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Impacts of groundwater constraints on Saudi Arabia's low-carbon electricity supply strategy

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Abstract— Balancing groundwater depletion, socioeconomic development and food security in Saudi Arabia will require policy that promotes expansion of unconventional freshwater supply options, such as wastewater recycling and desalination. As these processes consume more electricity than conventional freshwater supply technologies, Saudi Arabia's electricity system is vulnerable to groundwater conservation policy. This paper examines strategies for adapting to long-term groundwater constraints in Saudi Arabia's freshwater and electricity supply sectors with an integrated modeling framework. The approach combines electricity and freshwater supply planning models across provinces to provide an improved representation of coupled infrastructure systems. The tool is applied to study the interaction between policy aimed at a complete phase-out of nonrenewable groundwater extraction and concurrent policy aimed at achieving deep reductions in electricity sector carbon emissions. We find that transitioning away from nonrenewable groundwater use by the year 2050 could increase electricity demand by more than 40% relative to 2010 conditions, and require investments similar to strategies aimed at transitioning away from fossil fuels in the electricity sector. Higher electricity demands under groundwater constraints reduce flexibility of supply side options in the electricity sector to limit carbon emissions, making it more expensive to fulfill climate sustainability objectives. The results of this analysis underscore the importance of integrated long-term planning approaches for Saudi Arabia's electricity and freshwater supply systems.

Index Terms—

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