Grid-scale life cycle greenhouse gas benefits of electricity storage options

Sarah M. Jordaan*[1], Qingyu Xu[2], and Benjamin F. Hobbs[2]

School of Advanced International Studies[1] & the Whiting School of Engineering[2]

The Johns Hopkins University

Models that characterize life cycle greenhouse gases from electricity generation are limited in their capability to estimate emissions changes at scales that capture the grid-scale benefits of technologies that enhance renewable systems integration. When quantifying the life cycle emissions of an electricity grid, national assumptions about the generation mixes are often applied at annual time steps, neglecting to account for the regionalized differences in power systems that can result in variable emissions results. We present a grid-scale life cycle model that incorporates details of transmission and generation planning, which allows a geographically textured and thus more realistic assessment of not only the costs but life cycle greenhouse gas impact of storage options. Results from a co-optimized model of generation, transmission and operations, entitled the Johns Hopkins Stochastic Multistage Integrated Network Expansion Model (JHSMINE), will provide a detailed characterization of storage scenarios. The analysis will focus specifically on the western interconnection comprising the western geographic area of North America where the grid is synchronously operated. Storage scenarios will include the addition of 1200 MW of Pumped Hydro and the addition of 1200 MW of Compressed Air Energy Storage with new wind capacity. LCAs of individual technologies are limited in capturing potential grid-level environmental and economic improvements that emerge from co-optimized planning and renewable integration enhancements. The approach developed here will capture the electricity generation mix in the study area (using results from JHSMINE), thus the upstream fuel supply and downstream life cycle grid emissions associated with different planning outcomes. Results will provide insight into decreasing the cost of power to consumers, reducing environmental impacts, and increasing reliability of the U.S. power system.

* presenting and corresponding author (sarahjordaan@jhu.edu)