LIFE CYCLE ANALYSIS OF WATER REUSE

A life cycle analysis at each step in the production process reveals that the embodied energy value chain is an additive process, whereby at each step more energy is consumed in creating the water product. The energy envelope can be generalized when you consider the major differences between raw water pumping and treated water distribution between the East Coast and West Coast of the United States. Water is pumped and treated and then re-pumped in many cases several times in Western States where elevation changes can be significant (Wilkinson, 2000). In contrast, when we look at the relative pumping and distribution costs for Eastern States, the amount of energy consumed in delivery of the product can be an order of magnitude less due to the predominance of more gravity systems and less pumping energy.

The life of the piping infrastructure and structural components of most water treatment and wastewater treatment systems is 50 years or more. The process equipment, chemical systems, instrumentation and electrical systems within the facilities used in creating the water product typically has a life of 20 years.

A full life cycle analysis on a 50 year term shows the relative difference between the embodied energy in operational costs of water and wastewater treatment processes and the energy embodied in the material construction of the treatment plant (Figure 4). The embodied energy associated with the operation for the creation and distribution of the water product is about 30% of the operational life cycle cost through the life of a facility (Reiner et al., 2007). The relative cost of recycled water is similar to the life cycle cost of advanced treatment with nitrification. This is due to the value of the embodied energy in the life cycle costs of the recycled water that is applied and recovered from the system.

Figure 4. Life cycle energy usage envelope expressed as cumulative energy in GJ/MGD and GJ/m3.d

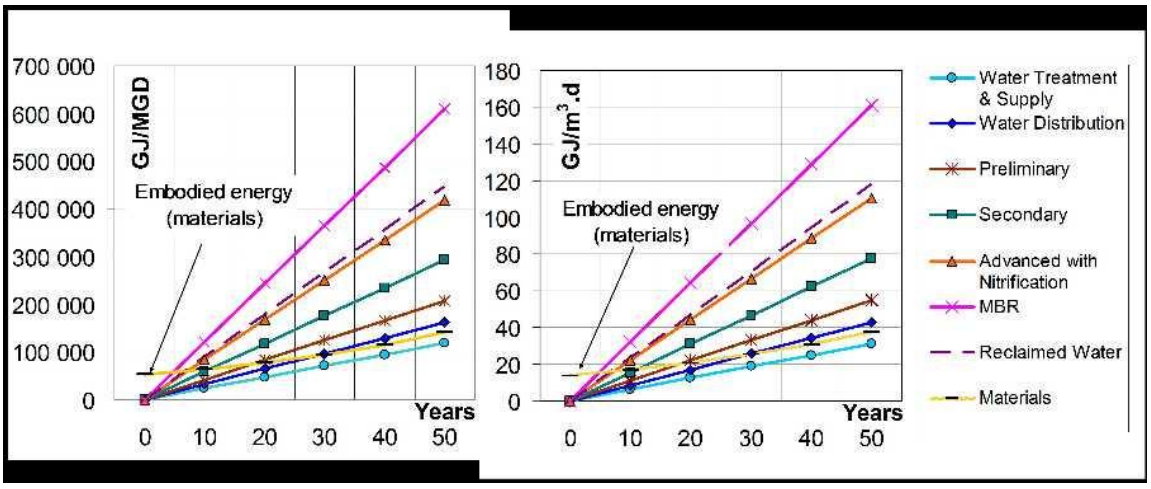

Figure 4 shows the Life Cycle Energy Usage Envelope for each process in terms of giga-joules per million gallons per day (GJ/MGD) and cubic meters per day

(GJ/m3.d). It was compiled from secondary research (Scheuer and Keoleian, 2002) and the data sources were obtained from a life cycle materials and energy balance on a membrane bioreactor recycling plant from several data sources (SAIC, 2006; Wilson, 2009). This graphic depicts an extraordinary amount of energy. As a point of reference one giga-joule is equal to 277 kWh, and on average, 98 kg (216 lbs) of carbon-dioxide (CO2) is produced per giga-joule.

When embodied energy in recycled water is accounted for over a 50 year life cycle term, at 12 cents per kWh, and not including interest, it has a value of US$ 3925/m3 per cubic meter or US$14,857,000/MG. The capital cost embodied in the construction materials for the recycled water infrastructure is very small when compared with the overwhelming operational energy recovery savings from the substitution of recycled water for a more pristine potable water source in the value chain. The analysis shows that the life cycle of a membrane bioreactor reclaimed water process is commensurate with the energy of an advanced treatment process when the natural water cycle of water treatment, supply and distribution is able to be substituted by the recycled water. In other words, recycled water value is artificially increased by the regulatory permitting requirements to meet secondary treatment standards and the energy usage sunk into secondary treatment.

Source:
http://www.iwawaterwiki.org/xwiki/bin/view/Articles/EmbodiedEnergyintheWaterCycle