**China’s ability to achieve national energy objectives depends on coordination of infrastructure and policy initiatives**

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## Overview

China’s energy sector is the world’s largest coal consumer and as a result CO2 emitter. Decarbonizing its electricity production is central for China to achieve its greenhouse gas emissions mitigation target. Integrating variable renewable energy resources requires power system planning models that run at high temporal and spatial resolution. We extend the SWITCH model, a mixed-integer linear programming model, to analyze capacity and transmission expansion for China under key policy scenarios and simulate hourly operational constraints at minimal cost. A carbon price at $20/tCO2 will be needed to replace most coal-fired generation by hydro, nuclear, wind, and solar, with each providing 11%, 28%, 16%, and 2% of total power by 2030, respectively. A 19% increase of total power cost over business-as-usual is needed to stabilize the CO2 emissions from power generation as described its 12th and 13th five-year plan by 2020, a 80% of emissions reduction is feasible by 2050 with about 23% extra cost if China plans to do it from today. A 15% of current renewable portfolio standards are shown to be insufficient to meet the emission reduction targets by 2020 if no new policy introduced.

## Methods

The SWITCH model – a loose acronym for Solar, Wind, Hydro and Conventional generation and Transmission Investment model – is a modeling tool with which many energy scenarios and policies can be explored. It is a mixed-integer linear program whose objective function is to minimize the societal cost of meeting projected electricity demand with generation, storage, and transmission between present day and future target dates to 2030 and 2050. The optimization is subject to reliability, operational, and resource availability constraints, as well as both existing and possible future climate policies (Fripp, 2012; Nelson et al., 2012). This study adapts SWITCH model to China and integrate with China’s policies and targets.

## Results

We demonstrate a carbon price at $20/tCO2 will be needed to replace most coal-fired generation by hydro, nuclear, wind, and solar, with each providing 11%, 28%, 16%, and 2% of total power by 2030, respectively. A 19% increase of total power cost over business-as-usual is needed to stabilize the CO2 emissions from power generation as described its 12th and 13th five-year plan by 2020, a 80% of emissions reduction is feasible by 2050 with about 23% extra cost if China plans to do it from today. A 15% of current renewable portfolio standards are shown to be insufficient to meet the emission reduction targets by 2020 if no new policy introduced.

## Conclusions

By optimizing capacity expansion and hourly generation dispatch simultaneously, SWITCH is uniquely suited to explore both the value of and synergies among various power system technology options, providing policymakers and industry leaders with important information about the optimal development of the electricity grid. Analyses like this can help identify the least-expensive response to climate change, but concerted action will be needed to develop such a system, including ensuring that the cost of renewable technologies continues to fall, securing low-cost financing for renewable power, and developing markets for energy services that can smooth the variation in renewable output.

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