Concepts for Carbon Pricing

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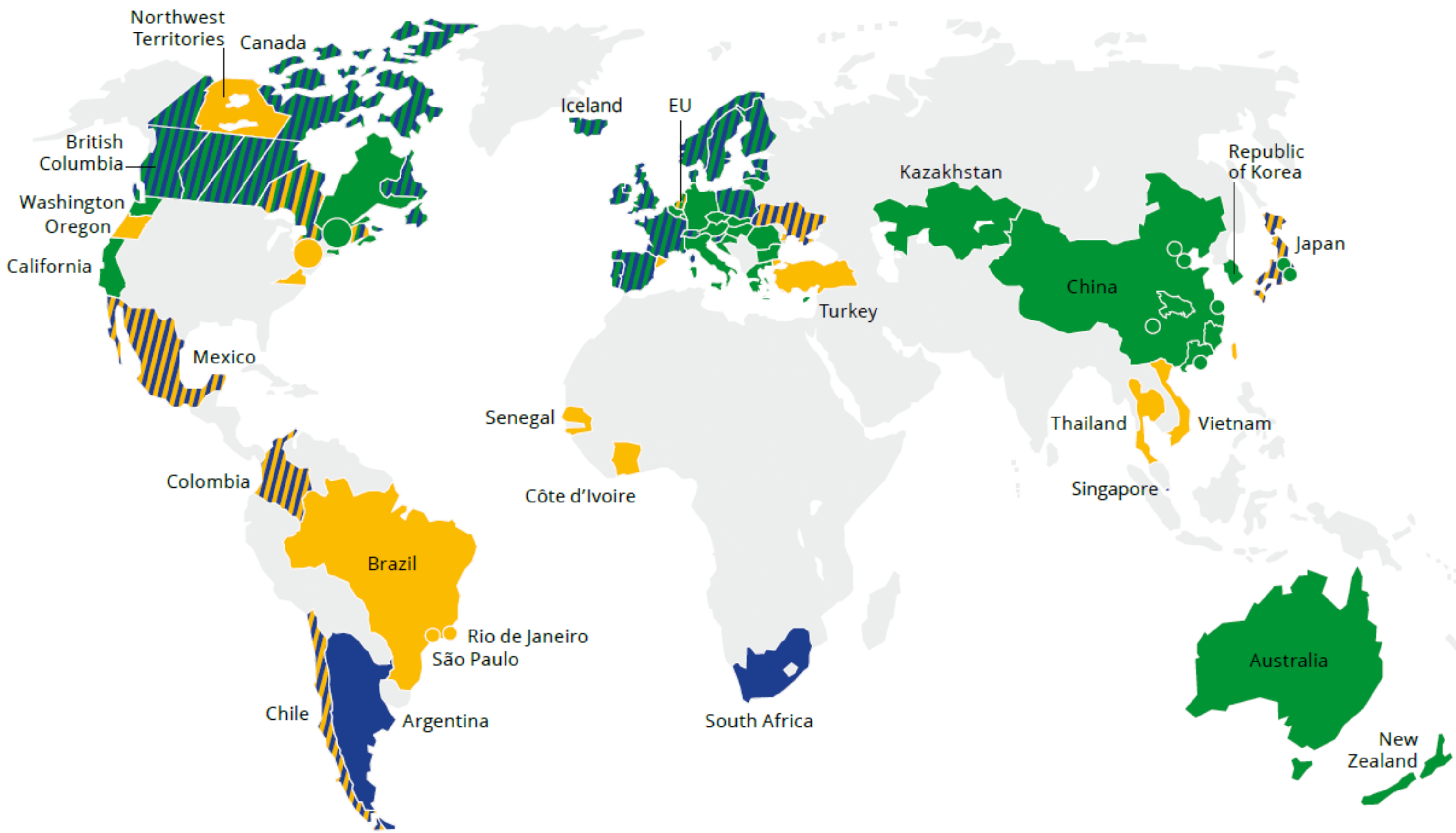
Drivers for carbon pricing

- Emissions reductions
  - Essential for addressing climate change
  - Pricing encourages fuel switching to lower carbon fuels
  - Pricing *potentially* encourages a reduction in energy demand, depending on use of proceeds

- Economic efficiency
  - Electricity generation produces carbon dioxide which contributes to climate change. The associated damages are not included in the price of electricity.
  - Pricing carbon will internalize the social cost of emissions
    - Carbon pricing is the **lowest cost option** for achieving a certain level of emissions reductions because it provides incentives to reduce emissions in every step from production through consumption

- Pricing promotes innovation and investments to achieve a reliable and affordable resource mix in the long run
  - Unlike for $SO_{2,}$ $NO_{x,}$ and mercury, control technologies for CO_2 are evasive & difficult to implement in the power sector
  - A carbon price increases the value of low-carbon resources

Existing Carbon Prices

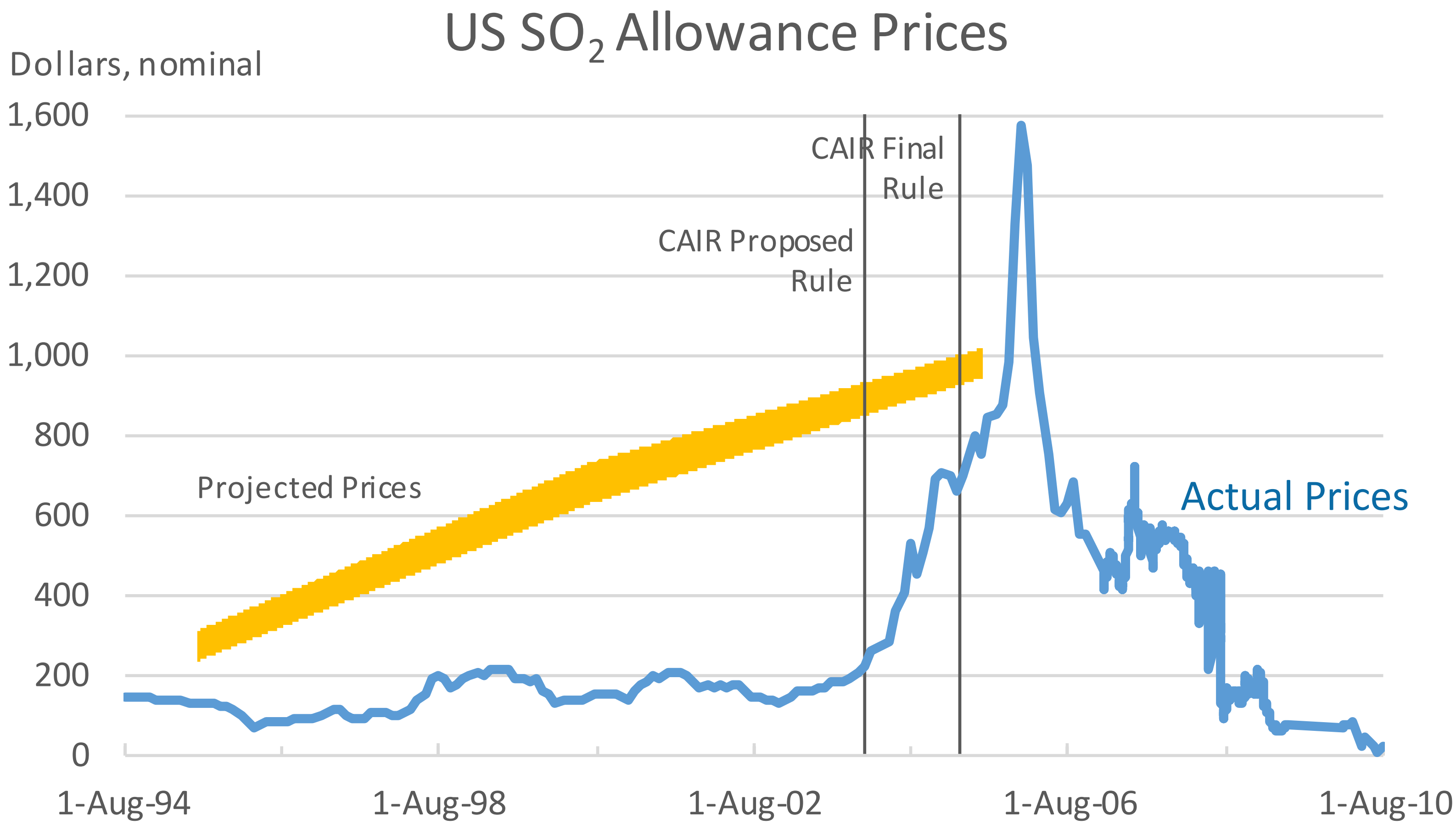


ETS implemented or scheduled for implementation
Carbon tax implemented or scheduled for implementation
ETS or carbon tax under consideration
ETS and carbon tax implemented or scheduled
Carbon tax implemented or scheduled, ETS under consideration
ETS implemented or scheduled, carbon tax under consideration
ETS and carbon tax implemented or scheduled, ETS or carbon tax under consideration

The large circles represent cooperation initiatives on carbon pricing between subnational jurisdictions.
The small circles represent carbon pricing initiatives in cities.

Source World Bank Group, State and Trends of Carbon Pricing 2019

Environmental prices are not new to the electricity sector

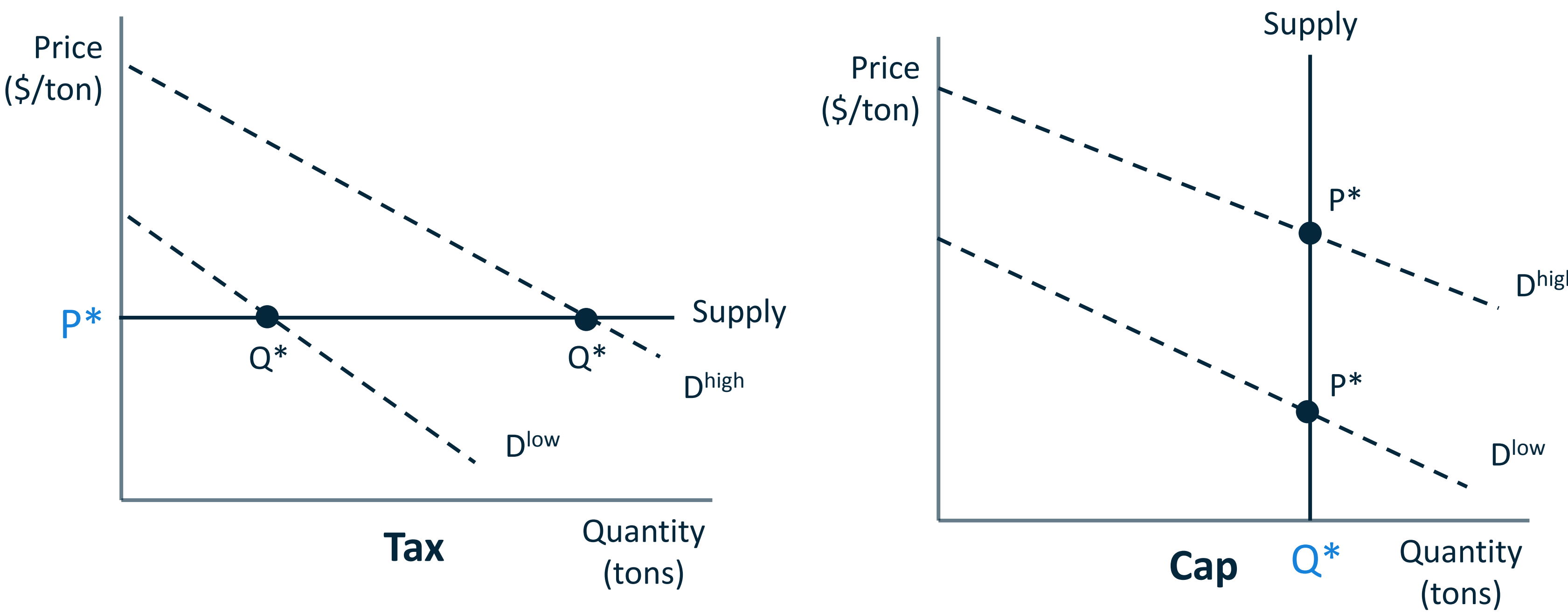


Outline

1) Review basic principles of carbon pricing
2) Survey of existing carbon prices
3) Interactions of carbon prices with companion policies
4) Falling prices in carbon markets
5) Leakage issues
6) Takeaways and lessons from regional programs

1. Basic Principles of Carbon Pricing

- Carbon pricing imposes a condition of **scarcity** on GHG emissions and provides an economic signal to emitters
- Approach 1: carbon tax sets a price
- Approach 2: cap and trade sets a quantity target



➢ Prices from either policy flows through wholesale energy markets

Most jurisdictions embrace cap and trade over carbon taxes. Why?

- Caps signal intermediate and long-term goals
- Use of allowance proceeds can build coalitions, and enables a lower carbon price
- Free allocation, where necessary, rather than exemptions
- Fungible allowances support longevity of program
- Opportunities for linking
- Implementation usually does not require legislation

Emissions Trading Has Been Used for Decades

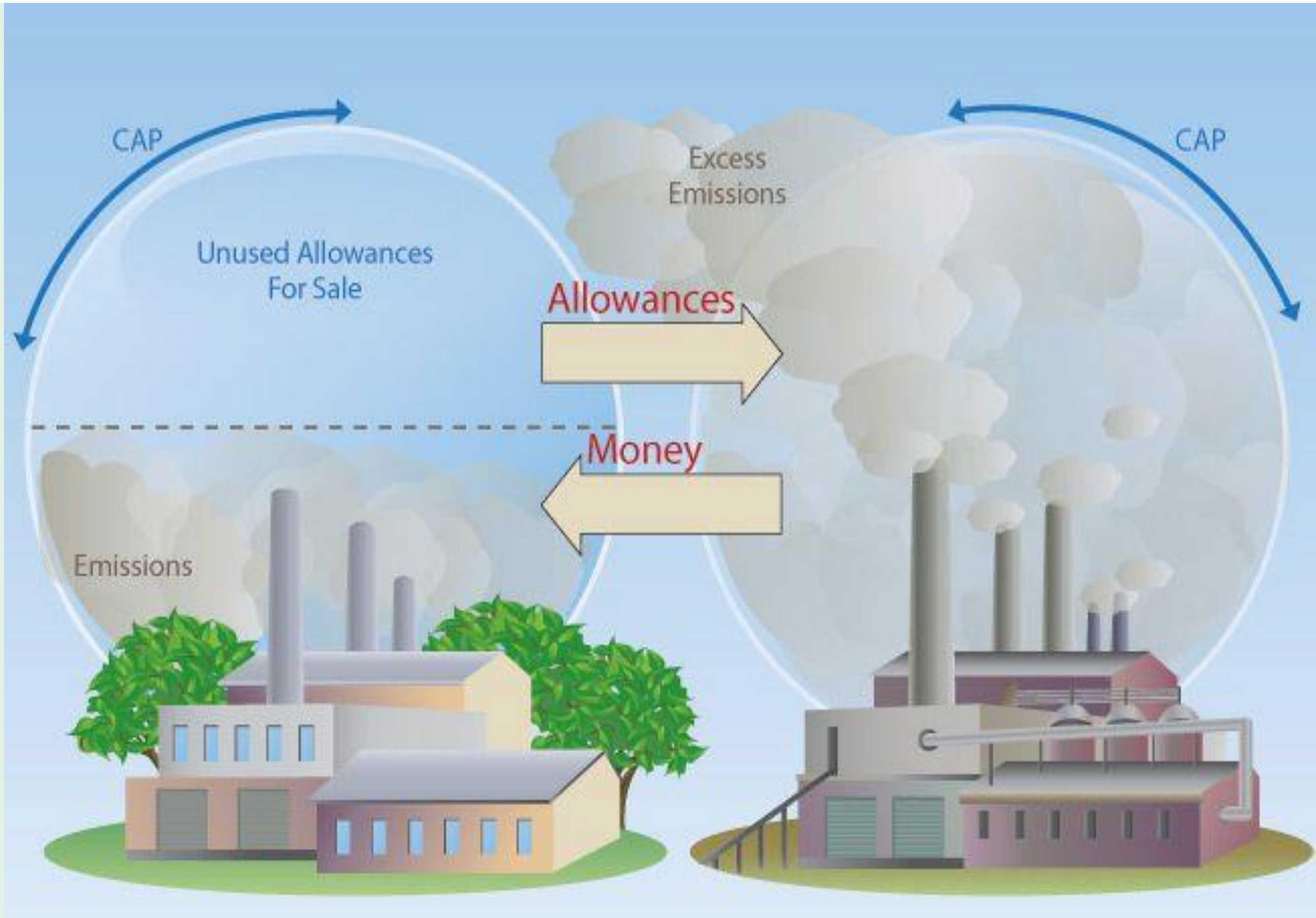
- Media reactions to first SO_2 allowance trades in 1992 were sometimes critical
  - "Why applaud a deal that lets companies buy pollution rights? *People will die.*"
    (op. ed. in USA Today)
  - Economists contrast market-based approaches to regulations, in which permits are given away for free.
- Variants of cap and trade have been very successfully implemented to reduce lead, SO_2, NO_x, and CO_2
- However, methods for reducing CO_2 are unique relative to these conventional air pollutants
  - Less opportunity for post-combustion control
  - Greater need for fuel switching, innovation and efficiency

Basic Principles for Cap-and-Trade Program Design

- Pricing is **economically efficient**: it provides incentives for the least-cost means of emissions reductions
- Key feature: pricing creates financial **asset value**
- Key question: how is that asset value **distributed** in the economy?

The Basic Principle of Cap and Trade

- Regulators limit total emissions (the "cap").
- Firms surrender one allowance per ton of emissions.
- Firms can buy or sell allowances.
- Firms that can reduce emissions at least cost will do so.



Source: EIA.

Deep Decarbonization Likely Involves a Substantial Expansion of the Electricity Sector

"All deep decarbonization pathways incorporate 'three pillars' of energy system transformation: energy **efficiency** and conservation, **decarbonizing electricity** and fuels, and **switching end uses** to low-carbon supplies…deep decarbonization cannot be achieved if any of the pillars is absent…

…Much of the direct combustion of fossil fuels …is replaced by decarbonized electricity, which **more than doubles the share of electricity in final energy consumption** in 2050." (options to reduce GHGs by 80% by 2050)

-- *Pathways to Deep Decarbonization Synthesis Report,* 2015

The technology pace for electrification is within historic experience

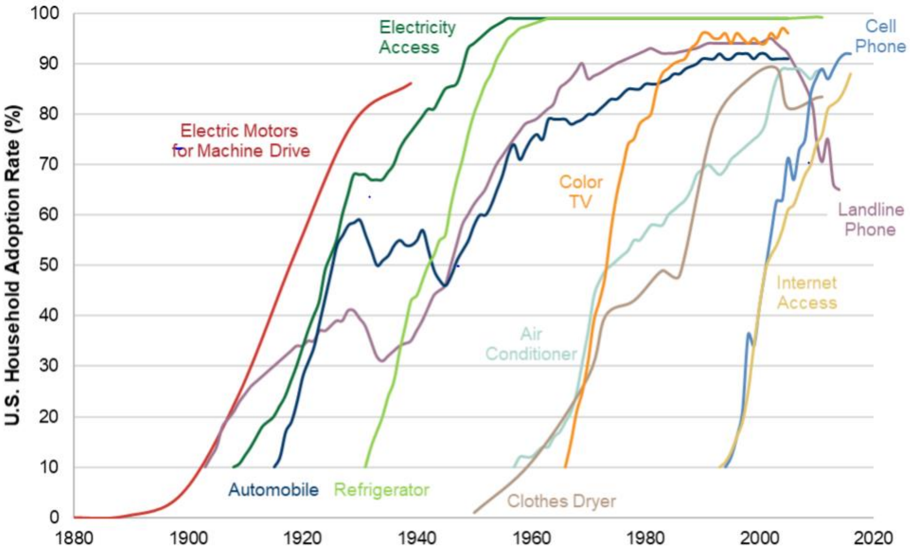


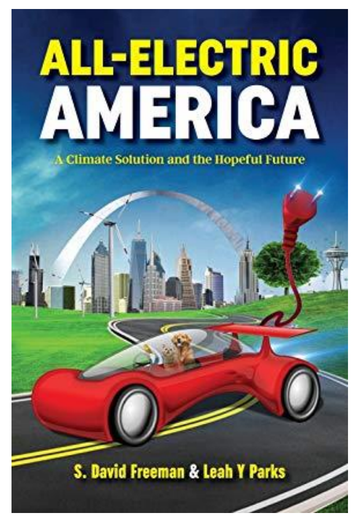
Figure ES-1. Diffusion of various technologies in U.S. households

Historic Rates of Technology Diffusion

In 2050, NREL sees

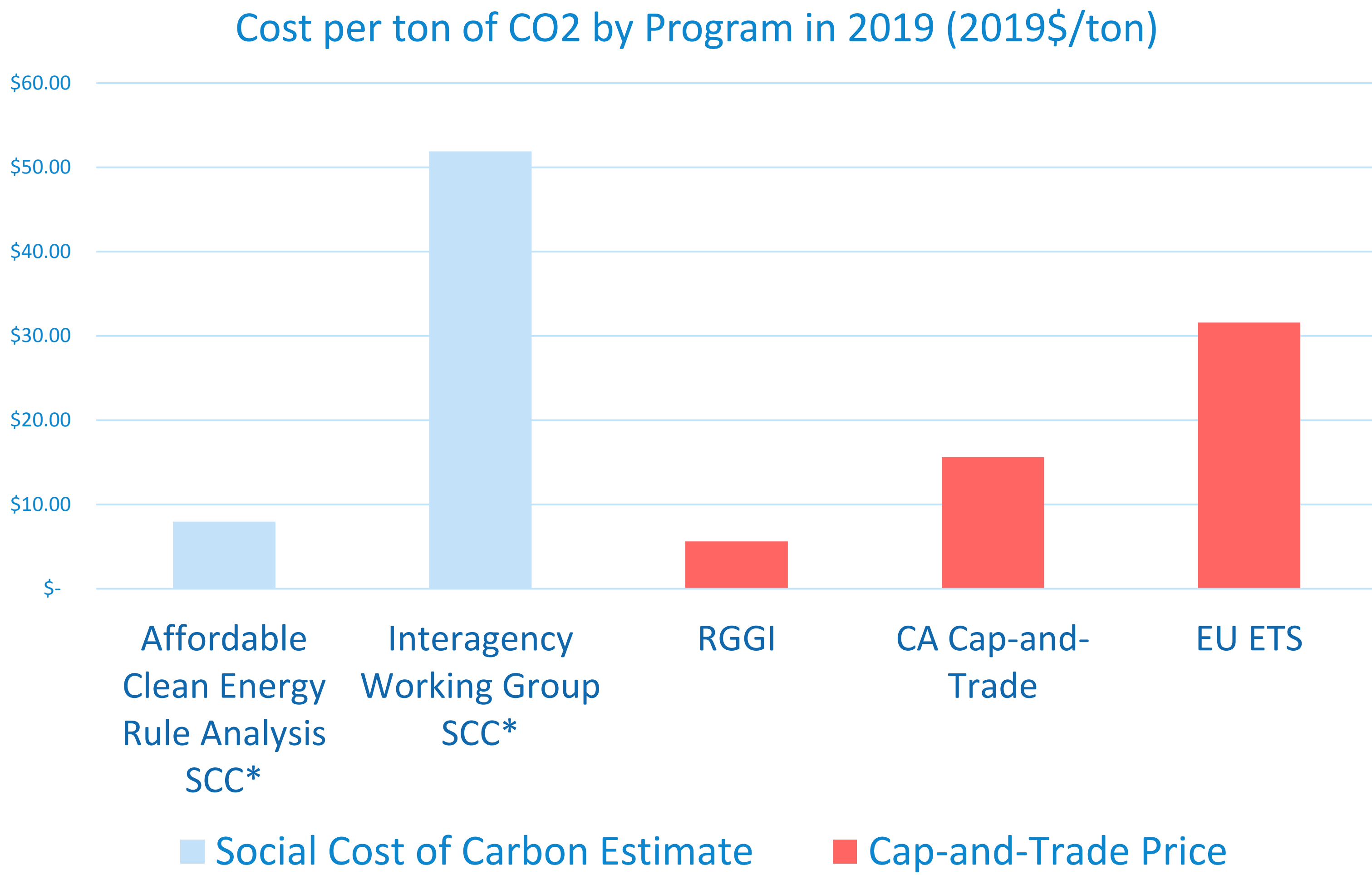
- **60-110%** growth in electricity use.
- electricity's share of total final energy increases to 32% to 41% (19% in 2016)

--NREL 2018 *Electrification Futures Study*



Electrify everything?

2. Existing Programs and Prices



*Based on the 3% discount rate scenarios

The Magnitude of the Carbon Price Matters for Impact

- Determination of the carbon price differs by program
- Cap-and-Trade
  - Prices are determined in the market based on a set quantity of emissions reduction
  - Prices from cap-and-trade depend on the stringency of the cap. A stricter cap will yield higher prices, and vice versa.
- Setting the price directly - social cost of carbon
  - Price calculation depends on a variety of assumptions, including the focus on domestic or global benefits and costs of carbon
  - A higher price will yield higher emission reductions, and vice versa

The Price in the Carbon Market is Uncertain

- The energy landscape has many moving parts
  - E.g., weather, fuel prices, economic conditions, technology costs
  - Consequently, costs of climate policy are difficult to predict
  - Very high and very low prices relative to expectations could be problematic for program effectiveness
    - Very high prices could affect competitiveness
    - Very low prices undermine innovation and early action, and reduce the carbon price effectiveness relative to regulations
- Flexible policies (cap and trade) can accommodate uncertainties
  - Policy design choices matter for managing costs

Natural Gas Price Fluctuations Have Been Large

Source: Macrotrends

- Natural gas prices are a **major driver** of the cost of achieving emissions reductions
- Also significant:
  - Energy demand
  - Technology costs

3. Policy Interactions

- Electricity sector policies include: renewable portfolio standards, energy efficiency standards, etc.
- Economic theory typically shows overlapping policies as departure from efficiency
- Nonetheless **companion policies** are a fundamental (and probably permanent) feature of climate strategies globally
- They are the central element of nationally determined commitments under the Paris accord

Companion Policies

- There are many reasons why companion policies are fundamental:
  - Political advantages
  - Carbon prices are often too low to drive needed emissions reductions
    - Politics
    - Leakage in the presence of incomplete global carbon pricing
  - Companion policies can drive long-term economic changes
- But it is sufficient to note:
  - Competition from outside the jurisdiction and associated leakage makes high prices unsustainable without a broad coalition

Dilemma: *Additionality* under an Emissions Cap

Cap and trade: Emissions reductions from companion policies lead to **the waterbed effect**

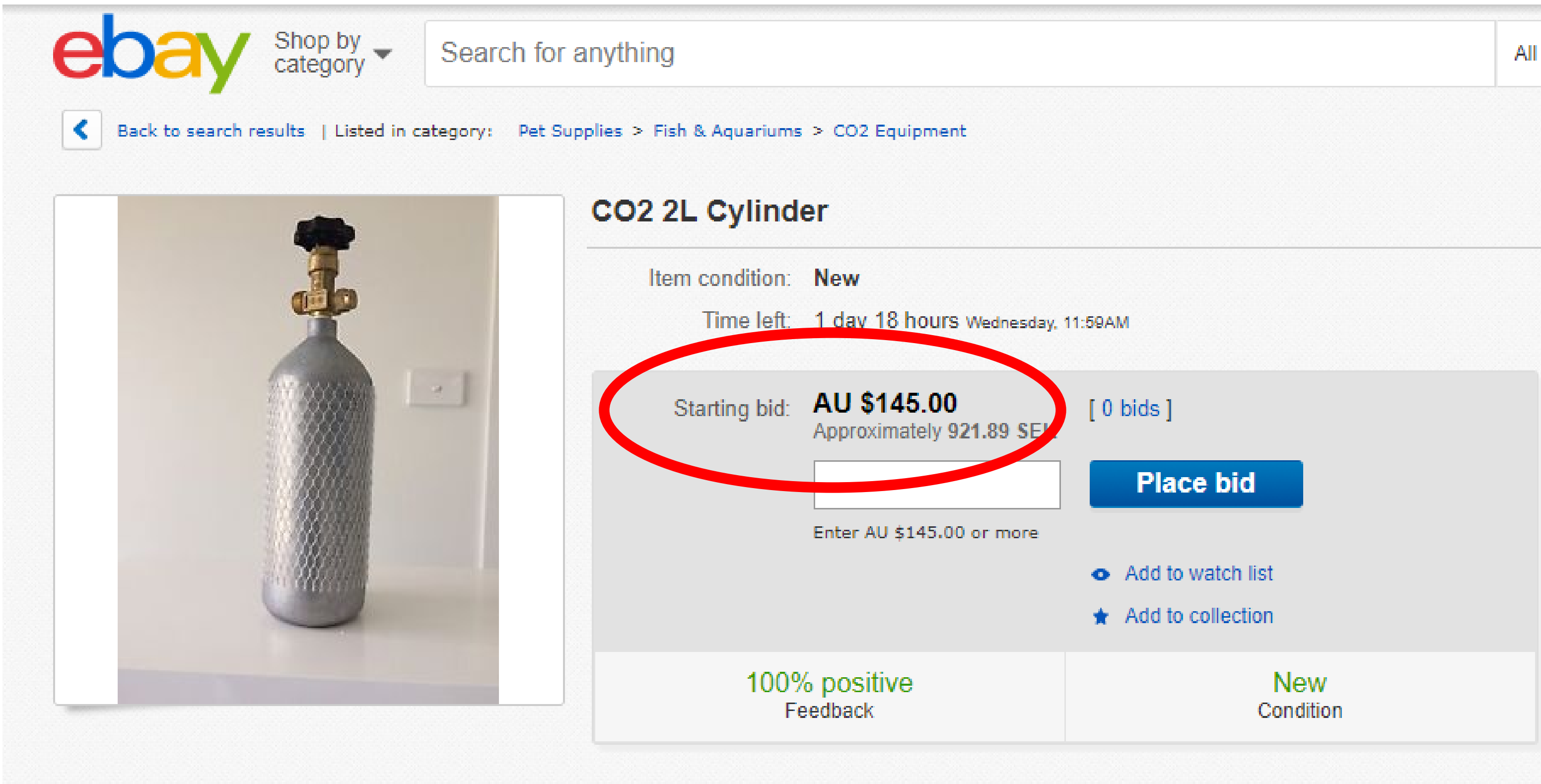
- An emissions cap is an **emissions floor**, leading to 100% leakage of individual efforts (at least in the short term)

- Prices fall, and emissions go up somewhere else!

4. Falling Prices in Carbon Markets

- Factors contributing to widely observed falling prices:
  - Program investments and federal and state policies
  - Over-allocation of allowances
  - Declining natural gas prices and electricity demand
  - Economic incentives lead to discoveries!
- **But falling prices erode the payoff to early actors and the price signal for further investments**

Price floors are auction “starting bids”



Most auctions have them!

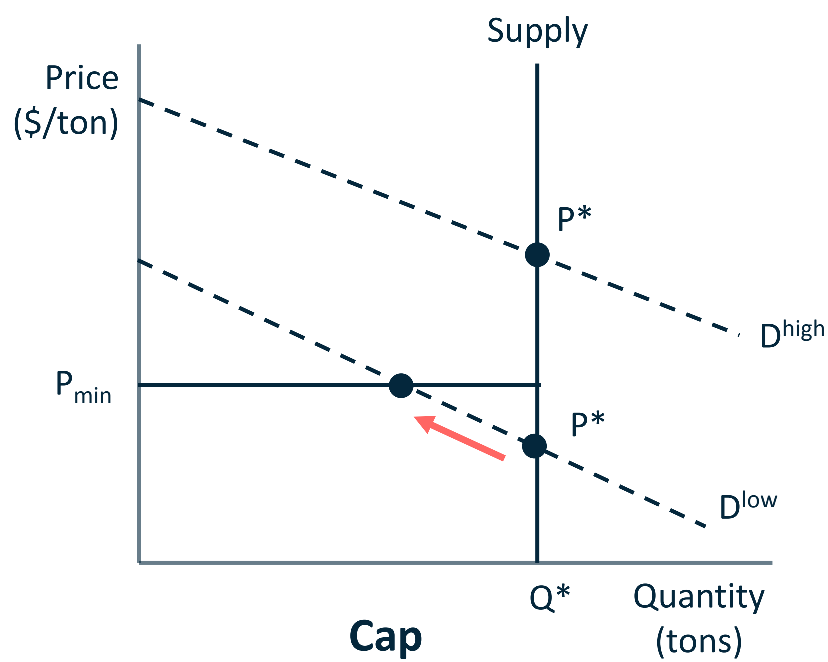
Price Floors in Carbon Markets

One solution is a price floor. All North American markets have a price floor implemented as an **auction reserve price** (like eBay)

- Bids below a floor price are not accepted

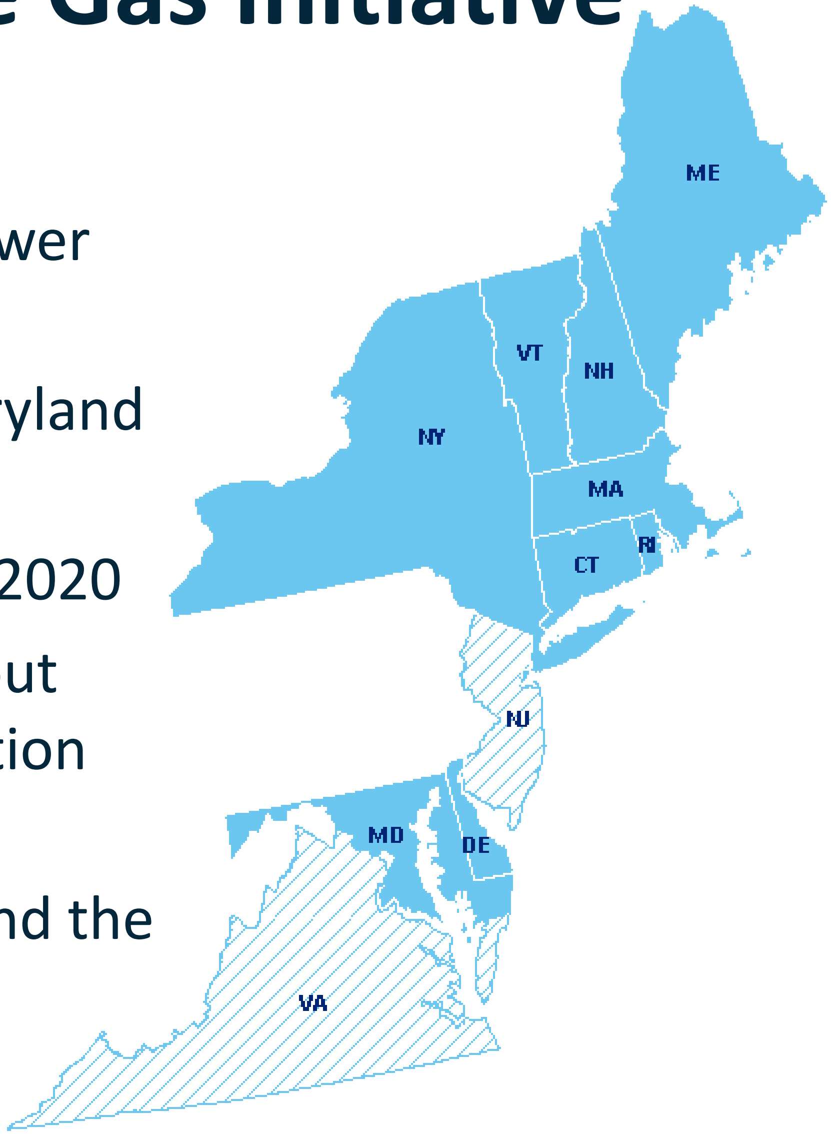
There is no minimum price in the EU. Instead:
Market Stability Reserve

RGGI has an additional feature called an **Emissions Containment Reserve (ECR)**

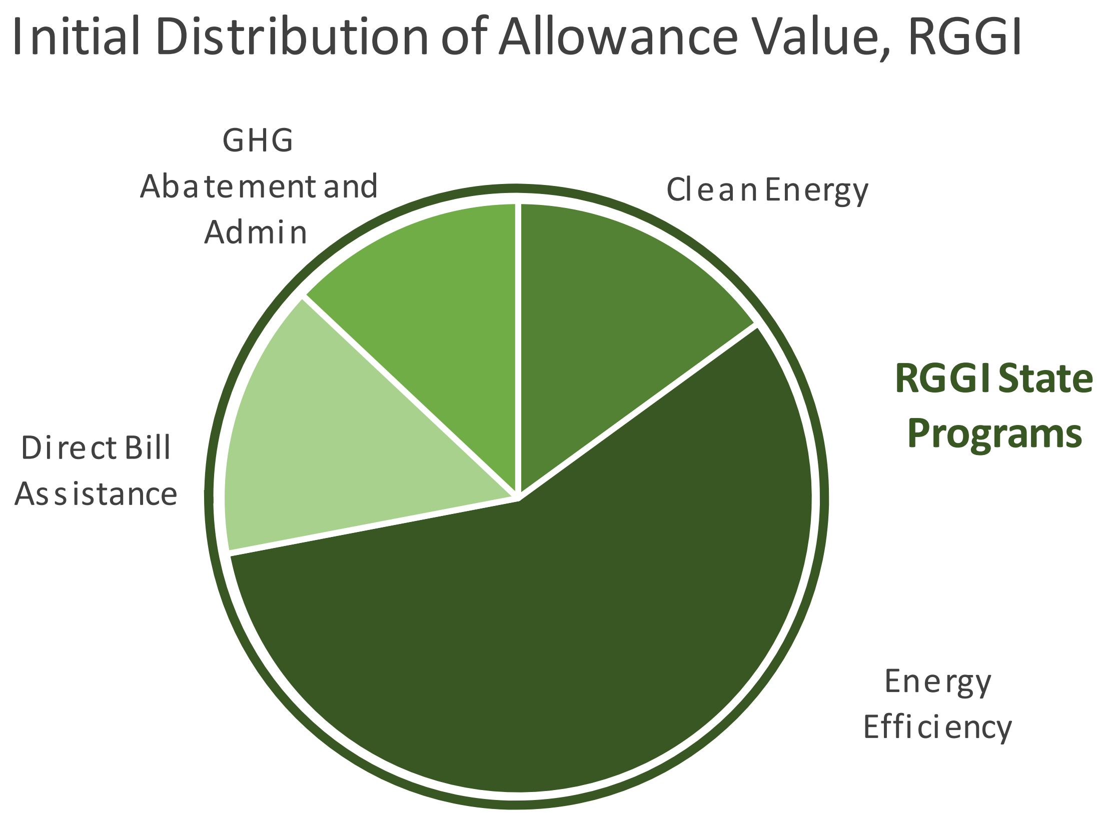


Regional Greenhouse Gas Initiative (RGGI)

- Established in 2005, applies to power sector CO_2 emissions
- Currently includes PJM states Maryland and Delaware
- New Jersey on board to rejoin by 2020
- Virginia announced plans to link but not able to implement the regulation currently
- Next: Expanding to other states and the transportation sector?

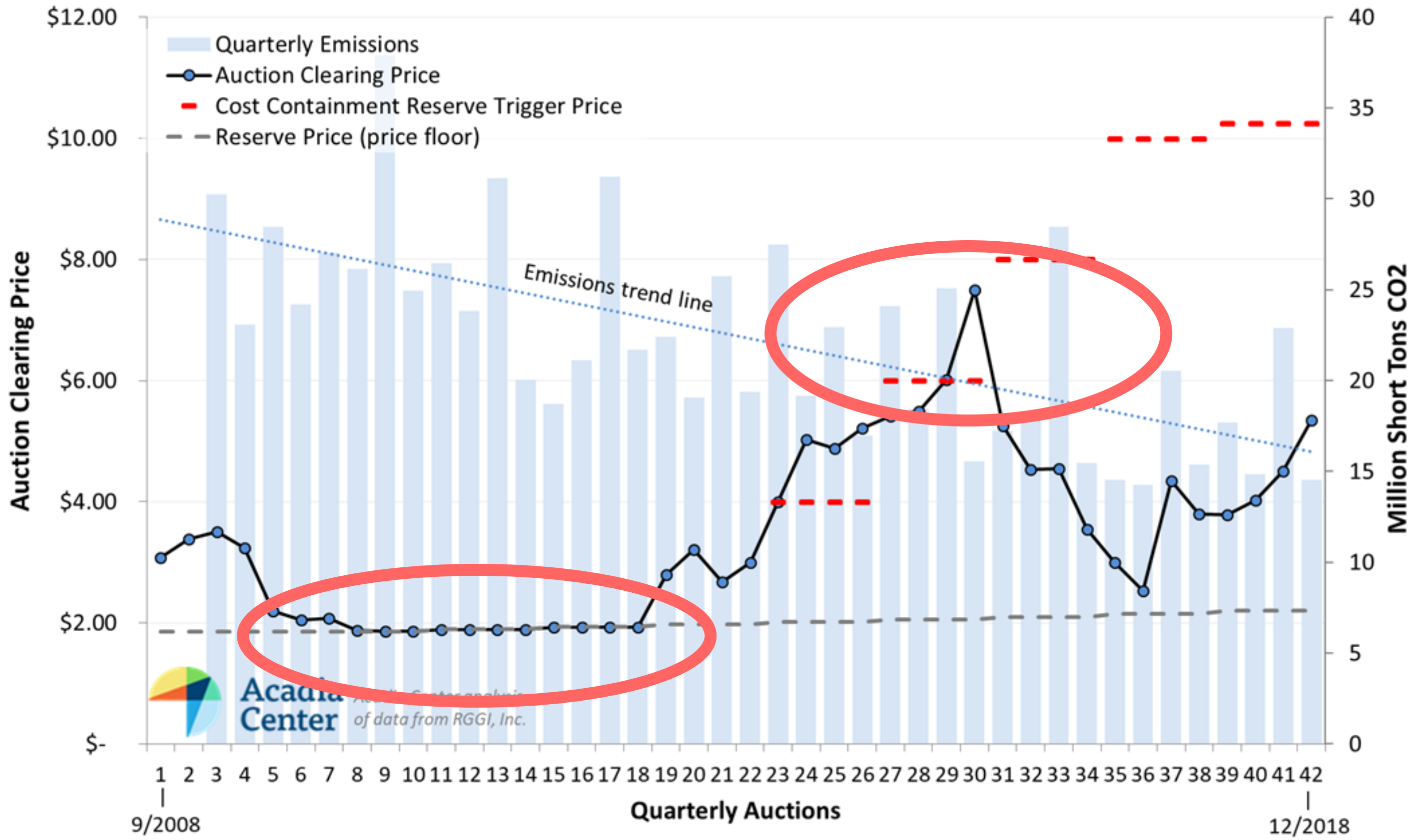


RGGI Distribution of Asset Value

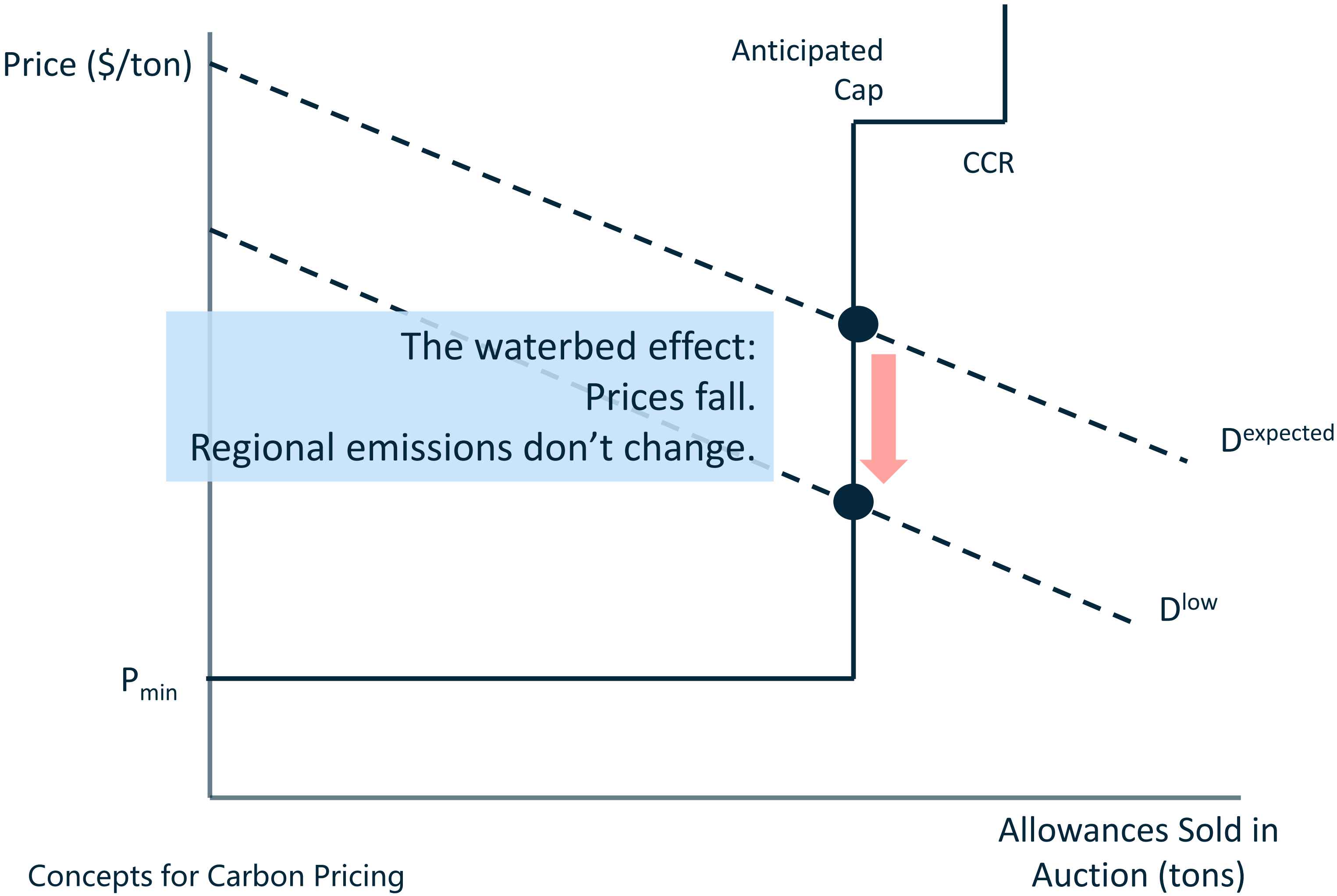


Note: This figure shows distribution of allowances for 2008-2014. Auctions began in 2008 and compliance began in 2009. State set-aside allowances and allowances unsold at auction are not included.
Source: RGGI, Inc. 2014 Proceeds Report.

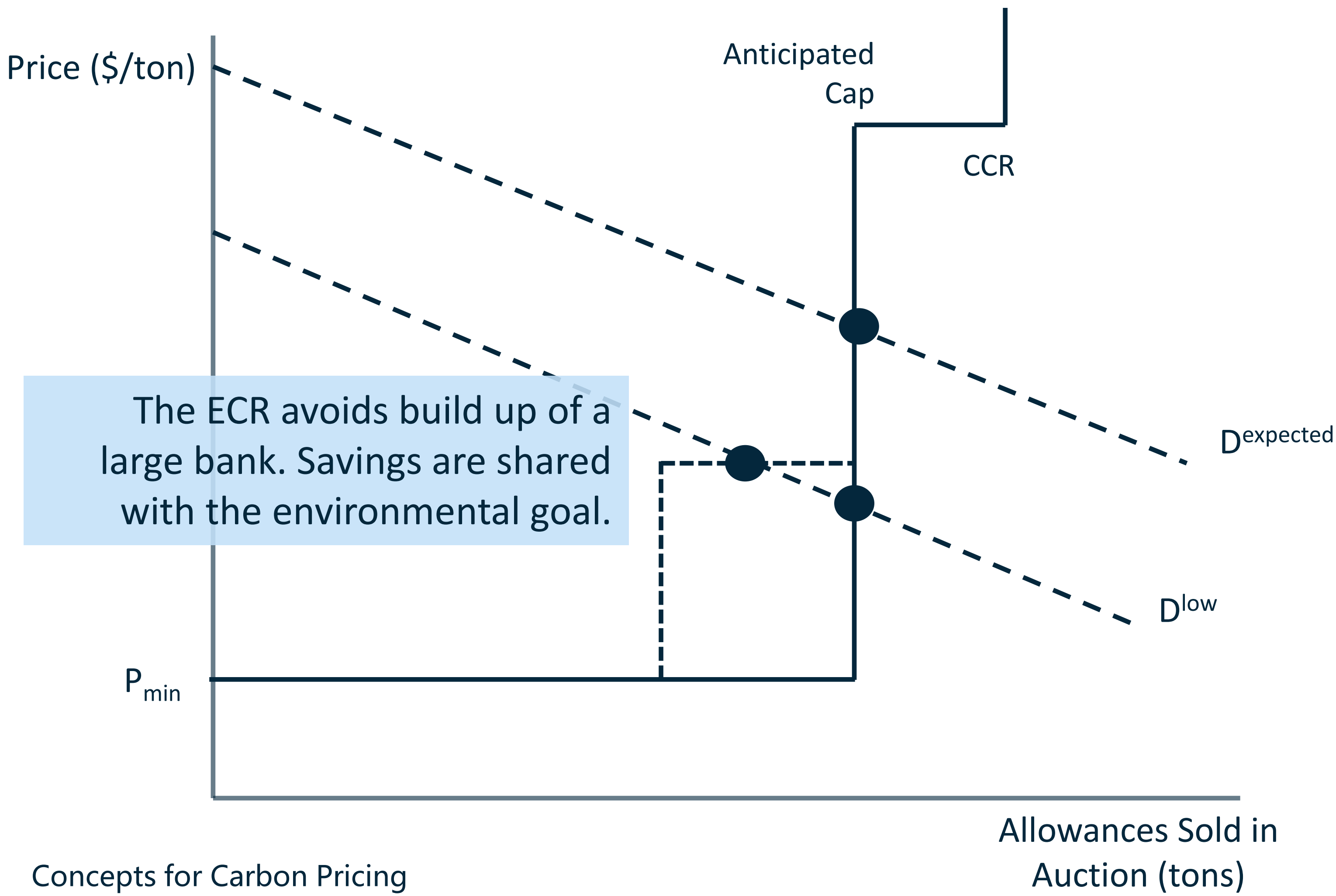
RGGI's Price Floor Was Crucial



A Supply Schedule *without* the Emissions Containment Reserve (ECR)



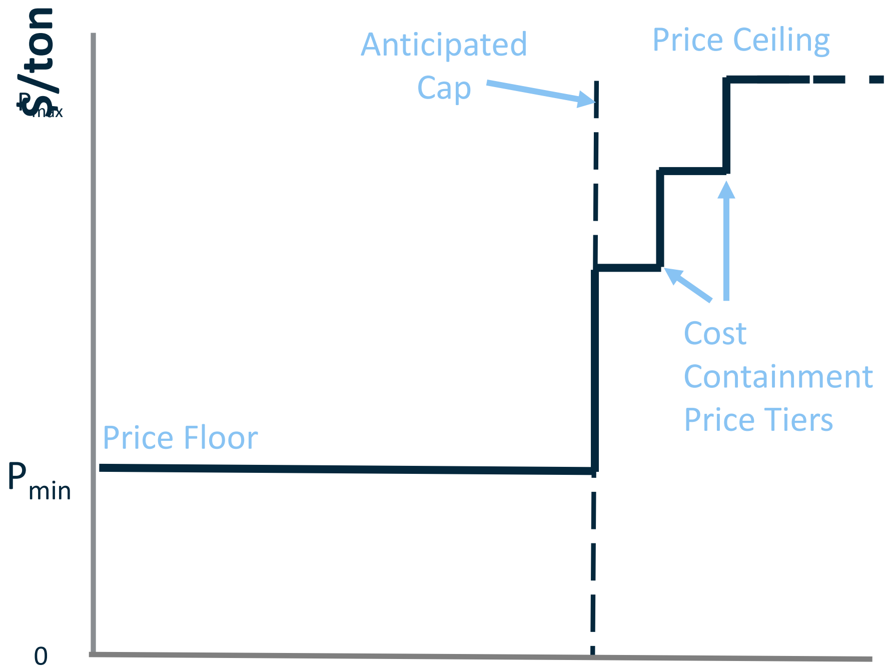
A Supply Schedule *with* the ECR



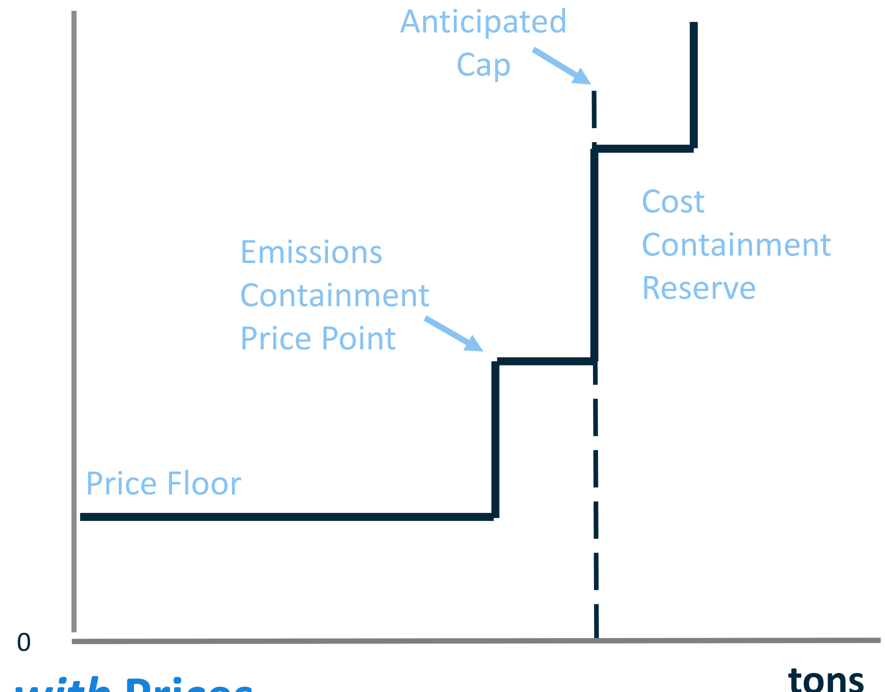
The ECR avoids build up of a large bank. Savings are shared with the environmental goal.

The New Model:
Supply in North American Carbon Trading Programs

Western Climate Initiative
(California and Quebec)



RGGI



Quantities *with* Prices

Note role for consignment auctions with free allowances

5. Leakage Issues

- Leakage refers to the change in **emissions** outside the jurisdiction.
- Leakage can significantly reduce the efficacy of a policy by relocating emissions rather than removing them
- For example, if New Jersey has a carbon price through RGGI and Pennsylvania does not, then this could cause emissions in Pennsylvania to increase
- The higher the carbon price, the greater the potential problem
- **Price** leakage also may occur, where the electricity price in a neighboring jurisdiction goes up due to changes in the wholesale market

Is Leakage Important?

- Existing programs such as RGGI monitor leakage closely
- If leakage exists, it undermines cost effectiveness, but at typical low carbon prices, programs remain cost effective relative to the social cost of carbon
- Leakage does not undermine other interests of leading jurisdictions to propagate program design and promote technology innovation

Program Design Plays a Role

- Investment of allowance proceeds in energy efficiency (RGGI) or other technologies reduces leakage
- Output based allocation (free allowances) to generators provides a production incentive that mitigates leakage
  - OBA can promote specific technologies
  - Negative leakage is possible, by expanding in-state generation that is covered under the cap
  - But, OBA uses auction proceeds that could be used for other purposes
- Border adjustments are also possible
  - CA’s first jurisdictional deliverer in day-ahead market
  - Energy Imbalance Market ‘true-up’

6. Some Key Takeaways

- Most economists argue that carbon pricing is imperative for least-cost transition
- Empirically, carbon pricing can co-exist with companion policies
- Addressing climate change likely involves a substantial *expansion* of the electricity sector
- A crucial design feature is the distribution of asset value into the economy
- An emissions **cap** is an emissions **floor** unless the waterbed effect is explicitly addressed
- The innovations in RGGI may offer an enduring model that addresses both quantities and prices of reductions

Thank you.

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Examples of State Policies under RGGI's Cap

- New York: 100% of electricity from clean sources by 2040
- Maryland: 40% reduction in GHG emissions economy-wide below 2006 by 2030, 50% renewable energy by 2030.
- Massachusetts: within-state cap-and-trade program to reduce carbon emissions from electricity by 80% from 2018 to 2050

➢ RGGI recently completed its second scheduled program review
  - State policies have enabled "adjustments" to the cap
  - RGGI proposed an Emissions Containment Reserve – a soft price step above the hard price floor