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Load-Following Capabilities of the BWRX-300

Due to the increasing use of renewable energy sources such as wind and solar, large daily energy deficits need to be overcome by consistent sources. In the world of nuclear energy, load-following techniques are under investigation as methods through which plants can meet the diurnal electric demands. Much research has been performed in the area of load-following controllers for nuclear reactors, which allow for precise maneuvering of control rod banks based on reactivity changes in the core. While the Advanced Load Following Control developed by AREVA has been shown to be successful in several European PWRs, reactivity controls include management of dissolved boron, which is not applicable to BWR systems. Research into BWR-specific load-following controllers has also been performed. Various types of controllers include: low-sensitivity, neural networks, and non-linear digital simulators. These controller systems can be broadly applied to all BWRs, although precise control is highly dependent on the specific reactor system. Another solution includes running the reactor at a constant thermal output and using an external system to compensate for changes in electricity demand. While the reactor produces constant power, changes in the grid demand are met by an energy storage and delivery system. For example, small-scale photovoltaic and wind turbine grids have incorporated hydrogen electrolyzers with hydrogen-based fuel cells to create a hybrid energy system for their needs. This design can be modified to use a nuclear reactor as the primary energy production system. The BWRX-300 is a natural-circulation 300 MWe SMR currently under development by GE-Hitachi. Due to the proprietary nature of their design, a similar reactor was designed by scaling the larger ESBWR down to BWRX-300 proportions. In order to analyze the effects of inherent load following maneuvers, a time-dependent systems code has been created that calculates system response to a changing thermal power. Additionally, a proton-exchange membrane fuel cell in conjunction with a hydrogen electrolyzer has been investigated to provide the desired load-following capabilities. Finally, the economic feasibility of these load-following methods was analyzed in terms of the levelized cost of electricity.