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# Sustainable Smart Water Systems (aka Sustainable Water Grid)

**Big Idea.** We recommend investment in new research and development of a multiscale framework that transforms water management in the U.S. through more efficient resource distribution and use. Our aging water infrastructure and management practices have not kept pace with the demands of a growing population and are at significant risk due to the emerging impacts of climate change. To address these challenges within this complex system, we require technological, industrial, and social innovations that go well beyond business-as-usual. We need a nation-wide Smart Water Grid — a holistic, coordinated, multidisciplinary research framework that transforms the U.S. water infrastructure and management practices into a system that is sustainable, resilient, and will get us through the next century.

**Reasoning and Justification.** Due to climate change and climate variability — e.g., El Niño and La Niña abnormal weather patterns — the temporal variability and spatial distribution of water availability has been dramatically changing. On the other hand, demand for fresh water — i.e., water for agriculture, water for the energy sector, water for industry as well as drinking water — has increased and will continue to increase, driven by population growth, industrialization, and globalization. Indeed, a significant fraction of the global population is located in areas or regions of high or extremely high freshwater supply risk, while other regions face the problems related to overwhelming amounts of water. The development of a comprehensive multiscale water management framework could facilitate the adaptation to climate change and climate variability impacts related to changing levels of water resources.

**Requirements.** To enable this, each framework must co-design and integrate advances from mathematics, computing, engineering, chemistry, economics, environmental sustainability, and social science to make resource use more efficient, sustainable, adaptable, and equitably accessible. The applications that these frameworks enable should include those for decision support, inference, modeling, and prediction, data analysis and visualization, and intelligent automation that span multiple temporal and spatial scales.

**Value and Impact.** The first-order impacts are (i) more efficient resource use through better water management, and (ii) a system that is more resilient to the extreme events induced by climate change. The second-order impacts include improved leak detection (e.g., smart water meters, remote sensing, GeoAI to detect and localize leaks) for consumers (inside, outside of residences) as well as for municipal water utilities. (Note that approximately one-third of municipal water is lost as the result of leaks due to aging pipes, running toilets, etc.). We foresee benefits in terms of science informed policy and gap identification (industry opportunities) in terms of technologies that impede understanding of system behavior and pricing as well as in terms of advances that inform the next of strategic investments, e.g., water storage and transport, desalination, etc.