PhD Dissertation Defense

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DYNAMIC HYDROLOGIC ECONOMIC MODELING OF TRADEOFFS IN HYDROELECTRIC SYSTEMS

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On an annual basis hydroelectric dams account for a significant fraction (about 7%) of total U.S. electricity generation and roughly two-thirds of the nation's renewable electricity generation. Although these are important contributions, it is the unmatched operational flexibility and extremely low variable costs of hydroelectric dams that distinguish them as prized assets in electric power systems. These operating characteristics give hydroelectric dams a tremendous competitive advantage over thermal generation sources (i.e., coal, nuclear, natural gas and oil)—simply put, dams are a cleaner, cheaper and faster way to produce electricity. Nonetheless, dams are known to have an array of negative environmental consequences for riparian ecosystems. In particular, dams block the transport of sediment and nutrients downstream, degrade downstream water quality, and radically alter natural river flow patterns downstream. Hydroelectric dams are also highly susceptible to sustained periods of low reservoir inflows, i.e., droughts. Reduced water availability limits the ability of hydroelectric dams to help meet peak electricity demand in power systems and can cause harmful financial consequences for hydropower producers. Hydropower producers face a future beset by unprecedented changes in the electric power industry, including the rapid growth of installed wind power capacity and a vastly increased supply of natural gas due to horizontal hydraulic fracturing (or "fracking"). There is also increased concern surrounding the potential for climate change to impact the magnitude and frequency of droughts. These developments may significantly alter the financial landscape for hydropower producers and have important ramifications for the environmental impacts of dams. This doctoral research investigates how management of hydroelectric dams may evolve alongside a rapidly changing electric power industry and in the face of hydrological uncertainty– and what that could mean for river ecosystems that are already strained by human impacts.

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