Multilevel energy-economic systems analysis under climate change

Abstract

Over the past decades, environmental and climate change issues caused by intensive energy-related economic activities has been arousing wide discussion and attention. Practical approach for optimizing energy-environment-economic (E3) system paradigm are desired for long-term management. This study aims at providing scientific basis for policy making from three levels. Firstly, at technical level, fossil-fuel power plants are currently facing stricter greenhouse gas (GHG) emissions target. Small modular reactors (SMRs) can provide a clean pathway to relieve environmental pressure caused by increasing fossil fuel consumptions and related emissions. A mature framework for SMR penetration studies under climate change is developed and has been applied to Saskatchewan, Canada. Energy systems are also vulnerable to and impacting on climate change. Changing climate conditions will affect the accessibility of renewable energy (e.g. wind, solar and hydro power), as well as energy demand for cooling and heating. Secondly, the effects of long-term climate change are identified and investigated. Mid-term energy system planning model under climate change is developed. Tradeoffs between environmental goals, economic benefits, and energy development can be reflected, which can provide a solid foundation for energy policy and strategy making. Thirdly, economy-wide policies are more recognized in the world to realize the GHG mitigation target. The interactions among various industries affect the performance of industry-based GHG mitigation policies, bring about compounded risks. Thus, a long-term E3 system planning model is developed, which facilitates the simulation and optimization of different policies. An in-depth decomposition analysis is conducted to investigate the inter-relationships between different industry sectors. The results are expected to support the industrial structure optimization and cost-efficient pathways identification. Overall, this study can assist decision makers to design adaptation and mitigation strategies under climate change.