Gasification of coal and biomass: A net carbon-negative power source for environment-friendly electricity generation in China

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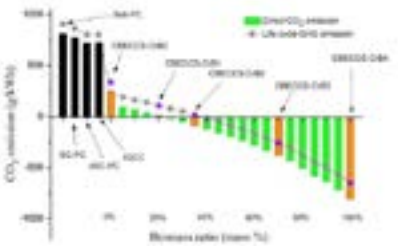
Realizing the goal of the Paris Agreement to limit global warming to 2°C by the end of this century will require most likely deployment of carbon-negative technologies. It is particularly important that China, as the world's top carbon emitter, avoids being locked into carbon-intensive coal-fired power generation technologies and undertakes a smooth transition from high- to negative-carbon electricity production. We focus here on deploying a combination of coal and biomass energy to produce electricity in China using an integrated gasification combined cycle system with carbon capture and storage (CBECCS). Such a system will also reduce air pollutant emissions, thus contributing to China's near-term goal of improving air quality. We evaluate the bus-bar electricity-generation prices for CBECCS with mixing ratios of crop residues varying from 0% to 100%, as well as associated costs for carbon mitigation and co-benefits for air quality. We find that CBECCS systems employing a crop residue ratio of 35% could produce electricity with net-zero life-cycle emissions of greenhouse gases (GHGs), with a levelized cost of electricity (LCOE) of no more than 9.2 US cents per kWh. A carbon price of approximately $52.0/ton would make CBECCS cost-competitive with pulverized coal power plants. Therefore, our results provide critical insights for designing CBECCS strategy in China to harness near-term air quality co-benefits while laying the foundation for achieving negative carbon emissions in the long run.



Recent Publications:

1. Xi Lu, Liang Cao, Haikun Wang, Wei Peng, Jia Xing, Shuxiao Wang, Siyi Cai, Bo Shen, Qing Yang, Chris P Nielsen and Michael B McElroy (2019) Gasification of coal and biomass: a net carbon-negative power source for environment-friendly electricity generation in China, PNAS 116(17):8206-8213.
2. Haikun Wang, Yanxu Zhang, Hongyan Zhao, Xi Lu, Yanxia Zhang, Weimo Zhu, Chris P Nielsen, Xin Li, Qiang Zhang, Jun Bi and Michael B McElroy (2017) Trade-driven relocation of air pollution and health impacts in China. Nature communications 8:738.
3. Xi Lu, Michael B McElroy, Wei Peng, Shiyang Liu, Chris P Nielsen and Haikun Wang (2016) Challenges faced by China compared with the US in developing wind power. Nature Energy 6:1.

4. Michael B McElroy, Xi Lu, Chris P Nielsen and Yuxuan Wang (2009) Potential for wind generated electricity in China, Science 325(5946):1378-1380.

5. Xi Lu, Michael B McElroy and Juha Kiviluoma (2009) Global potential for wind-generated electricity. PNAS 106(27):10933-10938

Biography

Xi Lu is an Associate Professor in the School of Environment at Tsinghua University. He has completed his PhD in John A Paulson School of Engineering and Applied Sciences at Harvard University in 2010. After then, he continued working at Harvard as a Postdoctoral Fellow, Research Associate and Lecturer until joining Tsinghua in 2015. His research interests emphasize study of the technical, economic, and environmental dimensions of low or zero carbon energy sources as a means to reduce emissions of greenhouse gases (GHGs) and air pollutants. He has published papers in Science, PNAS, Nature Energy, and Nature Communications on these topics. He has won the Chinese Government Award for Outstanding Self-Financed Students Abroad in 2010, selected in the One Thousand Program for Young Professionals in 2015, and received the National Science Fund for Excellent Young Scholars in 2017.

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