Appendix A

Moving the Coal-posts: Ottawa's Wrong Turn on Carbon Pricing for Electricity Generation

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Example of Dispatch Decision for a Plant with GHG Emissions

Consider the profit condition (π) for the operator of a power generation facility generating Y MWh of output with per MWh variable operating costs (c_{Op}) and fixed costs (c_{Fixed}), as well facing an per MWh electricity price (p_E). In addition, the plant will pay a carbon price (p_{GHG}) on its GHG emissions (E). Under an output-based pricing system the plant also receives an allocation of carbon credits at the benchmark emissions intensity (I_{OBS}) proportional to its output (Y).

The profit equation for the plant is then as follows:

$$\pi = p_E Y - c_{Op} Y - p_{GHG}(E - I_{OBS} Y) - c_{Fixed}$$

The plant's total emissions (E) will be equal to the plant's emissions intensity in CO_2-equivalent tonnes per MWh (I_{Plant}) multiplied by the plant's output (Y) – that is:

$$E = I_{Plant} Y$$

Substituting this into the profit equation yields:

$$\pi = p_E Y - c_{Op} Y - p_{GHG}(I_{Plant} - I_{OBS}) Y - c_{Fixed}$$

In this equation, the average carbon price paid for the plant's emissions will be the plant's total carbon costs (after adjusting for the output-based carbon credits) divided by its total carbon emissions. This will be:

$$\frac{p_{GHG}(I_{Plant} - I_{OBS})Y}{I_{Plant} Y} = p_{GHG}\left(1 - \frac{I_{OBS}}{I_{Plant}}\right)$$

For the dispatch decision, assume that fixed costs are sunk. An operator seeks to maximize profit from producing power by dispatching the plant whenever the electricity price exceeds the plant's marginal cost of generating power – including its costs for GHGs. Differentiating the profit equation with respect to output yields the condition for maximizing profit:

$$\frac{d\pi}{dY} = p_E - c_{Op} - p_{GHG}(I_{Plant} - I_{OBS}) = 0$$

Based on the "merit order" for a competitive power market, plants will be dispatched in order of their offers up to the demands from loads in the power market. The operator should offer the plant's capacity into the power pool at an offer (O) equal to its marginal cost of producing power in order. A plant will only be dispatched when the electricity price is equal or greater than the plant's offer (i.e., $P_E \geq O$). Substituting O for p_E in the profit

maximization condition and reorganizing yields the equation for the operator's offer into the power market:

$$O = c_{Op} + p_{GHG}(I_{Plant} - I_{OBS})$$

That is, the operator would want to produce power any time the market price is greater than its operating and carbon costs per unit of output (MW).

For the short-run decision by an individual operator about dispatching a plant, the operator's offer into the power pool should rise in proportion to the difference between a plant's emission intensity and the output-based standard. Put another way, the output-based allocation reduces the operator's offer into the power pool relative to its offer if facing the economy-wide carbon price.

Investment Decision to Improve GHG Emissions Intensity

The output-based allocation should not distort an operator's decision to invest in technology that reduces a plant's emissions intensity. To see this, consider the profit condition when investing in such technology at a cost (c_{Tech}) to reduce a plant's emissions intensity from high (I_{High}) to low (I_{Low}). For this decision, the profit incentive to make such an investment is then the difference in profits ($\Delta\pi$) for the operator introducing the new technology, holding all other variables constant.[1]

This difference in profits will be between profits in the state with low GHG emission intensity (π_{Low}), less the cost of the technology (c_{Tech}) and the profits in the counterfactual with the high GHG emission intensity (π_{High})

$$\Delta\pi = \pi_{Low} - c_{Tech} - \pi_{High}$$

Substituting in the above equation for profits in the each of the Low and High emission intensity states:

$$\Delta\pi = \left(p_E Y - c_{Op} Y - p_{GHG}(I_{Low} - I_{OBS})Y - c_{Fixed}\right) - c_{Tech} - \left(p_E Y - c_{Op} Y - p_{GHG}(I_{High} - I_{OBS})Y - c_{Fixed}\right)$$

Cancelling terms and simplifying:

$$\Delta\pi = p_{GHG}(I_{Low} - I_{High})Y - c_{Tech}$$

Since I_{OBS} is absent from the ultimate profit condition, the output-based allocation therefore does not distort the decision to invest in the emission intensity-reducing technology.

1 It is feasible that reducing GHG emissions could also improve a plant's ordering on the merit order curve and thereby result in the plant being dispatched more frequently – and therefore generating greater output. This would enhance the profit incentive for investing in the technology that reduces emissions intensity. However, this nuance is not relevant to showing that the output-based standard does not distort the investment decision.