Carbon Pricing and Cross-Border Electricity Trading for Climate Change Mitigation in South Asia

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Executive summary

1. Motivations underlying the research

South Asia region accounts for about 7% of the global greenhouse gas (GHG) emissions from fossil fuel combustion (IEA, 2015), and power sector is the main contributor with half of the total fossil fuel based CO_2 emissions. More than 90% of total power sector CO_2 emissions in the region comes from India. Recent developments on global efforts on climate change mitigation, particularly the Paris Accord, imply that South Asian countries will actively contribute to the global efforts to mitigate climate change. In fact, the Government of India has expressed its intention of reducing its emission intensity of GDP by 33 to 35% by 2030 from the 2005 level. Exploiting hydropower resources in Afghanistan, Bhutan and Nepal to replace thermal power generation in Bangladesh, India and Pakistan could help South Asia to achieve its goal under the Paris Accord. Timilsina et al. (2015) estimates that if existing cross-border electricity trading capacity in South Asia are further expanded to allow unrestricted flow of power across the borders, it would reduce power sector CO_2 emission by 8% from the situation in the absence of expanded regional electricity trading during the 2015-2040 period. This study adds new insights to the existing literature by assessing the power sector CO_2 reduction potential in South Asia when the regional electricity trade is further stimulated through a carbon pricing.

2. A short account of the research performed

We used a dynamic least-cost simulation model for long-term electricity planning. It identifies the sequence of investments for expansion of generation and grid interconnection so that the power supply systems (grids) meet their corresponding projected electricity loads at the least cost for a given time horizon (2015-2040 here). The total cost includes new investments needed for electricity generation expansion and cross-border transmission interconnection and costs of operating both existing as well as new power plants (e.g., fuel costs and operation and maintenance costs). The model accounts for several constraints including resource characteristics (e.g., potentials of hydro, solar, wind), technological characteristics (e.g., capacity limits, ramping time, provision of spinning reserves, capacity availability), and any other user specific constraints (e.g., government policies on nuclear power and plans for solar power development). While minimizing the cost of electricity supply for the planning horizon (2015-2040), the model considers every possible combination of building new power plants, existing transmission interconnections, and utilization of existing power plants and transmission interconnections. To estimate CO_2 reduction potential through carbon pricing along with the regional electricity

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cooperation and trade, we first developed a baseline scenario where cross-border electricity interconnection would not expand beyond what are currently in place or are already committed to build. We compare this baseline with a scenario that assumes an unrestricted trade of electricity between South Asian countries and they also introduce a uniform carbon tax starting from year 2020. Initially, the carbon tax rate is US$10 per ton of CO_2, it increases to 20 US$/t$CO_2$ in 2025 and then to 30 US$/t$CO_2$ in 2030.

The carbon tax would reduce regional power sector CO_2 emissions by 10% during the 2015-2040 period if there is no expansion of cross-border electricity trade from the level as of year 2014 (i.e., the base year considered in this analysis). The carbon pricing causes a huge substitution of coal based power generation with gas fired combined cycle based power generation. If cross-border transmission interconnection is expanded to the extent to allow an unlimited flow of power across the border, regional CO_2 emission during the 2015-2040 period would drop by 16% from the baseline. It is interesting to note that in the absence of expanded cross-border electricity trade, the carbon pricing alone does not unlock the hydropower resources yet untapped. When the cross-border interconnection constraints are relaxed, hydropower generation in the region would increase by more than 50% during the 2015-2040 period. If cross-border transmission capacity is expanded to allow unconstrained electricity trade, the total additional electricity supply costs (after adjustment of the carbon revenues) caused by the carbon pricing would drop by 6 percentage point.

3. Main conclusions and policy implications of the work

Using an electricity system planning model, this study investigates the role of carbon pricing along with regional electricity cooperation and trade to reduce CO_2 emissions from the power sector in South Asia. The study finds that if South Asian countries introduce a progressive carbon surcharge starting from US$10/t$CO_2$ in 2020-2025 to US$20/t$CO_2$ in 2025-2030 and to US$30/t$CO_2$ thereafter, it would reduce the power sector CO_2 emissions by 10% from the baseline during the 2015-2040 period. If the same carbon pricing scheme is introduced together with the expansion of cross-border interconnections thereby facilitating unlimited power trading across countries, power sector CO_2 emissions would drop by 16% from the baseline. The findings of the study suggest that unrestricted cross-border electricity trade in South Asia would cause significant environmental benefits, particularly reduction of CO_2 emissions, besides economic benefits, specifically the reduction in electricity supply costs. The climate change benefits (i.e., reduction of CO_2 emissions) would double if the cross-border electricity trade is further stimulated through a moderate carbon pricing.

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