Integrating energy sectors in a state-resolved energy system model for Australia

Tina Aboumahboub1, Robert Brecha1,2, Matthew Gidden1,3, Andreas Geiges1, and Himalaya Bir Shrestha1

1 Climate Analytics gGmbH, Climate Policy, Germany (tina.aboumahboub@climateanalytics.org)
2 Physics Department, Renewable and Clean Energy Program, Hanley Sustainability Institute, University of Dayton, Dayton, USA
3 International Institute for Applied Systems Analysis, Laxenburg, Austria

Australia represents an interesting case for energy system transformation modeling. While it currently has a power system dominated by fossil fuels, and specifically with a heavy coal component, there is also vast potential for expansion and use of renewable energy. Geographically, the country is divided into seven states and territories, two of which have power systems isolated from the rest of the country. Regions have widely differing characteristic energy mixes and resources, ranging from high reliance on brown coal (Victoria), black coal (New South Wales, Queensland), natural gas (Northern Territory, Western Australia) to states that have already moved toward renewable energy-dominant systems (South Australia, Tasmania). Renewable power systems across Australia are experiencing rapid growth, particularly in solar photovoltaics and to a lesser extent with wind power and battery storage.

In order to better understand the further potential expansion of renewable power systems in Australia, we developed the Australian Energy Modelling System (AUSeMOSYS) based on the open-source OSeMOSYS framework. We apply AUSeMOSYS to investigate cost-optimal transformation pathways towards a carbon-neutral energy system. The model is calibrated carefully to recent past trends in energy generation, including the recent and near-future rapid uptake of renewables in different regions, whether by policy decision or autonomous development. Beyond the power sector, AUSeMOSYS also provides scenario pathways for the uptake of electric vehicles and hydrogen powered transport, coupled to the power sector with a timeline through 2050. In order to investigate the full extent of renewable energy expansion given Australia’s recognized large renewable energy resource potential, we link selected industrial sectors to the power system model, e.g. steel production, where use of electric generation can further decarbonize Australia’s economy via hydrogen production and use.

In addition to the results showing the potential for large, integrated, cross-sectoral penetration of renewable energy into the Australian energy mix, we investigate modeling sensitivities to key parameters that can affect the uptake and use of renewable energy in the power system. For example, we study sensitivities in the choice of time-step resolution, the availability of trade between states in the National Energy Market (NEM) and the choice of carbon price and carbon
cap pathways that can lead to near-zero emissions from the energy system by mid-century.