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Energy and Water Linkages in Los Angeles: Bottom-Up and Big-Data Approaches

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Abstract: In Los Angeles (LA), water and energy management are highly connected. Water imports to the region from some sources are highly energy intensive, while local infrastructure uses energy to move and purify water and wastewater. In future decades, the region will likely shift to greater use of local water supplies. Several studies have documented energy conservation benefits that can result from water conservation and reduced imports for seasonally-dry regions such as Southern California. Here, we present an integrated, bottom-up analysis of the energy implications for water conservation and local supply enhancement in LA, including both water utility operations and buildings. Energy intensities for "full-cycle" water supply alternatives, estimated using data from existing literature and regional utilities, were applied to a previously-published model of LA County management (*Artes*) with least-cost optimization to understand the direct energy use implications of conservation and imported water cuts. For both LA City (4 million people) and LA County (10 million people), results indicate that promoting local supplies and water conservation yields energy benefits across water utility operations. Conservative estimates of average annual net and gross electricity consumption (with and without out-of-basin hydropower generation) for water supply and treatment are 3,000 GWh and 3,700 GWh in model scenarios with fully available historic imported water supplies. Reducing imports from the regional importer (MWD), which requires associated conservation and enhanced local water reliance, cuts energy intensive water supplies, reducing both gross and net direct energy use. But expanding local sources (groundwater and recycled water) likely results in some increased in-basin energy needs for treatment and pumping that, while less intensive than MWD sources, would be borne by local utilities. We also assessed building-level electricity and natural gas needs for heating water, a significant source of energy-for-water needs. We combined data from the *LA Energy Atlas,* a database of monthly energy consumption covering 1.3 million properties in LA County, and water utility service populations from *Artes*. Potential implications of switching natural gas water heaters to electric or solar thermal sources, which would reduce greenhouse gas emissions, were also assessed. Additional data collection and refinements would improve estimates at both levels. The analysis provides a robust case study for understanding water and energy relationships across sectors of urban water in a megacity, drawing on life cycle and industrial ecology methods.

***Keywords**:* water-energy nexus; conservation; urban water management; California; system analysis

Figure 1: Estimating average annual electricity use for modelled scenarios using Artes across LA County. Results are reported for both gross and net consumption based on considering out-of-basin effects of hydropower generation.