

Life-cycle Assessment of Urban Water Infrastructures

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Life-cycle assessment (LCA) is a procedure that can quantify the environmental impacts associated with a process or a product over its entire lifetime. LCA can be used as a tool to help determine system and design alternatives, which can help to establish energy and cost saving methods. In the future, the data collected during this research process will be used to complete a LCA on two urban water projects, an energy profile for California's water system and an update of the Wastewater-Energy Sustainability Tool (WWEST) that was created by mentor Jennifer Stokes.

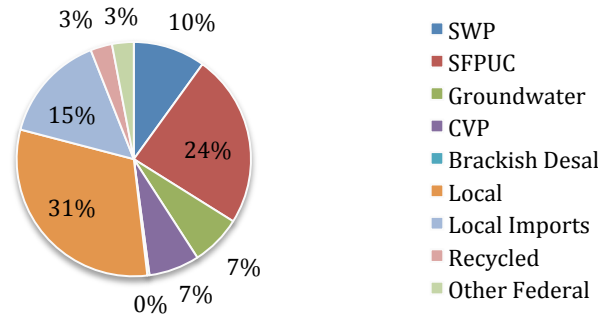
Understanding the relationship between energy consumption and the movement of water is important because this information can be used as a baseline for comparing future energy and cost savings. Over time, population growth will increase the demand for potable water, thus increasing the demand for energy. The majority of costs associated with processing water are due to energy consumption. In order to save money (and energy) it would be beneficial to know the least energy intensive processes for supplying and conveying water to consumers.

The goal of the first urban water project completed during the ReNUWIt REU at UC Berkeley was to expand the understanding of this energy and water relationship across the state of California. California is broken down into ten hydrologic regions, and each region obtains its water from a combination of different sources. The amount of energy required to supply/convey, treat, and distribute water to consumers varies depending of the source of supply. Possible supply sources include water delivered from state, federal, and local systems, as well as water from locally imported, recycled, desalinated, and groundwater sources. Looking at the distribution of water sources for a handful of water utilities within each hydrologic region will create a holistic picture of the energy it takes to move water across the entire state.

The first step towards creating this picture was to gather data about the water utilities from Urban Water Management Plans (UWMP). UWMPs provide information about the utilities' water usage and are intended to prove that utilities are managing their water responsibly so supplies will be able to meet future demands. Each UWMP illustrates the distribution of water supplies by reporting the percentage of water they obtain from each supply source.

The next step was to focus in on one hydrologic region, the San Francisco Bay region, to complete a more in-depth analysis. The California Public Utilities Commission (CPUC) provided a summary of the distribution of water sources for the entire Bay region in their embedded energy in water study. This distribution is shown below in Figure 1. Based on the CPUC percentages, eight utilities were selected to represent the total distribution of water supplies within the Bay region.

Figure 1. CPUC distribution of water supplies for the San Francisco Bay Region



The final portion of the project consisted of calculating the amount of energy used by each utility to supply/convey, treat, and distribute water through out the Bay region. Existing energy intensity data were collected from the Electric Power Research Institute, California Energy Commission, and Santa Clara Valley Water District’s Watts to Water reports. Table 1 shows the variation in energy intensity for each water source in the Bay region. As this project continues in the future, the energy intensity for the remaining hydrologic regions will be calculated, thus creating a complete picture of the correlation between water supplies and energy usage through out California State.

Water Source	Supply (kWh/AF)	Treatment (kWh/AF)	Distribution (kWh/AF)
Federal	870.0	87.0	390.0
State	1128.0	83.3	390.7
Local	0.0	64.2	390.9
Local Imports	92.4	64.2	394.6
Groundwater	86.6	3.0	396.1
Desalinated	1643.0	0.0	390.9
Recycled	0.0	1129.0	684.1

Table 1. Energy profile for the San Francisco Bay region

The data collected for the second urban water project will be used to update the WWEST program that evaluates the environmental impacts of wastewater treatment plants (WWTP). Data related to the WWTP’s operations, emissions, and energy use/consumption were collected from peer reviewed journal articles. The data were organized based on relevance to the liquid and sludge treatment processes. Data related to the plant’s influent and effluent flows helped to categorize the operations of the WWTPs. The input and output data provided information about the WWTP’s emissions and energy consumption. When the program update is complete, the WWEST will be able to reference the recent data and assess the WWTP’s environmental impacts with more accuracy.