Integrating Water and Energy Systems for Long-Term Resource Management

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Abstract

Availability of and access to water and energy are key ingredients for economic and social development. Predictions show that pressure on already limited water and energy resources is expected to increase in many parts of the world as a result of growing populations, rapid urbanization, increasing pollution and climate change impacts. The water and energy systems are highly interdependent and these interlinks provide important opportunities to improve resource security and prevent inefficient decisions which could exacerbate problems even further.

This thesis explores the benefits to be gained from and the drawbacks of ignoring the various interlinks. A review of several existing water-energy integration modeling methodologies shows that the different physical, temporal and spatial characteristics of the water and energy systems present several hurdles in analyzing the two resources simultaneously. This thesis overcomes many of these issues by developing a fully integrated hard-linked water-energy linear optimization model. A case study from Spain is used to demonstrate the applications of the model for simultaneous analysis of water, energy and climate change adaptation strategies. An integrated approach is shown to have several benefits including lower total costs, better resource efficiency and improved robustness for a wide range of variations in several uncertain parameters.

Key Words
Water-energy nexus; linear optimization; integrated modeling