Section 1: Overview
Concern about the costs of climate change motivate researchers to study public policy options for reducing greenhouse gases. A tax or price on greenhouse gas emissions is one way to incorporate the costs of emissions into commodity prices and economic decision making. Lawmakers in the United States (U.S.) are considering a national carbon price as part of the country’s climate change strategy. This paper presents estimates of short run impacts of a carbon price on the electricity industry using a cost-minimizing mathematical model of the U.S. market, with power plant-level data plus demand and transmission constraints that match the country’s regional electricity market structure. Carbon policy impacts are also analysed at the state level to provide insights for U.S. legislative representatives elected by citizens from their respective states.

Section 2: Context
U.S. carbon policy would likely cover emissions across much of the economy. Several economy-wide studies already have considered economy-wide impacts, however their wide coverage is done at the expense of more detailed analysis on individual industries. Electricity production causes more greenhouse gas emissions than any other sector, so it is important for policymakers to understand detailed effects of carbon policy on this industry. Most electricity and carbon policy research has modelled long run effects decades into the future. It is of course important to study long run effects of policy. However, significant uncertainty exists in these estimates, leading to divergent conclusions across studies with similar scopes. Furthermore, these models often give up short-term granularity for long-run coverage. Policymakers are rightly concerned with both long- and short-term effects of new laws, especially given short run election cycles in the U.S. This study provides a timely contribution given the growing discussion around carbon policy and proposed legislation in the U.S. congress.

Section 3: Research Results
Prices of $25 and $50 per ton of carbon dioxide equivalent emissions cause modelled electricity emissions reductions of 17% and 22% from present levels, respectively. This suggests significant electricity sector emissions impacts can be achieved relatively quickly from a modest carbon tax, and diminishing marginal reductions occur when increasing from $25 to $50. The model captures short run effects via operational changes at existing U.S. power plants, mostly by switching production from coal to natural gas, and does not consider long-run changes to the capital stock via retirements and new power plant installations. A state-level analysis yields the following modelled conclusions: 1) states which reduce the most emissions are high-coal consumers in the Mid-Atlantic and Midwest regions, 2) 15 states increase emissions after carbon policy because they increase natural gas consumption to offset coal decreases in neighboring states, and 3) a flat per-capita rebate of tax revenue will lead to wealth transfers across states.

Section 4: Conclusions
The paper presents results from a model of the U.S. electricity market built to estimate short run effects of a U.S. carbon price. The electricity market model captures short run operational changes to existing power plants caused by the carbon price. The majority of emissions reductions come from decreased coal consumption replaced with increased natural gas consumption. The model keeps the electricity capital stock fixed. The results do not include additional long run emissions reductions due to increased investments in low carbon-emitting production and increased retirements of high-carbon emitting power plants. The model assumes inelastic, exogenous demand and does not capture long run emissions reductions from decreased demand. The model estimates that a $25/ton tax leads to 17% emissions reductions and a $50/ton tax leads to 22% reductions from current levels of electricity emissions. These are equivalent to approximately 4.9% and 6.3% reductions from economy-wide greenhouse gas emissions. The estimated emissions reductions from a $50/ton electricity industry carbon tax represent 21% of the U.S.’s 2025 voluntary commitment under the Paris Climate Accord, holding emissions from all other industries constant.