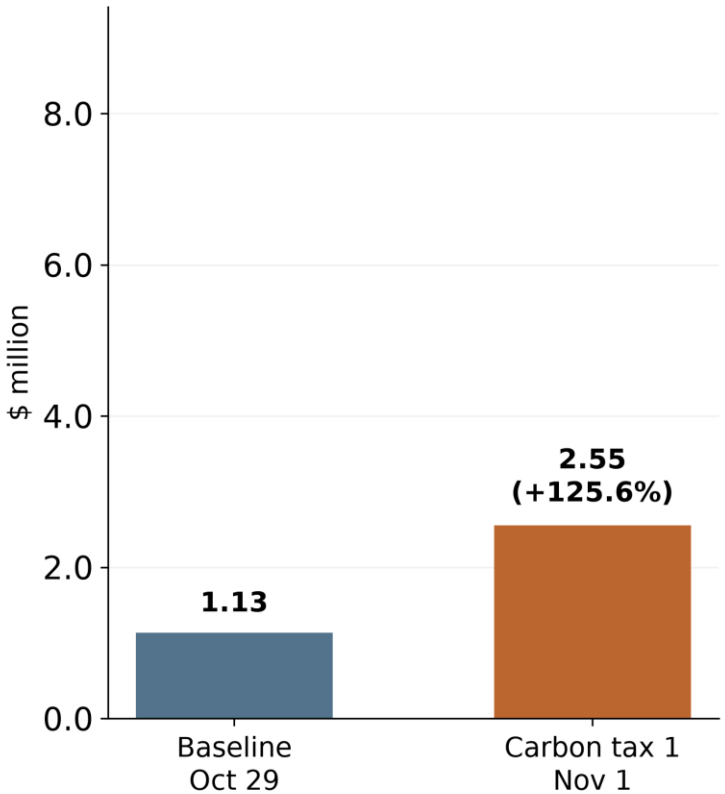
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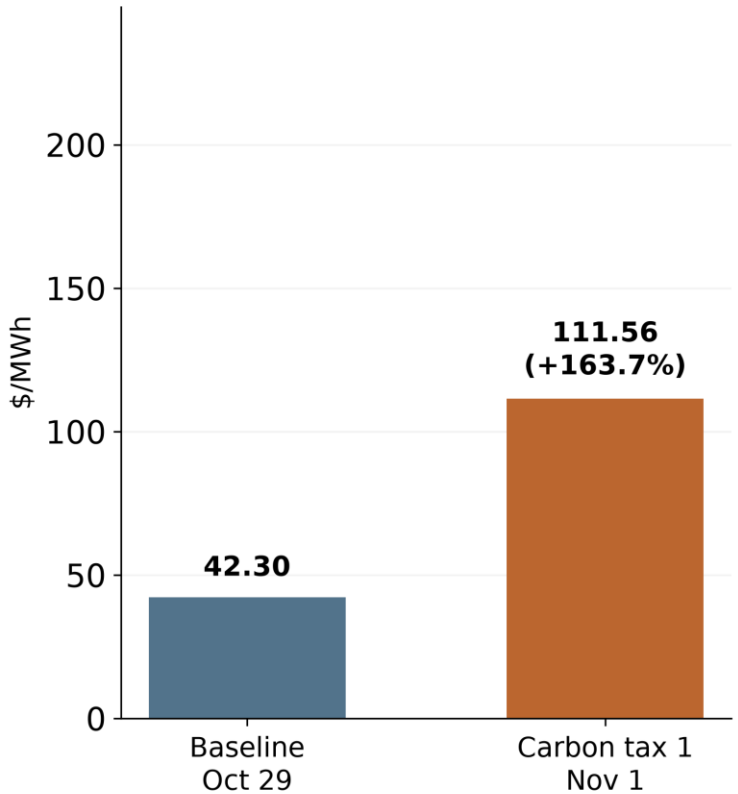
Section 2 · Baseline and carbon-tax rounds

Daily totals across all seven GENCOs and 4 electricity periods

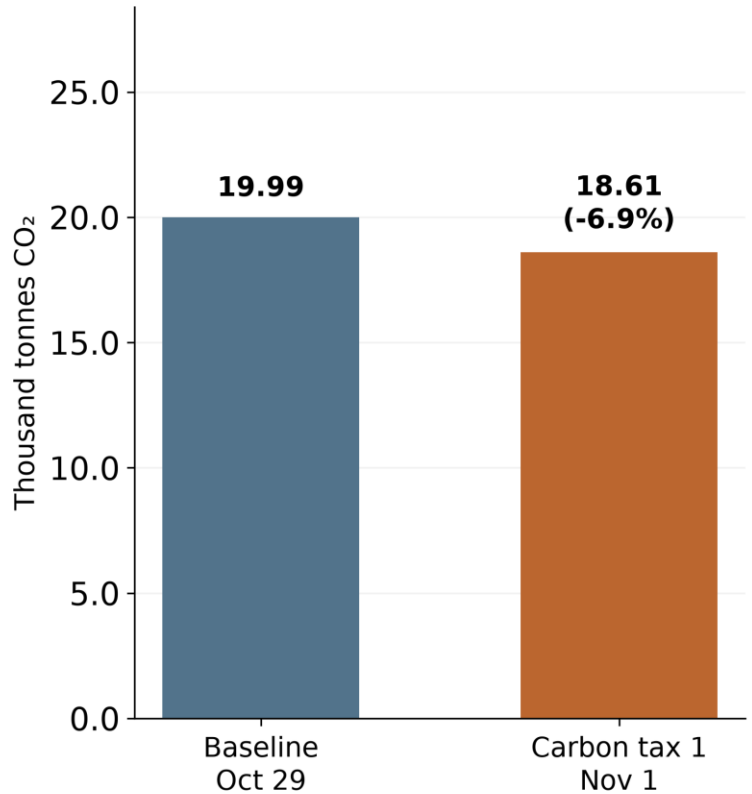
Total GENCO profits



Quantity-weighted price



Total emissions

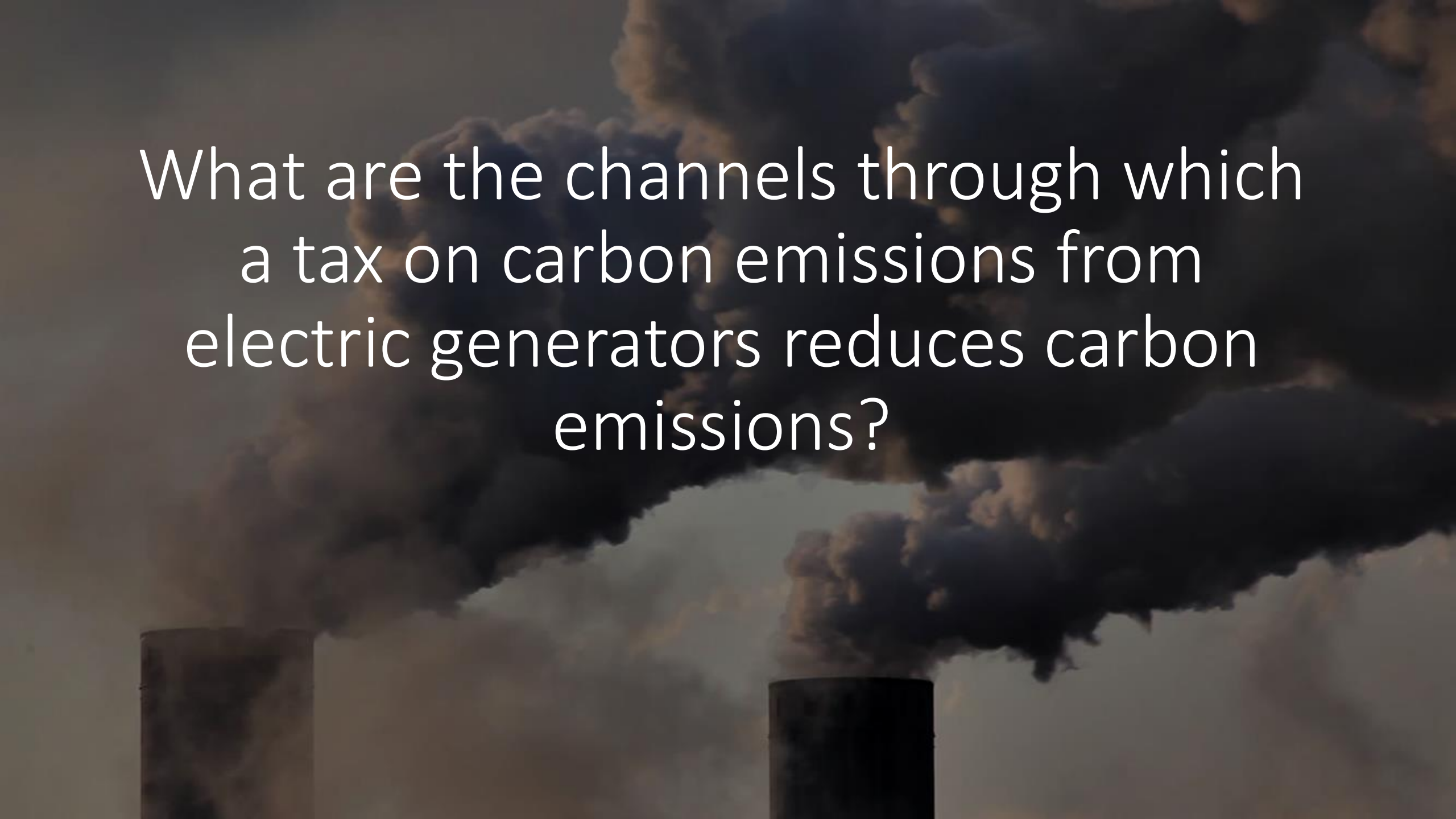


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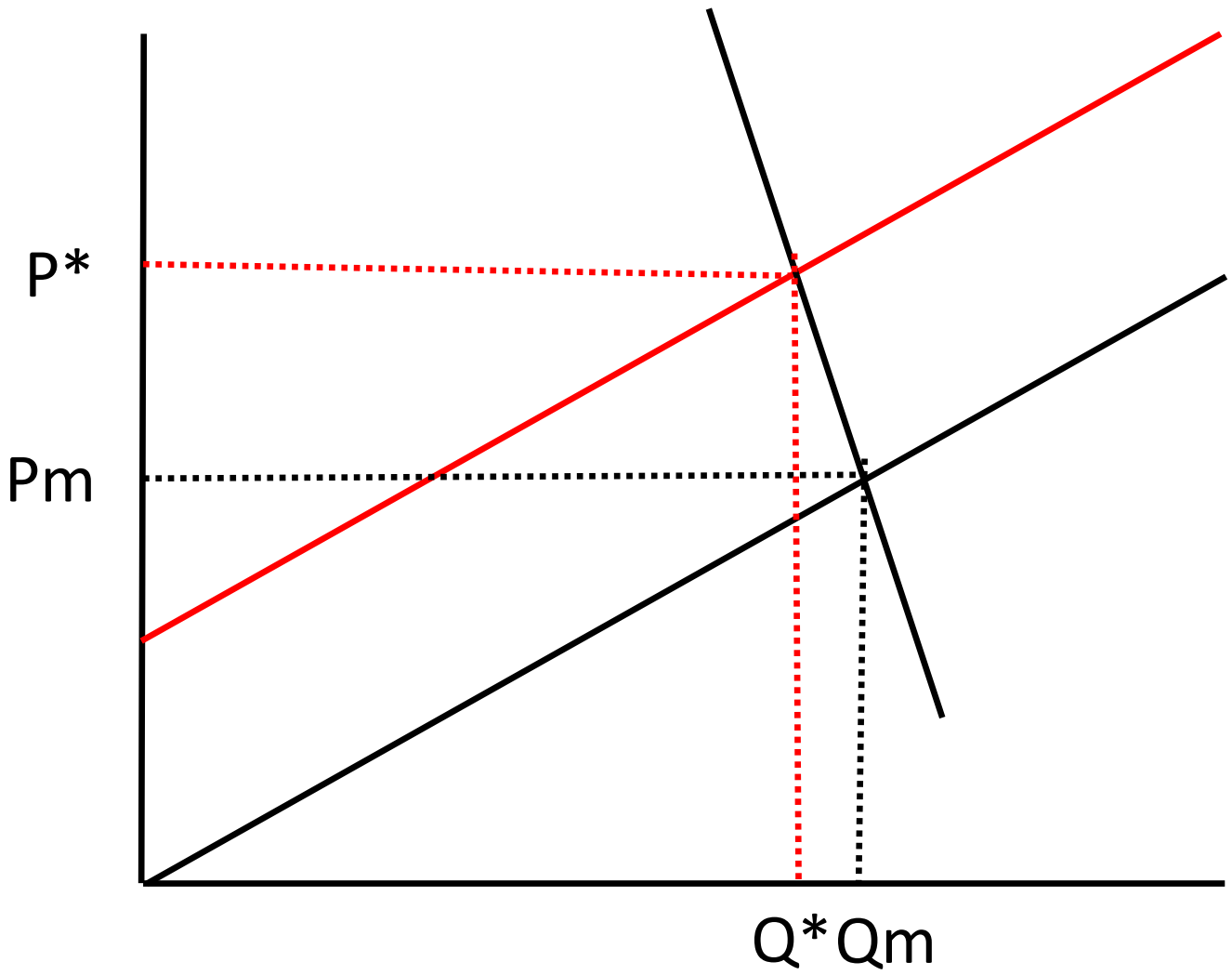
What do you make of these results?

- Question 1: Emissions did not go down very much. Why not?
- Question 2: Firm profits went UP. Why are power companies so opposed to a carbon tax?



What are the channels through which a tax on carbon emissions from electric generators reduces carbon emissions?

In markets with *constant* externalities, primary channel is through demand response

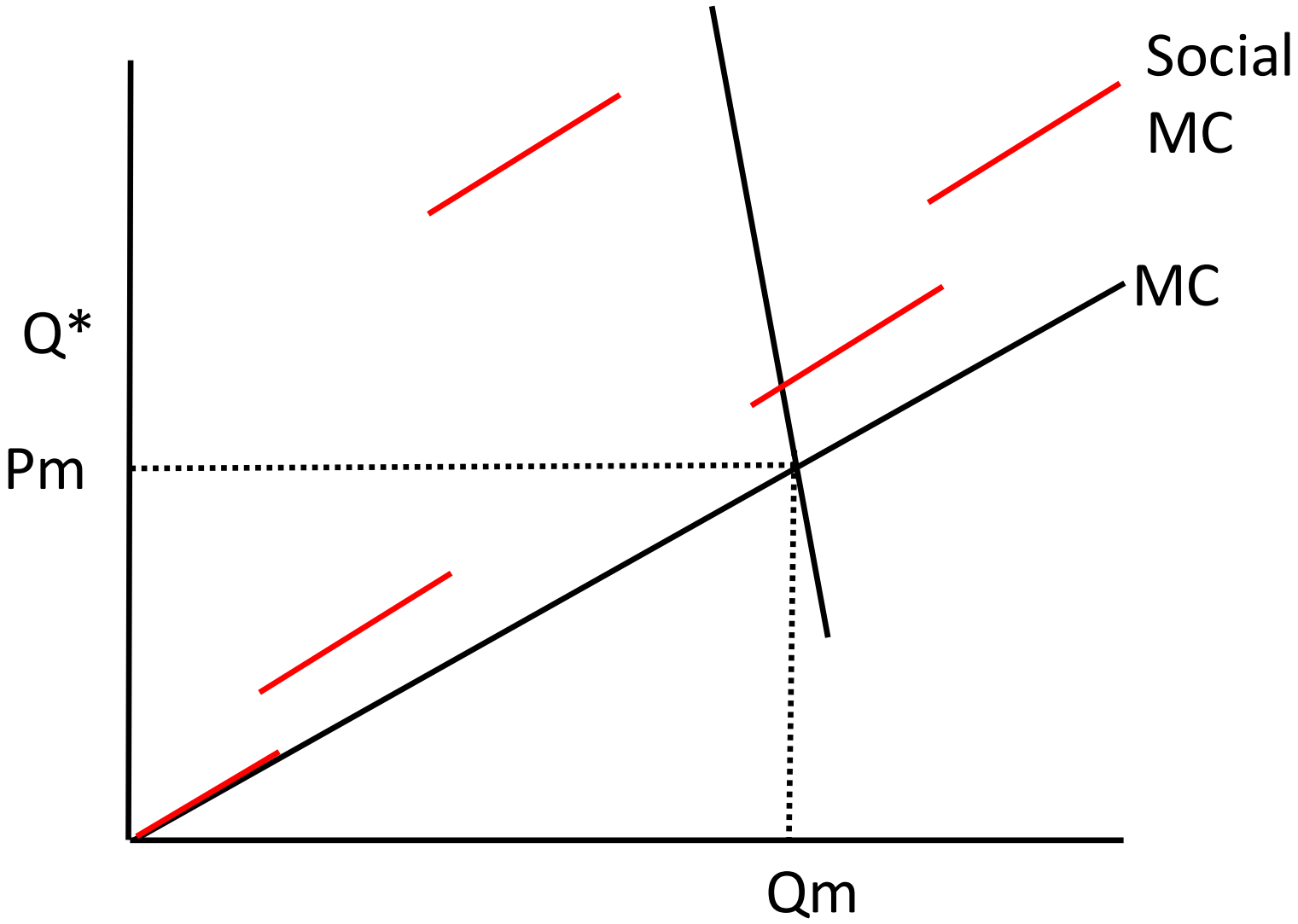


Tax = External MC

As we discussed last week, electricity demand is very inelastic.

So in the short run, this margin is unlikely to significantly reduce emissions

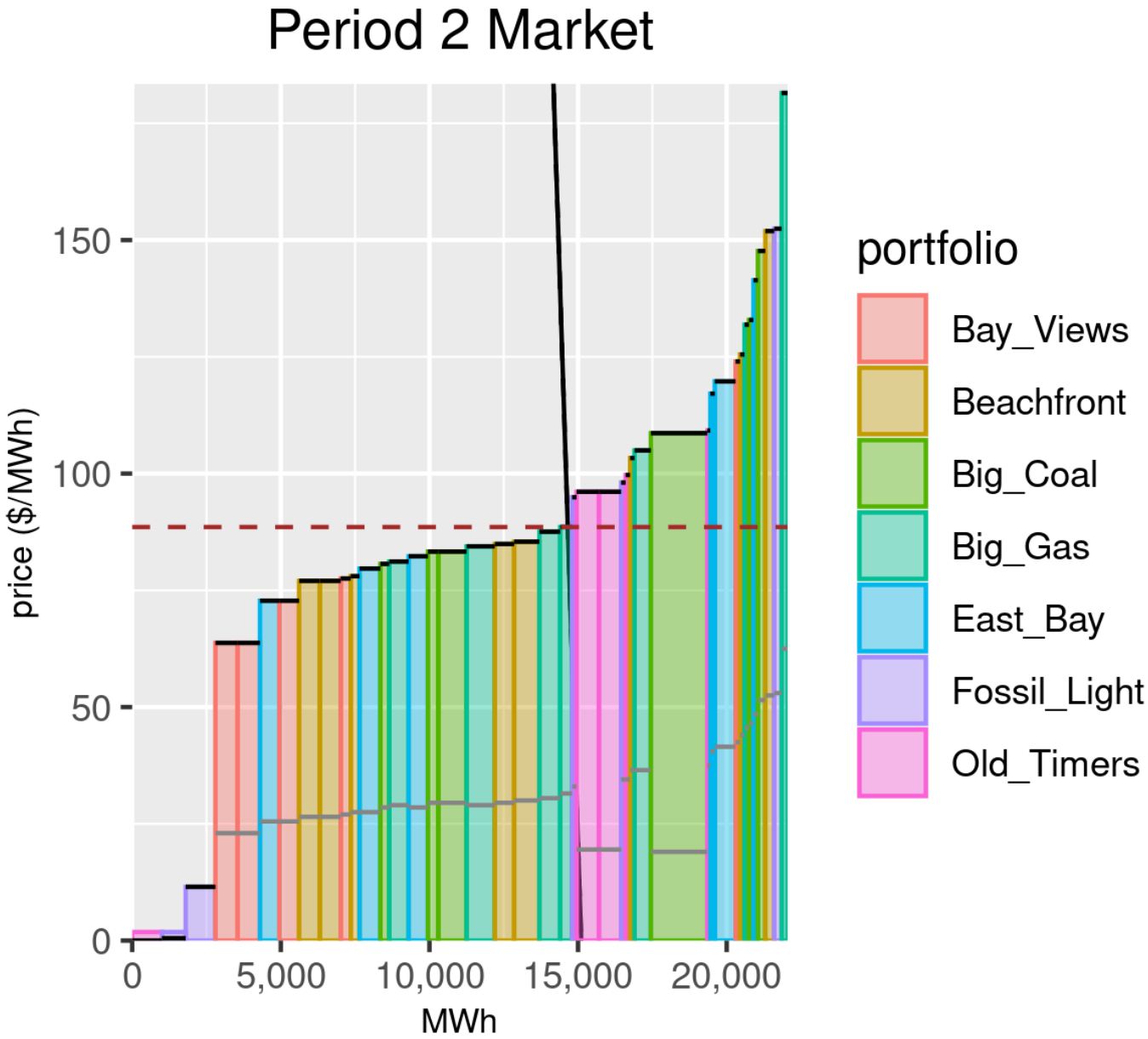
In markets with heterogeneous externalities, can reorder production to make it cleaner



This leads to <u>allocative inefficiency</u>: not just the wrong quantity consumed, but the wrong firms supplying Q*

In the simulated carbon tax game, I recomputed the baseline with a $163/ton carbon tax

- Can see that the bids change, but the *ordering* also changes



Market price: $88.55
Note: black marginal cost line assumes carbon price of $163
Note: grey marginal cost line assumes carbon price of $0

This exercise is inherently **short-run.**

What will change in the long-run?
(under a carbon tax vs the baseline)

We talked about investment before: LCOE

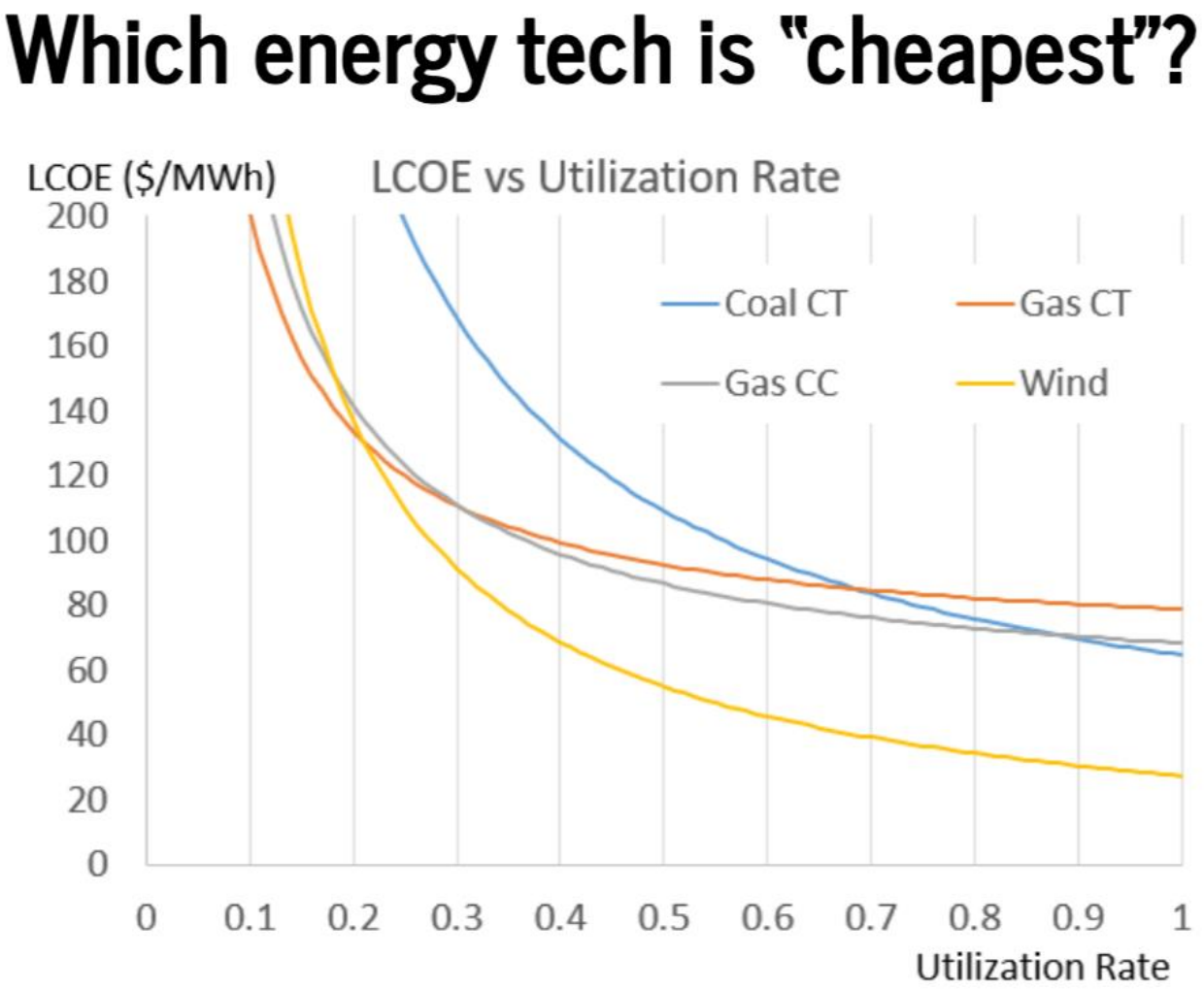
- Levelized cost of energy:

LCOE = var cost + (capital cost)/Q

This is the long run average cost per unit of quantity produced.

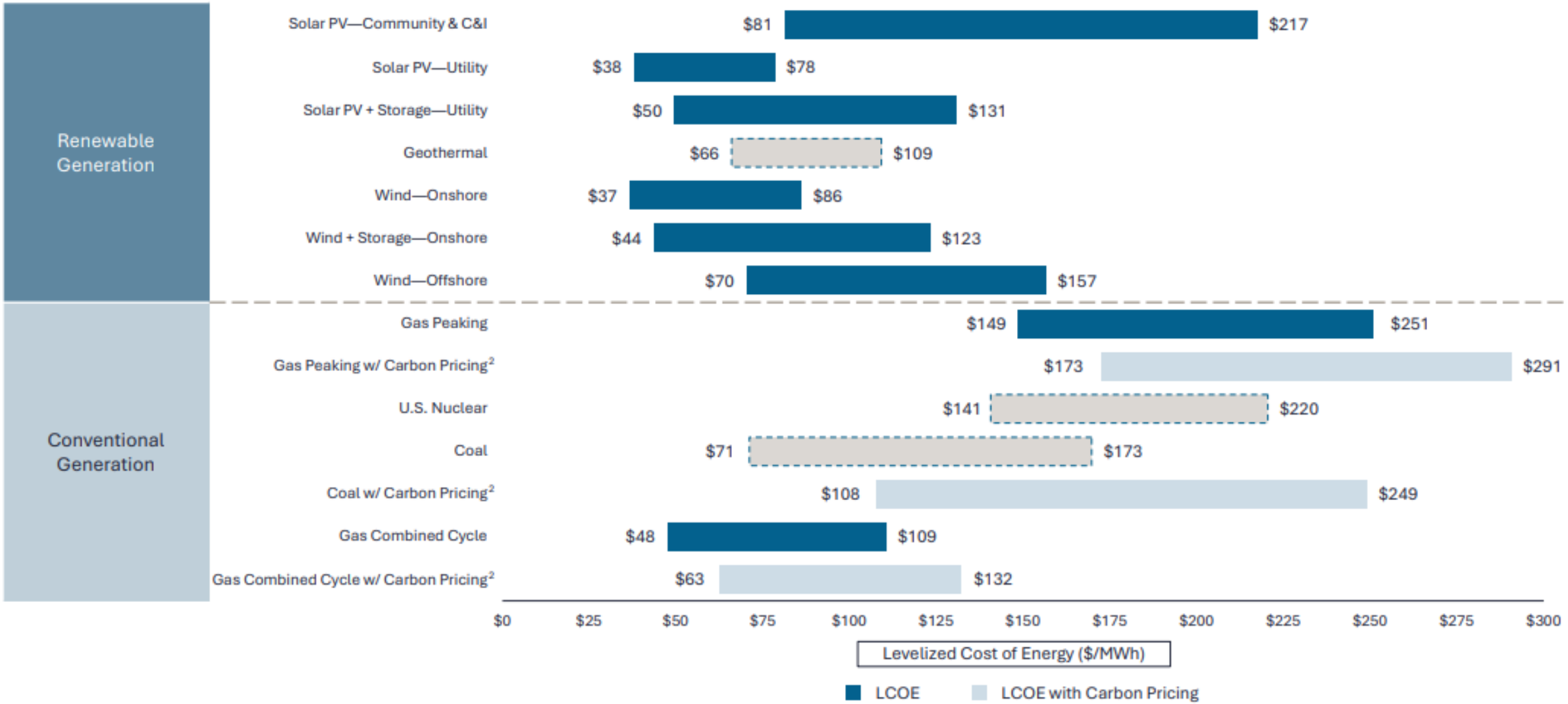
<u>A carbon tax is a variable cost.</u>

So it increases the LCOE for fossil fuels.



Levelized Cost of Energy Comparison—Sensitivity to Carbon Pricing

Carbon pricing is one avenue for policymakers to address carbon emissions; a carbon price range of $40 – $60/Ton[1] of carbon would increase the LCOE for certain conventional generation technologies, as indicated below



Will this increase renewable entry? Why?

What dermines investment in new plants?

Imagine a new plant is built. It will run for H hours (ie $20 * 8760$). It's lifetime profits will be:

$$\text{Profit} = \text{Revenue} - \text{Cost} = \sum_h (P_h - v) q_h - K$$

Divide by lifetime production $Q = \sum_h q_h$:

$$\frac{\text{Profit}}{Q} = \bar{P} - v - \frac{K}{Q} = \bar{P} - \text{LCOE}$$

So the asset will make money the average price it receives over its lifetime is greater than its LCOE.

Section 1 · Prices by electricity period

Baseline and completed carbon-tax rounds · market prices in $/MWh

Electricity period	Baseline Oct 29	Carbon tax 1 Nov 1
Period 1	$28.00	$83.29
Period 2	$29.50	$96.11
Period 3	$340.00	$350.00
Period 4	$43.00	$108.65

North and South have identical prices in every period shown.

Values are rounded to cents; the accompanying CSV retains calculation precision.

Increases entry if: P base < LCOE < P tax

Section 2 · Prices by electricity period

Baseline and completed carbon-tax rounds · market prices in $/MWh

Electricity period	Baseline Oct 29	Carbon tax 1 Nov 1
Period 1	$28.50	$84.92
Period 2	$30.00	$96.11
Period 3	$65.00	$140.00
Period 4	$34.50	$108.65

North and South have identical prices in every period shown.

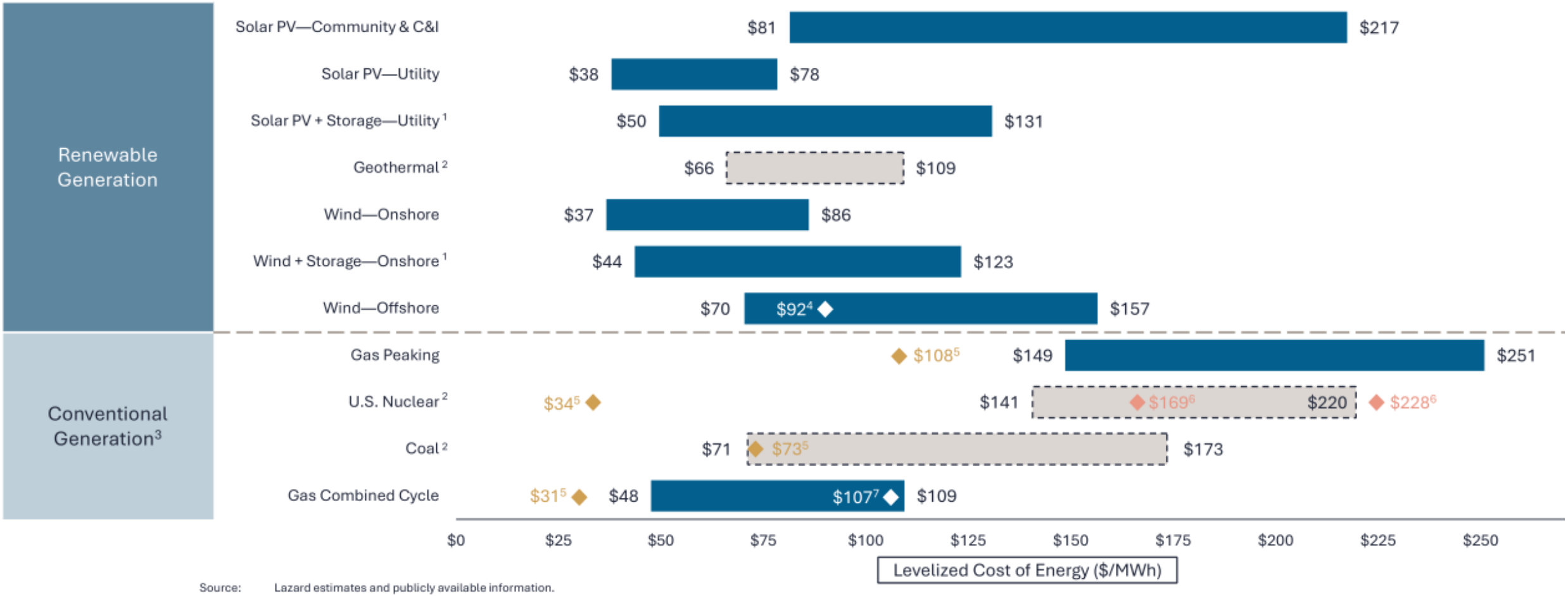
Values are rounded to cents; the accompanying CSV retains calculation precision.

Increases entry if: P base < LCOE < P tax

With no carbon tax, LCOE of renewables must beat the marginal cost of existing fossil.

Levelized Cost of Energy Comparison—Version 18.0

Selected renewable energy generation technologies remain cost-competitive with conventional generation technologies under certain circumstances



Source: Lazard estimates and publicly available information.

Final two days of the game: Investing in renewables

- The final two game links are “Renewables” and “Renewables 2”
- Genco’s can invest in renewable capacity
  - Pay a fixed cost (amortized over 4 periods)
- Other companies simultaneously do the same.
- The game clears at 9 am each night.

A list of possible renewable investments is in the google sheet

- Can’t produce every period!
- Sheet shows expected output each period
- Pay fixed cost no matter what

portfolio	plant	location	capacity	fixom	period
Bay_Views	Bay_Views_Altamont.Pass.1_1d8a	North	442	20000	1
Bay_Views	Bay_Views_Altamont.Pass.1_1d8a	North	154	20000	2
Bay_Views	Bay_Views_Altamont.Pass.1_1d8a	North	17	20000	3
Bay_Views	Bay_Views_Altamont.Pass.1_1d8a	North	0	20000	4
Bay_Views	Bay_Views_Central.Valley.1_4a37	North	0	21000	1
Bay_Views	Bay_Views_Central.Valley.1_4a37	North	0	21000	2
Bay_Views	Bay_Views_Central.Valley.1_4a37	North	544	21000	3
Bay_Views	Bay_Views_Central.Valley.1_4a37	North	0	21000	4
Bay_Views	Bay_Views_Shiloh.1_0c57	North	442	20000	1
Bay_Views	Bay_Views_Shiloh.1_0c57	North	154	20000	2
Bay_Views	Bay_Views_Shiloh.1_0c57	North	17	20000	3
Bay_Views	Bay_Views_Shiloh.1_0c57	North	0	20000	4

To buy plants, go to “Manage Power Plants”

- Note: This cannot be undone!
- Once you click buy power plant, it is there until the game clears…
- Tomorrow everything resets for next game.

