Do bans and subsidies work?

Beside the price of Lessons 3-4, two plain levers: a **rule** that says "no" → fits when every ton is worth cleaning and the source is easy to check · a **subsidy** that pays for the clean version → never free, but can buy **doublings**. Which weighs more: a judgment the lesson leaves open.

1 When is zero right?

Lesson 1's staircase

- Recall **Lesson 1**: mill, cleaning ton k costs `$10 · 20 · 30 · 40 · 50` · harm **$35** a ton → tax $35 → clean 3, dump 2
- Rule "no dumping" also cleans the $40 + $50 tons: `$90` to avoid `2 × $35 = $70` ⇒ **$20 lost** → where the line is under some bars, a rule is the blunt tool
- Harm **≥ $50** a ton (line above every bar) → clean all five ⇒ **zero is the efficient amount**: a number on the staircase, not a slogan · lead: harm at any dose
- **Standard** = a rule on what is allowed: a maximum amount · a required method · a ban (Policy 1's "regulation" lever)
- Practice · dye works `$15 · 25 · 35 · 45 · 55`, harm $30: ban spends `35 + 45 + 55 = $135` to avoid `3 × 30 = $90` ⇒ **$45 lost** ($175 vs $130) · zero efficient from **$55**



2 Price or rule?

three reasons

- Harm above every bar: a tax of $80 → also zero · so why ban? ① **nothing to find** (every ton worth cleaning = a cap of zero permits, Lesson 4) ② **cheap to check** at the source (one fuel refinery, not a meter on every exhaust) ③ **nothing to trade off** when one dose already harms
- Cost of a rule: blind to the bars · **technology standard** names the method → $300 filter on every boat where a $100 engine change cuts the same oil ⇒ **$200 wasted** · name the **amount** (liters a month) → room for the cheap fix

3 Rules that worked

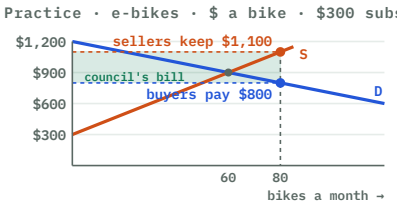
lead · ozone

- **Lead** harms the brain, children most (UNEP = UN Environment Programme; EPA = US Environmental Protection Agency) · in gasoline from **1922** → EPA limits from **1973**, lowered step by step = **phase-out** (a ban in steps on a schedule) → US road fuel **1996** (children's blood lead already −70%) → last country, Algeria, July **2021** · UNEP: > 1 million early deaths a year avoided · not proof alone: paint, pipes too
- **Montreal Protocol**, Sept **1987**: caps on CFCs (ozone-thinning chemicals) falling to zero · 24 countries + European Community → **198 parties** (members), every country · use −98% by 2011 (UNEP) · ozone layer back to 1980 state ≈ **2040** (Arctic 2045, Antarctic **2066**; WMO–UNEP 2022)
- Easier than CO_2: **few makers** · **substitutes ready** · cheap switch vs the harm | CO_2: every engine and furnace (Lesson 9)

4 The subsidy

the wedge upside down

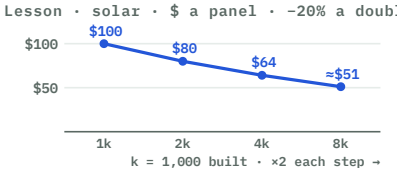
- **Micro 4**: tax = wedge between what buyers pay and sellers keep · subsidy = same wedge **upside down**
- Panels, $20 to the seller: 100 → **110** sold · buyers **$90** · sellers keep **$110** · council `20 × 110 = $2,200` → `$2,000` on 100 coming anyway ⇒ **$220 per new panel**
- **Subsidy incidence** = how it splits · **the side that reacts less to price keeps more** · practice e-bikes, $300: buyers $900 → **$800**, sellers → **$1,100** (1 : 2) · `300 × 80 = $24,000` · `$18,000` on 60 old bikes ⇒ **$1,200** per new bike



5 What a doubling buys

the learning curve

- **Learning curve** = cost falls a fixed share each time the amount **ever made doubles** · solar ≈ **20%**: `$100 → $80 → $64` (20% off twice ≠ 40% off once) · "Swanson's law" (2012 article; Richard Swanson, engineer) = a label, not a law
- **Your guess** (never graded or saved) → **IRENA** (International Renewable Energy Agency): panels **−90%** 2010-2019 · solar ≈ 38¢ → 7¢ a kilowatt-hour · practice batteries −25%: `$400 → $300 → $225` · 1,000 → 8,000 = **3 doublings**
- **For** the subsidy: buys doublings → cheaper for all, for good · **against**: a dollar often cuts fewer tons today than a dollar of carbon price · the lesson does not weigh them · university: **directed technical change**
- **Ten questions to ask about any green policy** (so far): **1** · What does the smoke really cost, and who pays that cost now? · **2** · Who owns the resource? What nobody owns, everybody overuses. · **3** · Does it cut where cutting is cheapest? · **4** · Does it fix the price or the quantity, and which mistake is worse here? · **5** · **Does it reward the cheap fix, the visible one, or the next invention?**



Watch out: a subsidy is **not free**: taxpayers pay it, most of it for what was coming anyway · a rule **does** cost: it cleans costly tons too · efficient ≠ zero, except when the harm tops every bar · Montreal does not prove a CO_2 treaty would be as easy