Relative Cost-Effectiveness of Electricity and Transportation Policies as a Means to Reduce CO_2 Emissions in the United States: A Multi-Model Assessment

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1. Motivations underlying the research

Given the absence of comprehensive federal climate policy in the form of economy-wide emissions pricing, climate policy in the United States is effectively defined by a collection of energy policies and measures at the federal, state and local levels. Two common energy policy instruments are tax incentives and technology standards. Although such instruments have been shown to be less cost-effective as a means to reduce CO_2 emissions than other policies, such as economy-wide carbon pricing, it can be challenging to compare the costs of CO_2 emissions reductions associated with such policies across sectors. This difficulty arises because of the wide range in estimates and inconsistencies in how such estimates are constructed for any given policy.

This study fills the gap identified above by comparing the cost-effectiveness of several US energy policies across the electricity and transportation sectors in terms of CO_2 reduction using a common framework and approach. Specifically, it considers wind and solar tax credits, a renewable portfolio standard, a renewable fuel standard, and an electric vehicle tax credit. It relies on three well-known, publicly available US energy system models (NEMS[f], ReEDS, GCAM-USA) incorporating up-to-date information about technology cost and performance to compare policy costs and examine robustness to the choice of model. The use of more recent cost and performance information relative to prior studies is particularly relevant in light of rapid technology advancement in some sectors.

2. A short account of the research performed

The models used in this study (EM-NEMS, ReEDS, GCAM-USA) are extensively documented, publicly available US energy system models that have been used in numerous climate and energy policy analyses. In the case of wind and solar tax incentives, the extension case extends the existing tax credits at their historical maximum value through 2050 (the production tax credit of 2.3 cents per kWh for onshore wind and the investment tax credit of 30% for solar). Similarly the EV tax credit extension extends the full applicable subsidy based on battery size up to $7,500 per vehicle to all new electric vehicle purchases (although this subsidy does not apply to HEVs without plugs). In the expanded RFS case, total biofuel volumes are increased to approximately 34 billion gallons in 2050, with most of the increase assumed to come from advanced biofuels. The expanded RPS case envisions a domestic policy environment in which at least some US states increase stringency beyond what they have already enacted. To avoid having to make judgments about which states enact which particular changes, the expanded RPS case is implemented by layering a single national RPS with unrestricted interstate trading on top of existing state RPSs. The national RPS increases the share of renewable sources in national electricity generation from about 40% in the Reference Case to roughly 50% in the expanded case by

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f NEMS refers to the National Energy Modeling System developed and maintained by the US Energy Information Administration (EIA): https://www.eia.gov/outlooks/aeo/nems/documentation/. In what follows, we will use the term EM-NEMS to refer to the version of the model used in this study to distinguish it from EIA's version.

2050. In addition to the four cases discussed above, several economy-wide carbon tax cases were evaluated. Specifically, four cases were run with carbon taxes starting at \$5, \$10, \$20 and \$40 per ton CO_2 in 2022 and rising at 5% per year in real terms. These trajectories were selected in order to understand how cost varies with stringency and to provide several points that would enable construction of the economic "efficient frontier".

3. Main conclusions and policy implications of the work

Results from this study confirm that the sectoral policies evaluated are less cost-effective as a means to reduce CO_2 than an economy-wide carbon tax and that the transportation policies evaluated are less cost-effective than the electricity policies. In addition, it is notable that the sectoral instruments considered, to the extent that they extend or modestly expand existing polices with national scope, do not achieve annual CO_2 reductions greater than ~200 $MtCO_2$ per year on average over the projection period. This suggests that more expansive policy would be required to achieve CO_2 reductions consistent with stated national policy goals. Our results also provide several insights about existing sectoral policies that are relevant as refinements and modifications to such policies are considered. First, we find that the current wind and solar tax credits strongly favor wind over solar, because the solar ITC applies to capital costs, which have decreased significantly in recent years. Second, despite known inefficiencies, renewable energy policies in the electricity sector are less costly than earlier estimates due to recent and expected future technology advancement. Third, in transport, we find that expanding advanced biofuel targets in the RFS by the amounts assumed here would be more cost-effective than extending the EV tax credit under plausible assumptions. Fourth, we find a significant rebound in fuel economy under the EV tax credit extension, such that there is a smaller increase in fuel economy of conventional vehicles when the LDV fleet electrifies. This effect tends to further increase the cost of the EV tax credit extension, all else equal. Finally, we find that the change in policy cost over time varies by policy and model, although the cost ordering among polices does not change when different timeframes are considered.