Beyond Cap and Trade: Emission Pricing and Technology Strategies

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Low Stabilisation Scenarios – Strategies, Technologies and Costs

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Why Is Innovation Important In Climate Policy?

- **Policy goals**
  - Stabilize greenhouse gas concentrations and temperature
  - Keep energy affordable, especially for poorer countries
- **Implications for emissions**
  - Ultimately, net greenhouse gas emissions must fall to zero
- **Need for breakthrough technologies**
  - Technologies with zero net emissions and tolerable cost when deployed on a sufficiently large scale do not exist today
  - Current focus needs to be on fundamental R&D and on critical enabling technologies
  - Deployment of the resulting technologies can only occur well into the future
- **What we expect from innovation conditions what it is worth doing now**
  - Optimal current carbon price equals the marginal cost of reducing emissions after innovations occur, discounted back to today

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What Kinds of Policies Can Induce Innovation?

- **Standard economic tools of emission trading or taxes on emissions cannot motivate the required R&D**
  - Current policies don't make R&D profitable – the expectation of future policies does
  - For fundamental economic reasons announcements of future caps or emission taxes sufficient to make R&D profitable are not credible
  - Therefore, requisite R&D will not take place under credible, short term, emission-pricing policies
- **Economic research and policy formulation need to focus on creating effective incentives for breakthrough R&D**
  - Commitments to innovation incentives that are credible and irreversible
  - Incentives that direct private R&D into lines likely to produce climate benefits

The Idea of Induced Technological Change

- **Induced technological change is assumed to be brought about by**
  - Learning by doing
  - R&D
- **Current caps could produce learning by doing, *but***
  - Compelling evidence of learning by doing in energy technology is missing
  - Learning by doing cannot create technology breakthroughs
  - Learning with one technology does not carry over to a different, successor technology
- **Emission trading comes into the picture because the prospect of high *future* carbon prices is believed to induce *current* investment in R&D**

A Primer on the Economics of R&D

- **Private sector R&D is motivated by profits to be earned from successful innovation**
  - Profits come from future licensing or use of technology breakthroughs that create new products or lower costs
  - Earning the profits requires protection of intellectual property so that imitation does not drive the market price down to cost of production with the new technology
  - It may be impossible to appropriate benefits of incremental steps
- **Climate R&D is a little different**
  - If benefits can be appropriated, profits depend on the price of carbon
  - That price is set by government policy
  - How the government reacts to successful R&D therefore is key

Carbon-pricing Policies and Induced Technological Change

- **Announcement of future carbon-pricing policies induces R&D *if:***
  - Governments can commit to future policies
  - Investors believe in the announcements
- **The problem with the theory of induced innovation**
  - Governments cannot commit their successors
  - The optimal policy response after innovations occur is to avoid carbon prices that would be high enough to provide a return on R&D

The Problem of "Dynamic Inconsistency"

- ***Expectation* of future policies motivates additional R&D on climate technology**
- **An announcement of a future carbon price sufficient to make R&D on climate technologies profitable is inherently *not credible***
  - Announced carbon price must be high enough that the investor expects to profit from *developing* the technology
  - Once the technology is developed, the carbon price only needs to cover costs of *using* the technology to bring about adoption
  - Since high carbon prices have other undesirable economic impacts, the optimal choice is to surprise the inventor by *reducing* the announced price *after* the technology is available
- **If inventors can see that the government will be motivated to change policy after an innovation is created, they will not believe the announcement, so that**
- ***Insufficient* R&D will be the result**

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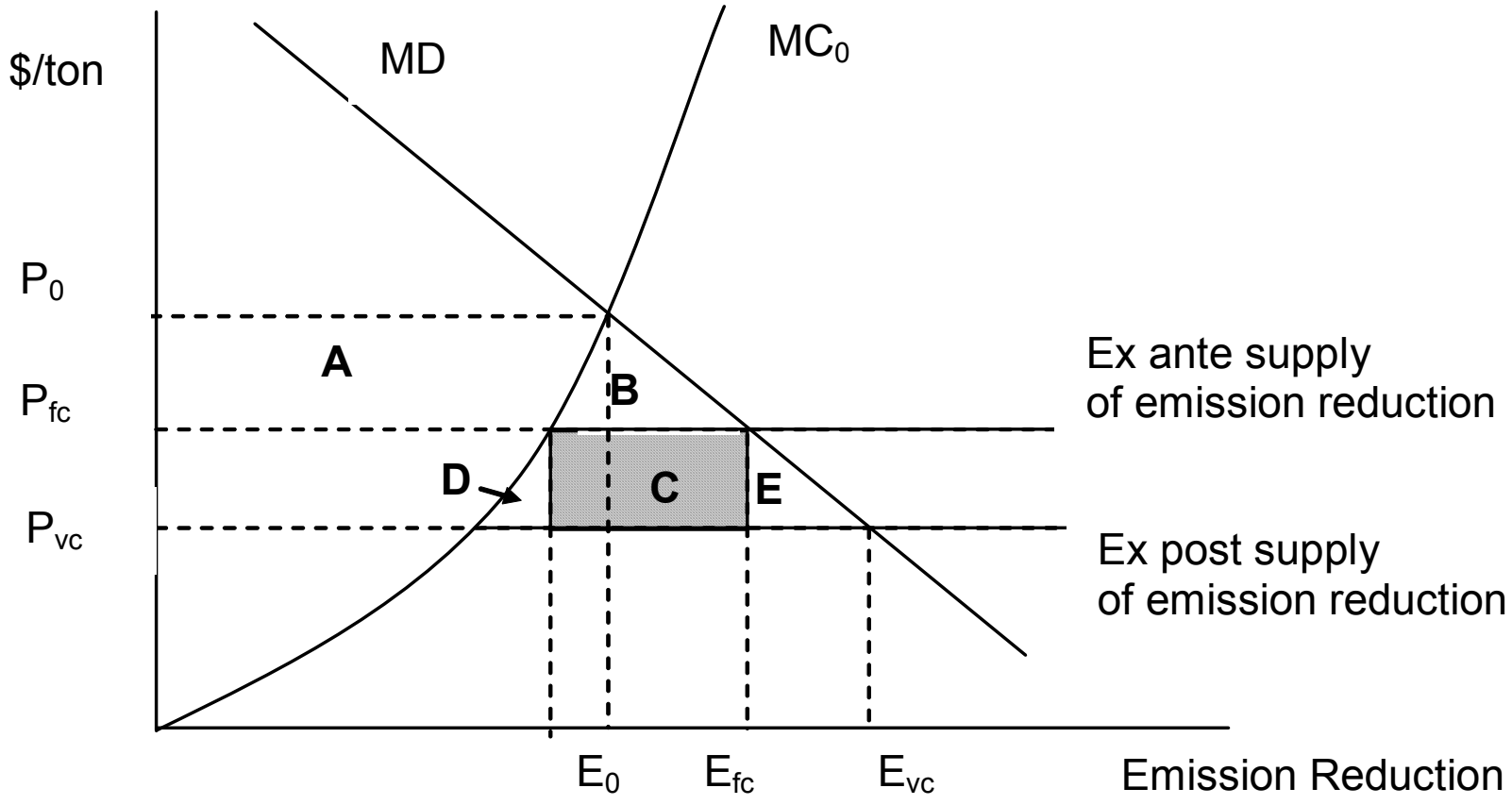
Optimal Carbon Prices Before and After Innovation



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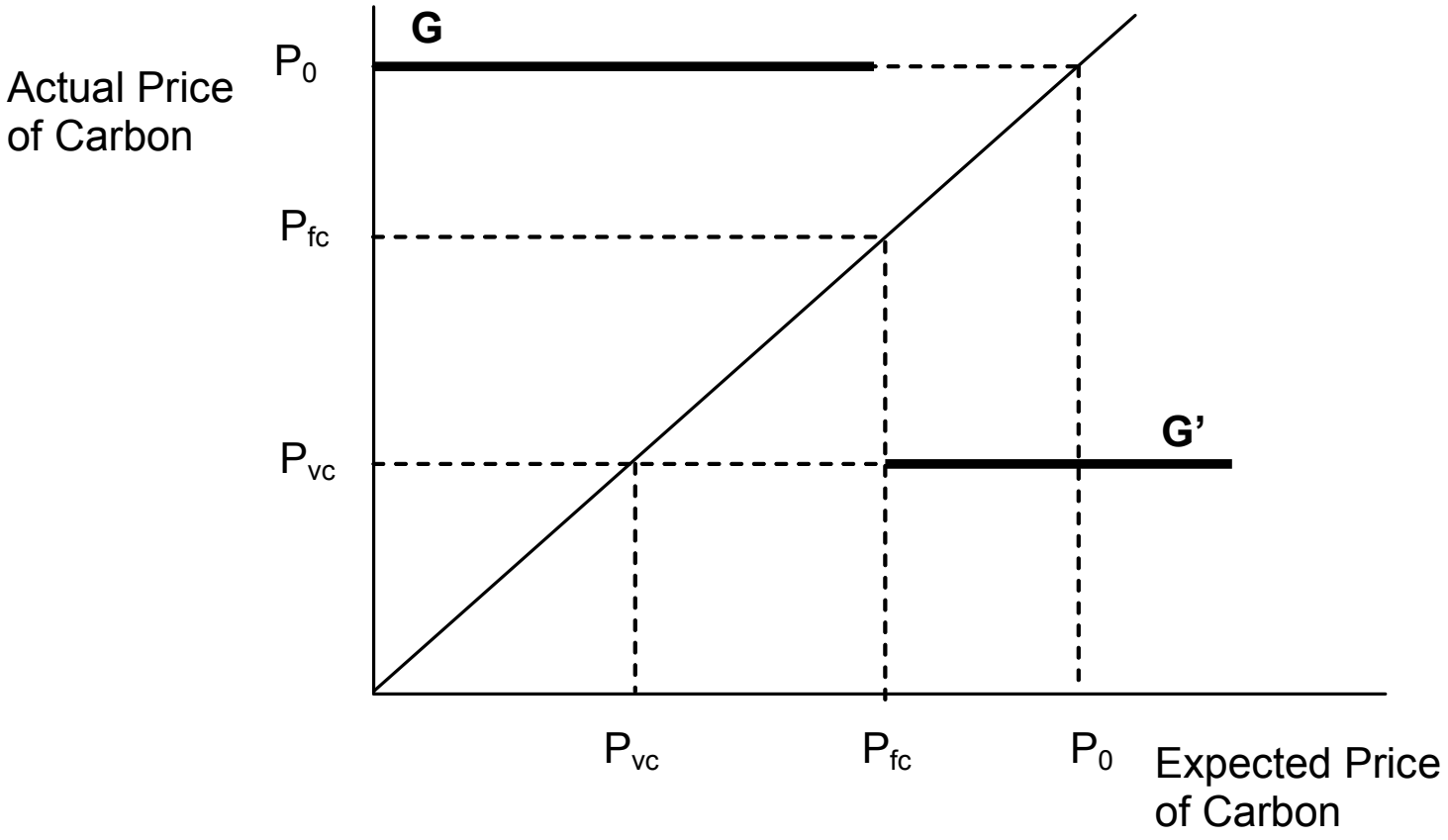
Dynamic Inconsistency In Setting Long Term Emission Caps: *An Example*

- **IGCC technology requires $100/T carbon price to cover operating cost, and $150/T carbon price to cover cost of R&D plus operation**
  - In 2005 government announces carbon price reaching $150/T by 2025
  - Inventors develop IGCC technology by 2025 that meets cost targets
  - Government's optimal policy in 2025 is to set carbon price at $101 to provide just enough incentive for adoption, and renege on promise to provide a return on R&D
- **Consequently, private investors will rationally disbelieve announcements intended to promote R&D**
  - Any carbon price low enough to be credible will be insufficient to stimulate R&D
  - Any carbon price sufficient to stimulate R&D will not be credible

Equilibrium In the Carbon Price Announcement Game



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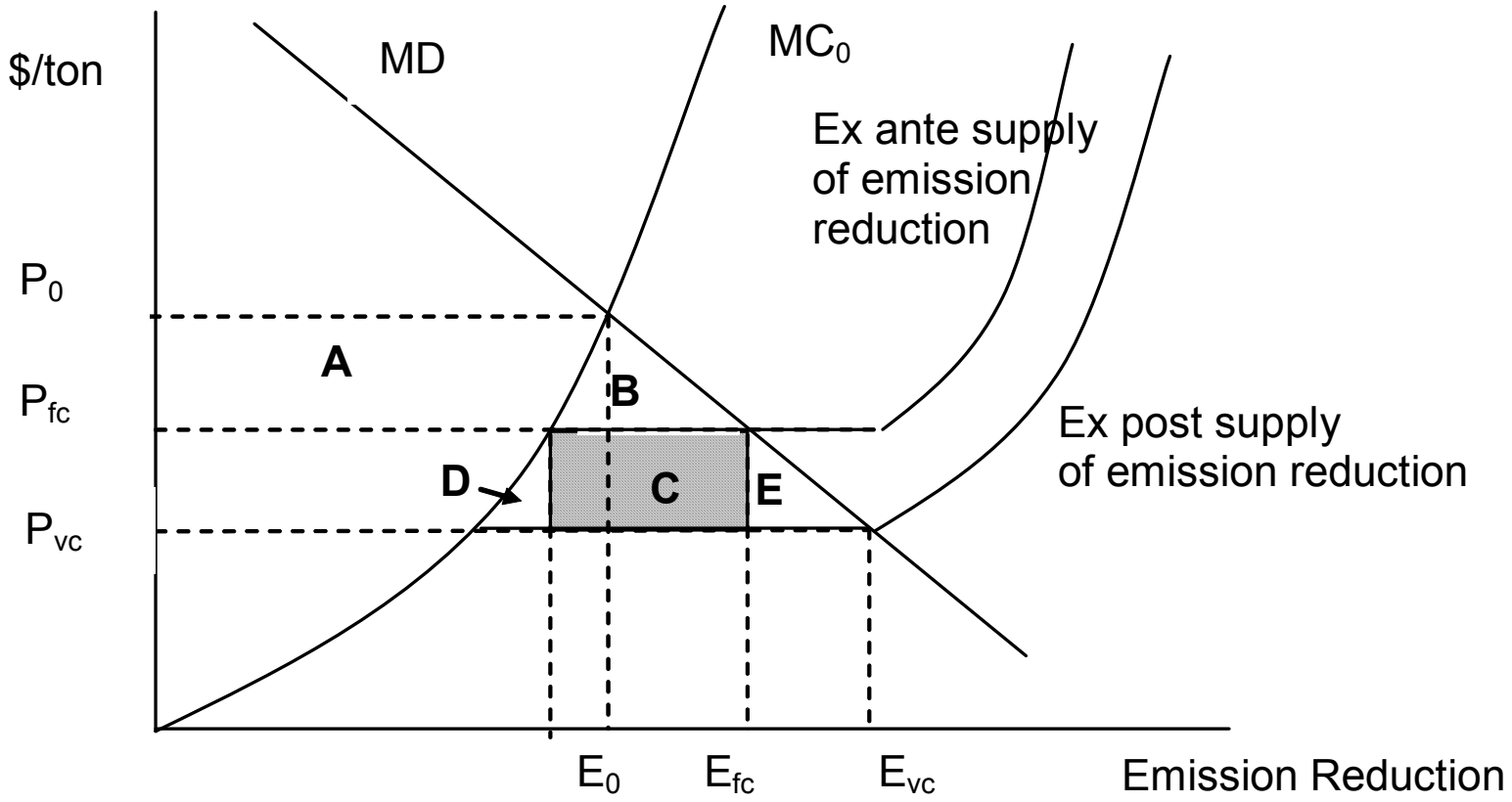
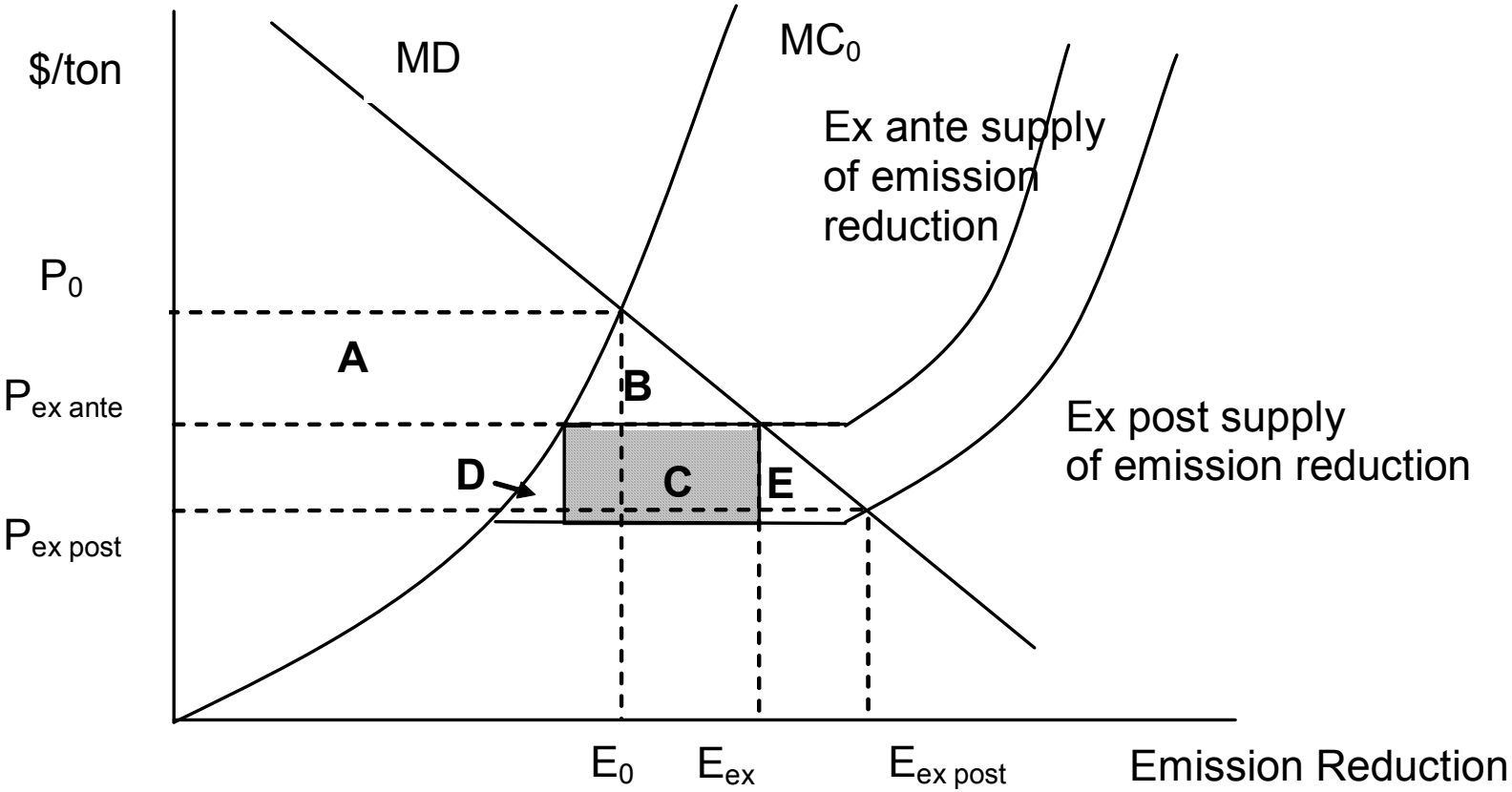
How General Is This Phenomenon?

- Does not require a single silver bullet technology or backstop with unlimited availability at constant marginal cost
- Appears whenever a new technology that requires R&D is on the margin at the ex ante price – the highest cost technology that would be used given announced prices
- New technology can be one with limited availability or increasing marginal cost – just makes the exposition more complex

Dynamic Inconsistency Appears Whenever Technology Requiring R&D Is On the Margin



Dynamic Inconsistency Remains Even If Carbon Prices Are Not Reduced to Variable Cost



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Time Inconsistency Appears In Other Markets

- **As a general economic principle, there are likely to be inadequate incentives for R&D into products dependent on future policy**
- **Pharmaceuticals research provides an example of exactly the same outcome**
  - Nordhaus: Pharmaceutical companies fund research leading to drugs that can be sold in the private market, because of the patent system that gives huge rewards to innovation.
  - Kremer: Little or no funding goes into new drugs for which governments would control the market, because even with patents governments can keep prices just at variable cost
- **Commitments now are necessary – to R&D incentives**
  - If a promise isn't sufficient, write a check
- **The hard part is – we can't just rely on the invisible hand of emission trading**

What This Conclusion Does Not Imply

- **The problem is not uncertainty about future policies**
  - It is the predictable "ex-post opportunism" of governments that cannot make binding commitments to future policies
- **The problem is different from classic non-appropriability or other externalities of R&D**
  - Even a perfect patent does not guarantee government will "make a market" for new technology
- **The effects of dynamic inconsistency can't be removed by R&D subsidies that address externalities**
  - The issue is direction not rate
- **Carbon-pricing policies do have a role**
  - They are useful to get technology "off the shelf," but they can't put it "on the shelf"

A Painful Conclusion

- **The great merit of emission trading was getting government out of decisions on how to achieve a policy goal**
  - Now we have to look directly at public policy to stimulate innovation
- **What policy commitments are credible and irreversible?**
  - If a promise isn't sufficient, write a check
  - Direct incentives for current R&D effort (or other clearly worthwhile investments) are required
- **How can those incentives be designed in a way that**
  - Avoids past mistakes?
  - Provides incentives for creating new technology, not subsidies for use of existing technology?
  - Puts decisions about the direction of R&D in private hands?
  - Makes it more likely the R&D will lead to climate-friendly technology rather than innovations in goods sold in private markets?

Framework for a New Approach to Innovation

- **Recognize key role of breakthrough technology**
- **Admit that near term caps and announcements of high future carbon prices will not bring it about**
- **Learn from past mistakes in energy R&D**
- **Investigate approaches to incentives that have promise**
  - Prizes
  - Shared funding
  - Industry consortia
  - Capacity creation
- **Include technologies suitable for developing countries**

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GHG R&D Goals Can Help to Decide on Current Actions

- **Set a goal**
  - What is a target for affordable technology ($/ton removed)?
  - What is the realistic timing target for commercial availability?
- **Identify the scientific and technological advances needed to meet these goals**
- **Develop a lifecycle spending path to make advances and achieve goals**
- **Infer what emission reductions in near term are worth**
  - expected value of avoided cost of emission reductions after R&D is successful

What Are the Steps Toward a Technology Strategy That Can Achieve Low Stabilisation Goals?

1. Create the institutions and funding for effective R&D leading toward zero-emitting technologies that can be deployed on a massive scale
2. Lay groundwork to improve incentives to invest in state-of-the-art technologies in developing countries now
3. Use simple, carbon price-setting policies to incentivize uptake of cheap near-term reductions where they do exist

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