**Future carbon dioxide emissions emitted by the Pennsylvania electricity sector**

Created by Xiaodi "Daniel" Sun, Mike Griffin, and Ines Lima Azevedo.

*Introduction*

In 2016, the U.S. released its mid-century strategy for reducing carbon dioxide emissions by 80% of 2005 levels by 2050.[1] Deep decarbonization will reduce the effects of climate change, which include more frequent and intense heat waves, droughts, extreme weather events, and disrupted ecosystems [1]. Deep decarbonization will require significant changes to the electricity sector, as each state must change its fuel mix by relying less on fossil fuel and incorporating more renewables. Studies that analyze pathways to deep decarbonization all find that the fuel mix needs to shift dramatically towards renewables, requiring carbon capture sequestration and up to 70-90% electricity generated by renewables.[2–6] Pennsylvania is used as an illustrative case study, because Pennsylvania is less affected by climate change than many other states, is third in electricity generation and $CO_2$ emissions across all U.S. states,[7] and has recently developed the extensive infrastructure for unconventional natural gas production that is envisioned by some as a potential CCS sink. Additionally, Pennsylvania's nuclear fleet, which is a low carbon emissions fuel source and generates 38% of electricity in Pennsylvania, is expected to completely retire by 2049.[8]

In this tool, we explore carbon emissions from the Pennsylvania electricity sector as a function of electricity demand, fuel mix, and percentage of fossil-fuel electricity treated by carbon capture sequestration. We want people to understand what kind of changes the Pennsylvania electricity sector needs to undergo to meet ambitious deep decarbonization goals, such as reducing carbon dioxide emissions by 80% of 2005 levels by 2050.

*Methods*

We assume baseline demand in 2050 is equal to the amount of electricity generated in 2015, which is 220 TWh, because generation has fluctuated by about +/-5% from year to year in the last decade.[7] We set the lower bound of demand in 2050 to 150 TWh, because that is how much retail electricity was sold in 2015.[7] The lower bound reflects the scenario in which PA stops exporting electricity and only meets demand within the state. We set the upper bound of demand in 2050 to 480 TWh, which is the amount of electricity generated in 2015 plus the amount of fuel

consumed by the transportation sector in 2015. The upper bound reflects current demand plus all demand from the electrification of vehicles.

Carbon dioxide emissions in 2005 and carbon dioxide emission factors of coal and natural gas plants in 2015 are estimated using emission index data from Schivley et al.[9] On average, coal plants emit 2200 pounds carbon dioxide per MWh and natural gas plants emit 910 pounds per MWh. We assume all renewable

We assume carbon capture and sequestration captures 90% of carbon dioxide emissions from coal and natural gas plant, which is consistent with reported values used in other technical studies.[10]

*References*


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