Designing Cap and Trade Incentives

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Environment Canada

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Cap and Trade Is a Specific Design?

1. **Climate externalities:**
   - Climate costs omitted by market.
2. **Consumer myopia:**
   - Consumers ignore future energy costs.
3. **Advanced research externalities**
   - Business invests too little.

Cap and Trade was designed to fix a specific problem: problem #1.

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Known Designs:

- A **carbon tax** is know to be the best design. It's twice as broad, and more constant over time, than cap-and-trade credit prices.
- **Standard cap** and trade, is a political compromise, but optimal except for the two noted problems.
- **Widget-intensity cap and trade** is a further compromise, and lacks a validated design. (Province-wide targets come close.)

Widget intensity is not carbon intensity, which means tonnes / GDP. A government report correctly identifies the proposal as widget intensity. Some businesses make more than one type of widget—a problem.

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Rigorous analysis of Problem & Designs

- Designs can be checked with rigorous economics.
- A carbon tax, has been proven efficient
- Standard cap and trade has been proven equivalent to a (fluctuating) carbon tax for the sectors it covers.
- Federally proposed targets have been proven inefficient (wasteful) relative to either of the above.
- A province-wide intensity target has been proven equivalent, on the production side, to standard cap and trade within provinces. However, like all intensity caps, it fails on the consumer side.

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The Main Goal and Main Principle

- **The Goal: minimize cost** of any given level of achieved abatement (economic efficiency).
- **The Principle** (to achieve the goal): Use a uniform incentive (normally the credit price).
- Uniform means:
  - Everywhere
  - By every party
  - By every method
- This is what a correct carbon price would do.
- This is what markets do (see appendix).

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The Law of Inefficiency

With a non-uniform incentive, money will be wasted.

(The present intensity-cap design does not provide uniform incentives.)

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The Electricity Market Meets the Carbon Credit Market

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In Alberta, caps work through the market

- Low "Targets" ☐ Low cap
  - ☐ High permit price
  - ☐ Low profits for coal
  - ☐ Less coal used, and
  - ☐ No new dirty coal plants built.
- It's not that companies want to hit the target.
- And they won't.
- The cap will hold, because some are over and some under. That flexibility is the point.

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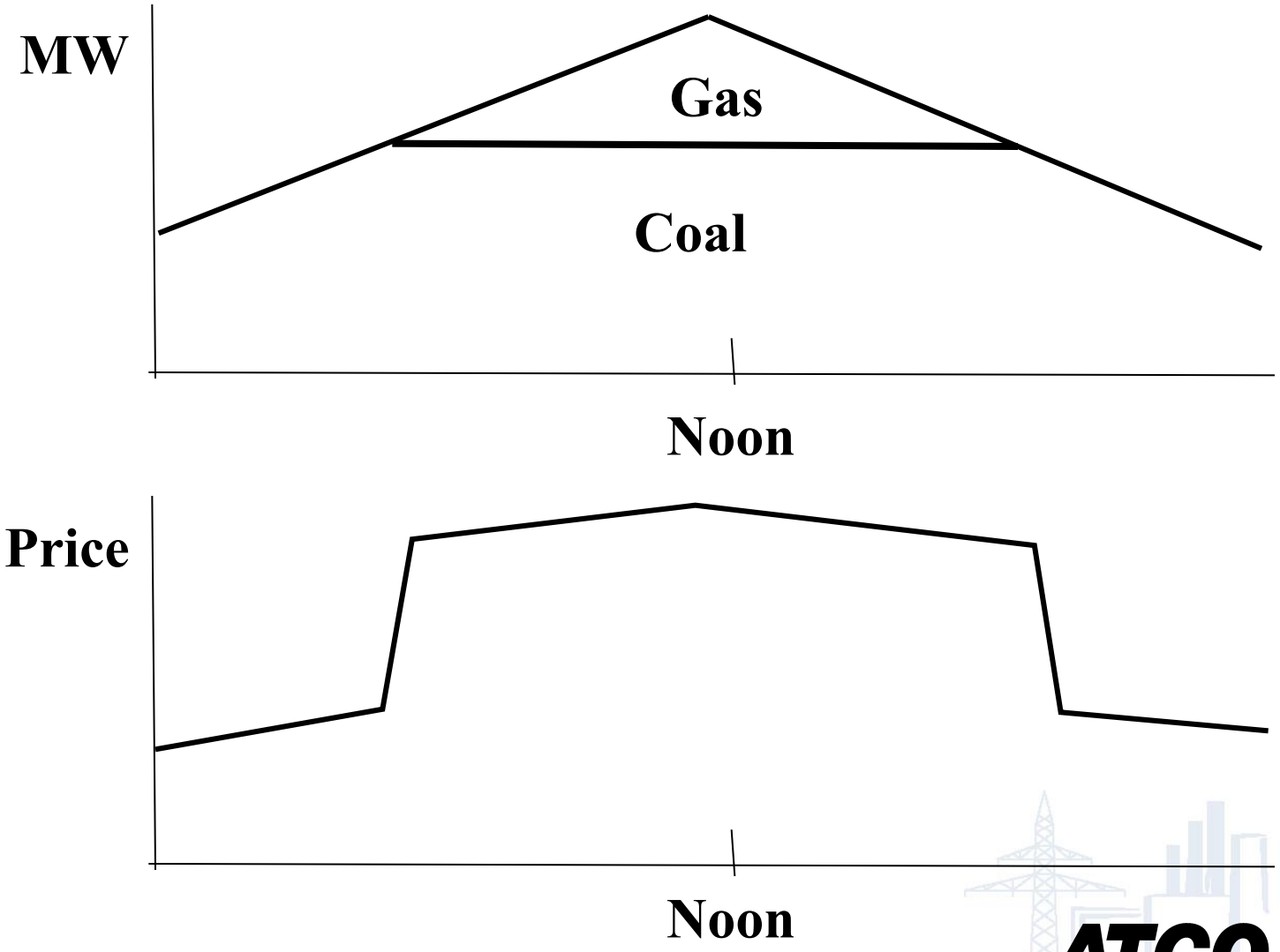
Daily Electricity Market



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Daily Electricity Market

- Electricity from gas costs more per MWh (just for the fuel), so gas charges a higher price.
- But all electricity gets the same price
  - (Market law of 1 price, Jevons, discovered 1876.)
- Coal breaks even when it's setting price, but makes a "profit" to cover the cost of the coal plant when gas sets price.
- Gas breaks even when it sets price.

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Daily Electricity Market

- These prices make sure the right plants run at the right times.
- These prices also get the right plants built.
- Prices induce ☐ the least-cost fleet, and
  ☐ least-cost production

One price for electricity. One incentive carbon. That's a market-based approach.

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How Credits Affect Electricity Prices

- Power producers think of a carbon tax or standard carbon credits as an increase in the fuel cost.
- The electricity price is basically the fuel cost of the most expensive unit running.
- Electricity price = fuel cost + carbon tax
- All the prices change. Does the market still dispatch the right plants and build the right plants?

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How a $30/tonne Carbon Tax Works

- It raises the cost of gas by $15/MWh.
- It raises the cost of coal by $30/MWh.
- So coal costs $30 more and earns $30 more when it is setting price.
- And, costs $30 more but earns $15 more when gas is setting price.
- It makes a lot less profit, during the only time it makes a profit, when gas is setting price.
- That's the whole point of the carbon tax.
- But, ouch.

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How a $30/tonne carbon credit works (1)

- Assume some or all of carbon credits are given out for free under a standard cap & trade scheme.
- Same thing happens: prices up $30 and $15
- Even though the credits are free!
- People used to forget this.
- If a coal producer gets 100 tonnes per day of credits for free and uses all 100,

  the producer still asks: "If I made one more MWh how much would it cost me?"
- The answer is still "cost of coal + $30."

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How a $30/tonne carbon credit works (2)

- So coal is paid $30 more than before when it sets the price, and $15 more than before when gas sets the price.
- But it doesn't have to pay any tax.
- And it doesn't have to pay for all the credits.
- Hmmm. That sounds OK.
- That can offset lost profits of coal.

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How a $30/tonne carbon credit works (3)

- Can standard cap and trade work?
- Yes.
- Electricity costs more, so consumers buy less.
- Because the price gas goes up less than the price of coal, there is some shift to gas.
- If grandfathering is done "right" then cap-trade provides the same incentive for new clean coal plants, as a carbon tax.

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How a $30/tonne carbon credit works (4)

- What's the "right" way to grandfather.
- Always make sure grandfathering (fairness rules) provide no incentives.
- Here's how.
- Dear grandfather,
  - You will get X credits the first year, and if consumers do Z you will get … [design it any way you want, provided …
  - grandfather can do nothing to change the value of the grandfathered credits.

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How a $30/tonne carbon credit works (5)

- Since grandfather cannot affect his payments, the payments won't cause him to do something tricky to increase the payments.
- In particular, if the plant shuts down, the payments must continue till some predefined termination date.
- Otherwise, the plant will stay open to collect the payments.

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Market Summary

- It gets complicated quickly, so keep the design simple
- Separate the two big problems.

  1. Efficient uniform incentives for efficiently saving carbon and producing electricity.
  2. Grandfathering / fairness considerations.

- By "separate," I mean that the grandfathering part contains parameters that can be adjusted achieve any fairness compromise without affecting incentives.
- The fight over #2 can easily wreck #1

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Widget Intensity Cap and Trade

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Widget-Intensity Design Overview

- No incentives for consumer conservation.
- "Targets" are a euphemism for free allocated credits.
- Free allocation is tied to production so it can
  1. easily distort incentives, and
  2. distort the cap.
- This distortion can be removed with uniform (provincial) targeting.

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Targets = Free Credits

- Target Rule: If you need more than Q×T credits you must buy them, and if you need less, you can sell the extra. Q×T is your carbon target.
- Free-Credit Rule: You get Q×T credits for free. If you need more, you must buy them, and if you need less, you can sell your extra credits.
- There is no real difference between the Target Rule and the Free-Credit Rule.
- Targets are just free credits.
- This is not good or bad, I just point it out because …

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It Helps to Think about Free Credits

- No one tries to "hit the targets."
- Companies want to make profits.
- Many things are easier to understand by thinking about "free credits."

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How Intensity Credits Work (an exampled)

- Say a gas plant has a target of 0.8 t / MWh.
- Say its intensity is 0.5 t / MWh.
- Then every time it generates 1 MWh, it receives 0.3 t of credits that it does not need.
- If the credit price in Canada is $30 / t, this is $9/MWh.
- Competitive gas plants will bid down the price of electricity by $9/MWh when gas is setting the price.
- Consumers buy more, not less.

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Credits for Intensity Reduction

- If a plant reduces its intensity, then it emits less carbon for the same MWh produced.
- It gets the same number of credits,
- But for each tonne of GHG reduction it has one more credit to spare:

$$\Delta C = \Delta G_I$$

Increased credits = GHG reduction,
for an intensity reduction.

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Credits for Fuel Switching (1)

- A coal plant produces 2 MWh more, and emits 2 tonnes more.
- A gas plant produces 2 MWh less, and emits 1 tonne less.
- Suppose the required intensity reduction is 20% for both, to 0.8 for coal, and 0.4 for gas.
- The coal plant needs 0.4 fewer credits, and the gas plant needs 0.2 more credits.
- The net reward for saving 1 tonne is 0.2 credits.

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Credits for Fuel Switching (2)

The general rule for fuel-switching credits is

$$\Delta C = R\, \Delta G_F,$$

where R = required reduction, e.g. 20%.

increased credits = R × (GHG reduction)

for Fuel Switching.

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Changing Intensity & Fuels

$\Delta C = \Delta G_I + R\,\Delta G_F$

This is a non-uniform incentive (not efficient)

say, R = 20%, and $\Delta C = 100$

100 = 100 + 20% × 0 ☐ 100 tonnes saved

100 = 80 + 20% × 100 ☐ 180 tonnes saved

100 = 110 – 20% x 50 ☐ 60 tonnes saved

All 3 strategies gain exactly the needed 100 credits.

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How the Cap Can fail

- Suppose coal plants cannot reduce intensity—it's too expensive.
- Say gas co-gen plants can by curtailing output (true).
- Coal will be desperate, so it will offer to buy credits from gas. It will pay enough to get gas to curtail enough that its decreased intensity frees up the credits coal needs.
- The result will be more CO_2, but both gas and coal will comply with their reduced intensity targets.

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Intensity Incentive and Caps

- Because saving carbon in different ways reduces needed credits by different amounts,
- The effective cap will vary according to the strategy of the participants.
- Non-uniform incentives will call carbon abatement to be more expensive than necessary.

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Fixing Widget-Intensity Cap-&-Trade

Overview of the Efficient Design[32]

- To make the cap firm, and
- to minimize abatement costs,
- incentives must be equalized across all methods of GHG reduction.

- This was the whole point of Cap and Trade to begin with.

☐ Equalize all "targets," because targets provide part of the incentive.

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Fleet-Based: Better and Worse

- Within a fleet, whether a tonne of GHG is saved by fuel-switching on intensity-changing, the fleet gains 1 carbon credit.
- All forms of abatement have the same reward per tonne saved, within a fleet.
- Within-fleet savings are (1) efficient and (2) do not break the cap.

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Between Fleets: The Hydro Game

Fleet 1 = 90 MWh at intensity 1.0

Fleet 2 = 40 MWh at intensity 0.0

Everyone must reduce intensity 10%

Fleet 1 buys 10 MWh from Fleet 2.

Fleet 1 = $(90 \times 1.0 + 11 \times 0)/100$

$= 90/100 = 90\%$

The credit requirement is satisfied, but GHG did not change at all.

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Variations on the Hydro Game

- Suppose fleet, A, has intensity 1.0.
- Another, B, of the same size is half 0.5 and half intensity 0.0. The fleets are equal size.
- If fleet B sells its "0.5" capacity to fleet A,
- then fleet A's average intensity will fall to 0.83 and fleet B's average intensity to 0.

- Both have improved, but nothing happened to CO_2 emissions.

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Variations on the Hydro Game (2)

- If the required intensity reduction was 20%,
- And the fleets were both size 100, then
- Fleet A will need

  $150 \times .833 - 150 \times 0.8 = 5$ credits
- Fleet B will have an extra

  $50 \times 0.2 = 10$ credits
- Fleet B can then sell 5 credits to A, and 5 credits to the oil industry, thereby effectively reducing their cap.

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Difficult to Fix

- It seems difficult to stop this game by patching the flawed design.
- It is impossible to stop companies from buying and selling generation.
- If the sell their generation, they can no longer be evaluated as owning it when they can no longer control it.

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Provincial-Based Intensity Cap-&-Trade

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A Non-Gaming Approach

- Correctly designed economic mechanisms, cannot be gamed.
- Uniform provincial targets fix all problems within the province:
  - Minimize cost in the province
  - Maintain the cap in the province
- Work for inter-provincial trading.

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Provincial Product Standard

- All facilities, or fleets (no difference) have the same intensity target T.
- Let T_0 = the provincial intensity in ~2006
- Let IR = intensity reduction: 18%, –2%, …
- All plants (fleets) need credits:

$$C = Q \times I - Q \times T_0 \times (1 - IR) = \text{GHG} - \text{target GHG}$$

- This covers coal, gas, hydro, …

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Provincial Targets, or a Canadian Target?

- Two approaches.
  1. Provincial T, and align inter-provincial incentives.
  2. Canadian T, and reverse inter-provincial flows.
- Number 1, requires very little information and it is easily attainable. Beyond gathering this information, implementation is trivial.

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Inter-Provincial Incentives

- Inter provincial power transfers are a matter of public record and are measured quite precisely. Between any pair of provinces only a single number per years needs to be collected.
- A good incentive can be implemented simply by annually adjusting each provincial target.
- The calculation is trivial.

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Inter-Provincial Formulas

- If BC has intensity target I_{BC}, and exports E MWh to Alberta, with intensity target I_A, then

  $$C = (I_A - I_{BC}) \times E$$

  credits are transferred from BC to Alberta.
- If Alberta's output was Q_A and BC's was Q_{BC}, then the Provinces targets are changed the next year by

  $$T_{BC} \square T_{BC} + C / Q_{BC}$$
  $$T_A \square T_A - C / Q_A$$

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Benefits of a Provincial Target

- The cap is secure.
- For producers, the incentives are efficient.
  - ☐ abatement is least cost.
- Inter provincial wealth transfers are small, and these are due to power transfers that save carbon.
- The "targets" are simpler.
- New-fuel standards and funny retirement rules disappear.

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Fairness and Grandfathering

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Fairness Overview

- Abatement incentives will discourage dirty coal, by reducing its profitability.
- Careful grandfathering allows fairness transfers without any disruption of incentives.
- This is not difficult, but requires determination and attention to details.

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Grandfathering Under Various Systems

Carbon tax, normal, or intensity-based caps:

- All have the same fairness problems and the same need of grandfathering.

- If there is ***anything*** that can be done by the recipient to affect grandfather payments, incentives will be distorted.

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How Does Grandfathering Work?

- Normal Cap-Trade
  - ☐ Cost of credits passed through
  - ☐ Grandfathering = free credits
- Intensity Cap-Trade
  - ☐ Credit costs not passed on.
  - ☐ Grandfathering = let some costs pass on.

- Grandfathering under an intensity-based system is done by given out some credits that are not intensity-based, that are based on historical information.

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Who Needs It Most?

Highest priority at the top:

1. Coal built under regulation, but that has not reached its accounting life.
2. Coal built under regulation, but not ready to retire.
3. Gas or post-Kyoto coal (built to clean-as-gas standard)
4. Any grandfathering over about 20—30% should be handed out evenly.
5. Plants built after 2006 should not be eligible.

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Rationales for Need

- Coal will be hurt most.
- PPA holders said they took this risk into account when they bid low (1999).
- Plants built since then, should have been at least as aware of this risk.
- The older a plant, the shorter the duration of grandfathering required as it's been partially paid off (for plants built under regulation).

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Consumer Incentives

- Under intensity-based cap, the more grandfathering, the better the consumer incentives.
- Under a normal cap, if grandfathering is diluted with intensity-based give-aways, consumer incentives are reduced.
- With a normal tax or a carbon cap, consumer incentives are maintained if some credits or revenues are returned to consumer.

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Impact of Grandfathering on the Cap

- An incentive cap can be perfectly maintained, if the grandfathering is adjusted for load growth.

- If normal cap and trade uses some intensity credits to dilute grandfathering, it partially turns into an intensity cap instead of an absolute cap.

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Appendix

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Why a Uniform Incentive Is Efficient

- With each abatement method,
  the more you do the more expensive it gets.
- The first coal plant replaced is old, the last is new.
- Example: Two methods and their $ / tonne cost:
  - Method A: $2, $2, $5, $10, $20
  - Method B: $2, $4, $8, $16, $32
- Uneven incentives GHG Credits $1 for A, $5 for B
  - ☐ 2 tonnes for $6
- Uniform incentive GHG Credits $3 for all methods:
  - ☐ 3 tonnes for $6
- A uniform price always picks the cheapest selection of methods.

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