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Technological learning for carbon capture and sequestration technologies

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Abstract

This paper analyzes potentials of carbon capture and sequestration technologies (CCT) in a set of long-term energy-economic-environmental scenarios based on alternative assumptions for technological progress of CCT. In order to get a reasonable guide to future technological progress in managing CO_2 emissions, we review past experience in controlling sulfur dioxide (SO_2) emissions from power plants. By doing so, we quantify a "learning curve" for CCT, which describes the relationship between the improvement of costs due to accumulation of experience in CCT construction. We incorporate the learning curve into the energy-modeling framework MESSAGE-MACRO and develop greenhouse gas emissions scenarios of economic, demographic, and energy demand development, where alternative policy cases lead to the stabilization of atmospheric CO_2 concentrations at 550 parts per million by volume (ppmv) by the end of the 21st century. We quantify three types of contributors to the carbon emissions mitigation: (1) demand reductions due to the increased price of energy, (2) fuel switching primarily away from coal, and (3) carbon capture and sequestration from fossil fuels. Due to the assumed technological learning, costs of the emissions reduction for CCT drop rapidly and in parallel with the massive introduction of CCT on the global scale. Compared to scenarios based on static cost assumptions for CCT, the contribution of carbon sequestration is about 50% higher in the case of learning, resulting in cumulative sequestration of CO_2 ranging from 150 to 250 billion (10^9) tons with carbon during the 21st century. Also, carbon values (tax) across scenarios (to meet the 550 ppmv carbon concentration constraint) are between 2% and 10% lower in the case of learning for CCT by 2100. The results illustrate that assumptions on

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