What is the right price of pollution?

Two factories must cut CO_2: why one price per ton makes the cheapest cuts first, tax vs cap and trade, and what Sweden and the EU saw.

1 Problem · tool

external cost

- **Problem** → CO_2 warms the planet, harm falls on **others** (**external cost**, Micro 10) ⇒ price of goods leaves it out ⇒ firms do not cut alone
- **Tools** → **rule** (same cut for all) · **carbon price** = price on each ton given off, by **tax** or by **cap and trade** (permits)

2 Model

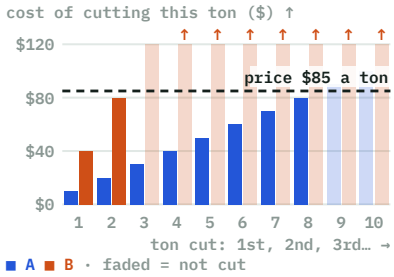
cost of cutting

- 2 factories, each gives off **10 tons** a day · goal: cut 10 in all
- **Marginal cost of cutting** rises ton by ton → A n-th ton `$10·n` · B n-th ton `$40·n`
- Rule **5 each** → A $150 + B $600 = **$750** · move 1 ton B → A: saves $200 − $60 = **$140**

3 One price

cut if cost < price

- Each factory cuts **every ton that costs less than the price**, pays for the rest
- $85 → A cuts **8**, B cuts **2** = 10 tons · cost **$480** vs $750 ⇒ saves **$270** · last cuts cost $80 each ⇒ no swap saves more = **cost-effective**
- $75 → A 7 + B 1 = **8** tons · $280 + $40 = **$320** vs 4 each $500 ⇒ saves **$180** · $65 → A 6 + B 1 = **7** tons



4 Right price

= harm per ton

- **Social cost of carbon** = harm of 1 more ton ⇒ right price = Pigouvian tax (Arthur Pigou, English economist, 1920 · Policy 4) · toy model **$85** · real estimates differ a lot
- Cut a ton only if **cost < harm** · harm $45 → cut A's 4 tons + B's 1 = **5** · cost $100 + $40 = **$140** · harm avoided 5 × $45 = $225 ⇒ net **+$85**
- All 10 tons: cost $480 > harm avoided $450 ⇒ net **−$30** → goal is not zero CO_2 at any cost

5 Tax or cap

price vs tons

- **Cap and trade** → state prints permits (1 ton each) = the **cap** · firms trade · market sets the price
- 10 permits, 5 each → B buys **3** from A · price ≈ **$85** · same 8 + 2 as the tax
- Cut 6 tons: 14 permits, 7 each · A cuts 5 (sells 2) · B cuts 1 (buys 2) · permit $55 → B pays **$110** vs $240 cutting 3 tons ⇒ saves **$90** (**gains from trade**)
- Tax fixes the **price** · cap fixes the **tons** → cold winter: cap ⇒ permit price ↑ · tax ⇒ CO_2 ↑
- Tax $75 on 12 tons left ⇒ state collects **$900** · free permits ⇒ **$0**

6 Evidence

Sweden · EU

- **Sweden 1991** · tax ≈ **$26** a ton → ≈ **$126** by 2020 (highest in the world) · CO_2 + other warming gases **−27%** (1990-2018) · income per person **over +50%** (1990-2019)
- Fall ≠ proof → other changes too ⇒ need a **comparison group** (similar countries, no tax) · Julius Andersson (economist, Stockholm) 2019: transport CO_2 **≈ −11%**, mostly the tax
- **EU permits** · 2005 start · ≈ **40%** of EU emissions (gases given off) · 2007 price ≈ **0** (too many permits ⇒ not **scarce**) · cap tightened ⇒ 2023 plants **≈ −47%** vs 2005

7 Trade-off

policy card

- Energy costs more, can weigh more on small incomes ⇒ **carbon dividend** = money paid back equally · Switzerland: CHF (Swiss francs) 120 a ton, ≈ ⅔ back to people + firms · CHF 61.80 each (2025, incl. a small solvent levy)
- Factory moves abroad (**carbon leakage**) ⇒ EU charge on imported steel, cement… (CBAM = Carbon Border Adjustment Mechanism, from 2026)
- FOR cuts where cheapest, firms choose how · AGAINST costlier energy today, right price uncertain · **positive** (data can test) ≠ **normative** (values)
- Policy card: problem **CO_2 harm left out** → tool **price per ton** → model **10 tons for $480, not $750** → evidence **Sweden −11%, EU −47%** → trade-off **cheap cuts vs costlier energy**