Electric renewable energy systems

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Using the MESSAGEix-GLOBIOM model (Supplementary Note 2) and adding the new feature of inter-regional electricity trade into the model (Supplementary Note 3), we conduct a scenario analysis to assess the impacts of the planned UHVDC interconnection on global energy transition and climate change mitigation.

Renewable electricity trade differs between scenarios with capped interconnections and uncapped interconnections (Fig. 2). Compared with the capped cases, more renewable electricity is traded across regions in the uncapped cases, particularly to the South Asia region.

In addition, if we measure the 2020-2100 cumulative CO2 emissions from only the energy sector and the electricity sector, the emissions would reduce by up to 1.8-6.4% and 6.4-9.8% in the uncapped interconnection cases, respectively. This indicates that grid interconnection via UHVDC lines can facilitate the sharing of remote high-quality RESs at a global level (namely a better configuration of global RES use in electricity generation), resulting in lower CO2 emissions.

a, Changes under the carbon price of US$15 t-1 CO2 in Eurasia and Africa. b, Changes under the carbon price of US$50 t-1 CO2 in Eurasia and Africa. c, Changes under the carbon price of US$15 t-1 CO2 in South Asia. d, Changes under the carbon price of US$50 t-1 CO2 in South Asia. e, Changes under the carbon price of US$15 t-1 CO2 in the former Soviet Union. f, Changes under the carbon price of US$50 t-1 CO2 in the former Soviet Union. All changes are relative from the relevant "no interconnection" baselines. The carbon price is in 2010 US dollars.

The changes are between an "uncapped interconnection" scenario and a "no interconnection" baseline scenario with the same assumptions of renewable cost (low cost) and carbon price (2010 US$50 t-1 CO2) in Eurasia and Africa, South Asia and the former Soviet Union.

For the South Asia region, we find that imported electricity mainly replaces coal power generation (Fig. 6a, using the year of 2050 as an example). The relative changes in coal power generation in 2050 from relevant "no interconnection" baselines range from -2% to -39% for capped interconnection cases and from -81% to -91% for uncapped interconnection cases, the higher ends being achieved with lower renewable costs.

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