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The Water Energy Nexus

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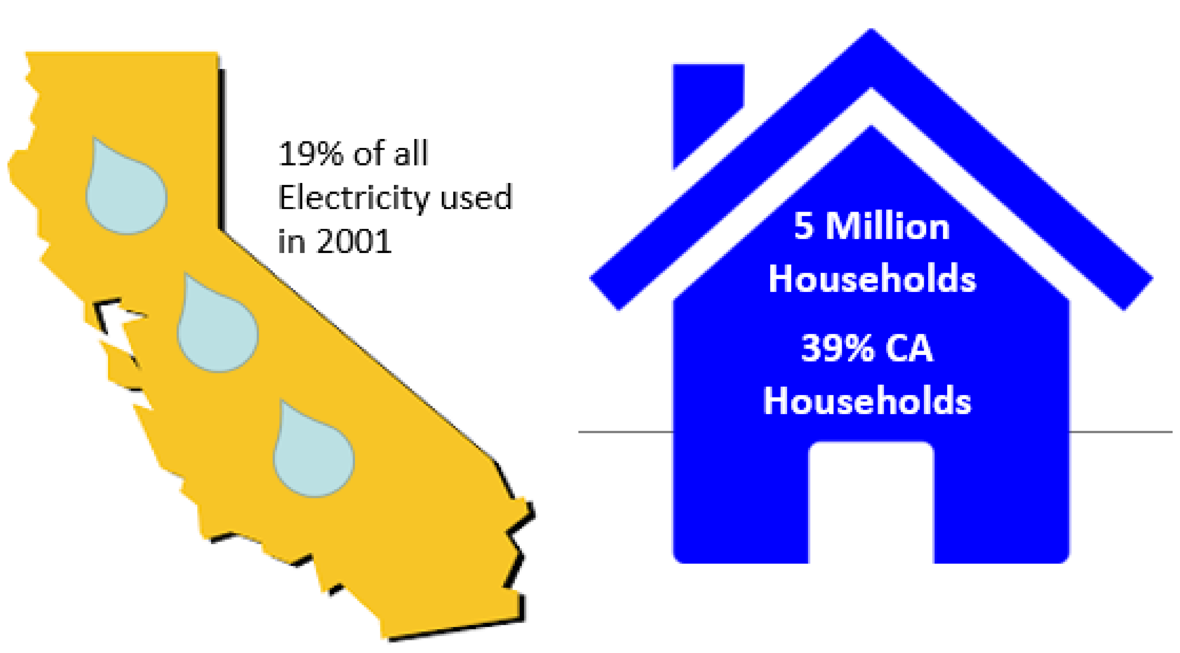
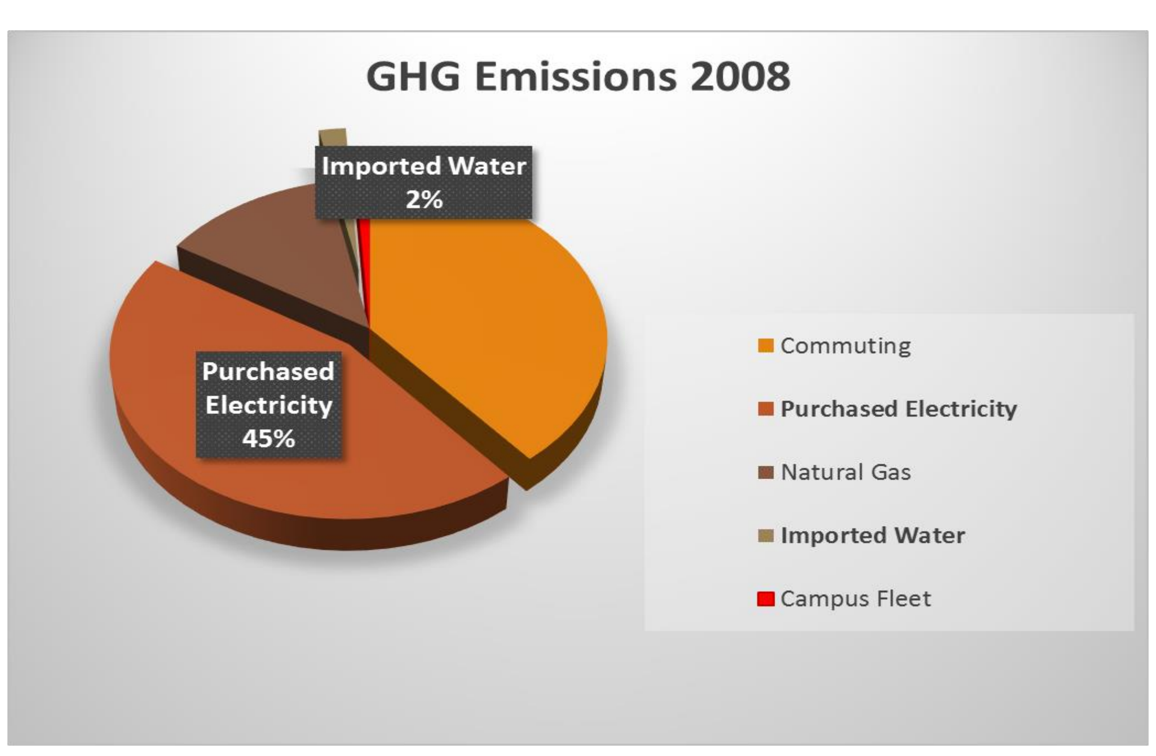
University of California, Riverside Carbon Neutrality Initiative Fellowship

Introduction

Here in California water and its relationship to us is on our minds all of the time. But what is seldom mentioned is the relationship between water and energy, often called the Water Energy Nexus. According to the California Energy Commission, in 2001 19% of the states total energy usage was directly associated with the usage of water. This is enough energy to power 39% of the states homes for a year. The project presented shows the efforts to understand this relationship at the institutional level using The University of California at Riverside (UCR) as the model. A deeper understanding of this relationship at a university level, particularly given the UC's pledge to be carbon neutral by 2025, has real implications. Be it economic savings to the campus, lowering carbon emissions or enhanced transparency and accountability all we must do is reach out with the will to make change.





Project Goals

In March of 2007 the University of California (UC) signed the American College and University Presidents Climate Commitment, joining over 150 other universities and colleges in a commitment to "maintain greenhouse gas (GHG) emission inventories and to achieve climate neutrality as fast as possible." Additionally, the UC system adopted climate protection targets to "reduce GHG emissions to 2000 levels by 2014, and 1990 levels by 2020" This projects, funded by the University Office of the President under the Carbon Neutrality Initiative Fellowship Program focus was to determine the water energy relationship on the campus of UCR as a method of reaching these goals through greater understanding, transparency and accountability of both water and energy usage. Due to a dearth of metering determination of the exact relationship was not possible. But what we do know is that the largest contributor to the campuses green house gas emissions is from purchased electricity as seen above. Therefore finding the amount of purchased electricity directly associated with water was chosen as the method of attacking this problem.

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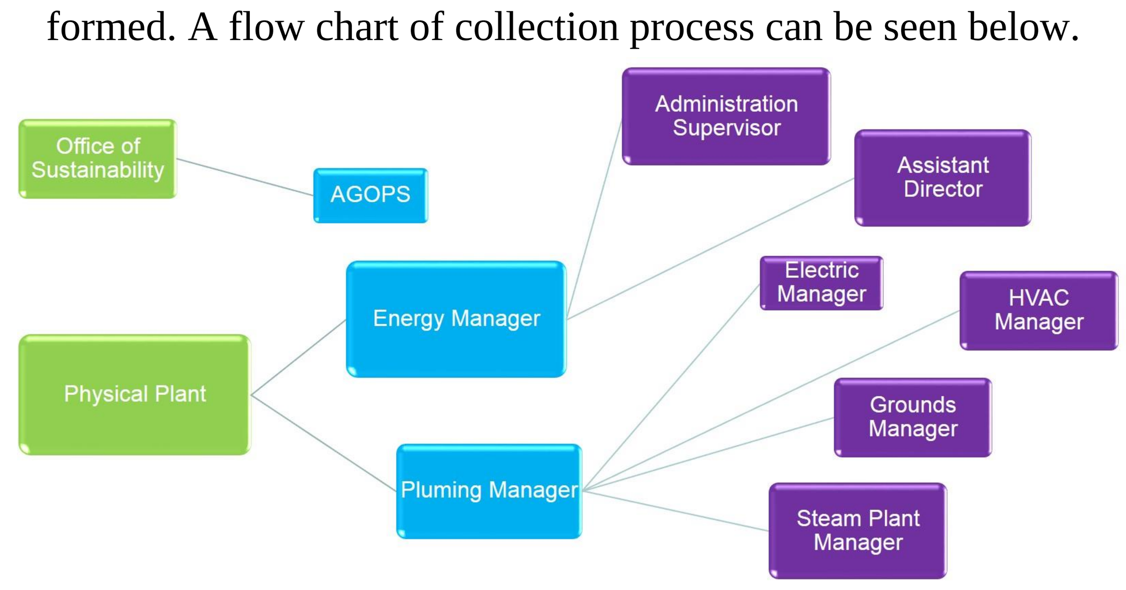
Materials and Methods

In order to determine the percentage of UCR's purchased electricity first the main contributors were determined. This list is not exhaustive but does represent the largest and most accessible data available.

1. Moving Purchased Potable Water to Reservoirs
2. Moving and Using Irrigation Water
3. Heating and Cooling Water for HVAC
4. The Use of Water in Individual Buildings

First a conceptual map of how these systems are connected and used on campus was formulated. Next the collection of the data began. Since the exact relationship in real time could not be obtained data was collected from many different sources and for a minimum of 3 years for averages to be formed. A flow chart of collection process can be seen below.



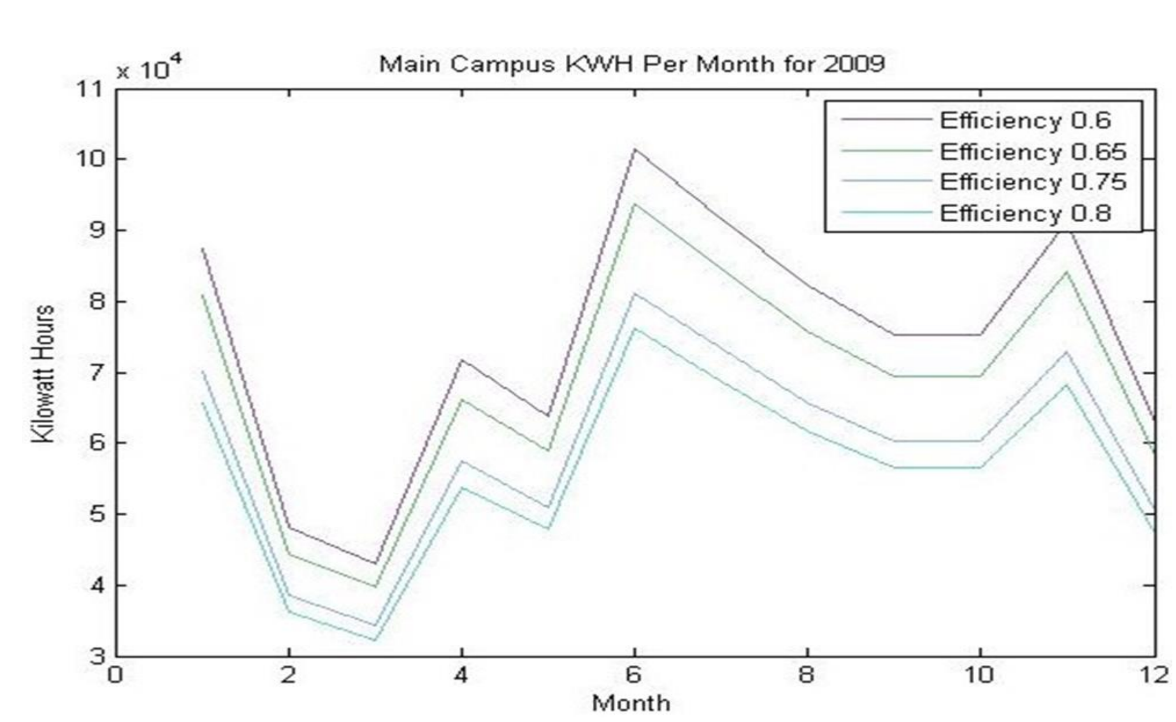
Finally once the data was collected energy outputs had to be calculated. If the first law of thermodynamics for incompressible flow is applied across a pump the rate of energy addition is calculated as follows.

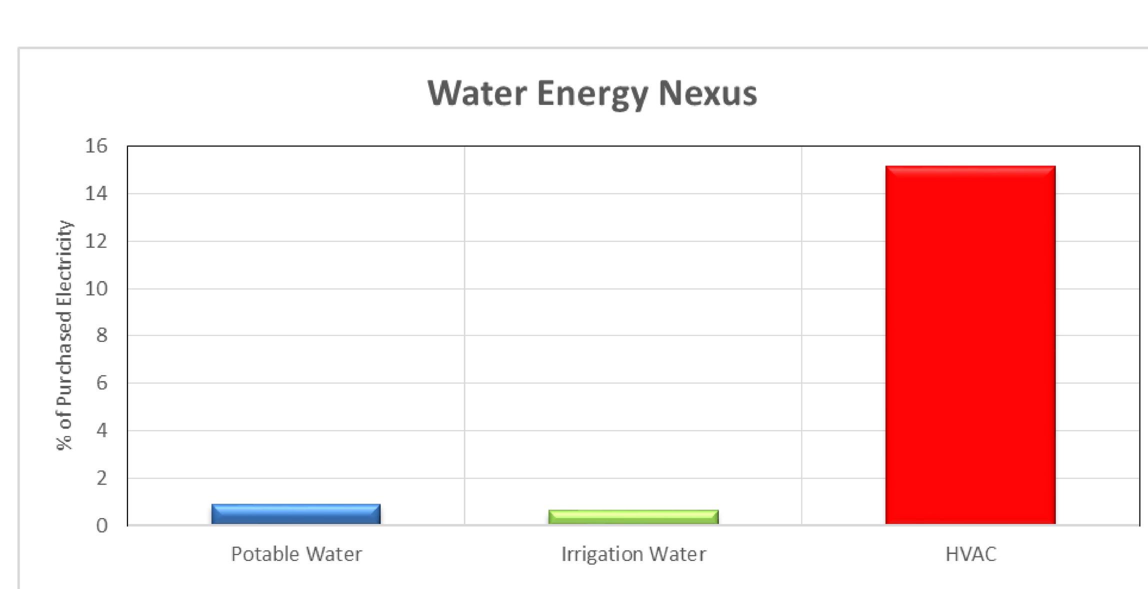
$$\omega T = \frac{\rho Q g H}{\eta_p}$$

The left hand side is the energy supplied by the pump, rotor angular velocity and applied torque respectively and the right hand side is energy given to the fluid, which was calculated and is density, flowrate, gravitational acceleration, hydrodynamic head and efficiency respectively. A computer program was written to calculate the energy used for a range of efficiencies since real time data could not be obtained.

Results and Outcomes

A very reasonable picture of the water energy relationship at UCR was formulated. Individual use of buildings proved too cumbersome to retrieve under the time constraints and was a small enough piece that its contribution relative to the other three was negligible.

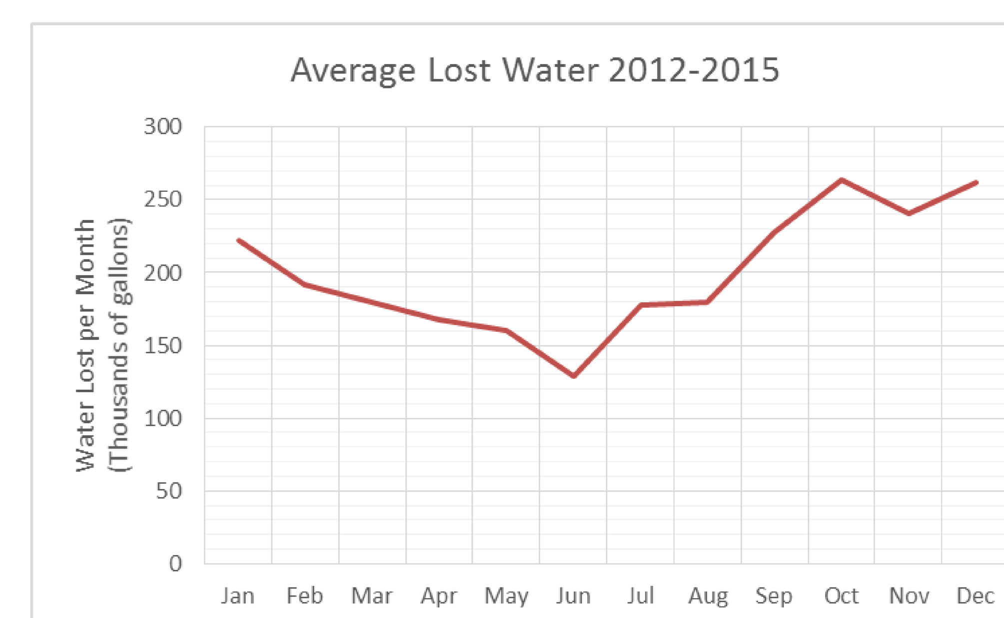




Conclusions

The most interesting finding was that the relationship for UCR seemed to scale down from the state level of 19%. With only three of the main contributors calculated and numerous other smaller contributions left out a value of approximately 16%, on average per year, of the campuses total purchased electricity was determined. This is significant as it shows that simply using water on a campus can have large impacts to the carbon footprint. This would mean that the usage of water at UCR represents 8.5% of the total GHG emissions for the campus. Secondly the largest contributor by over 95% was simply form cooling water for the HVAC systems on campus.

On a less related note but worthy of mentioning is the amount of water lost on campus due only to inefficiencies in our HVAC system.



Future Goals

Continuing the work moving forward will consist mainly of advocacy. Much more needs to be done on this campus in particular and the UC in general to conserve water, to understand our consumption, to be more transparent with it and to be accountable for the lack of action. This project has shown that significant progress can be made in regulation and conceptualization of our carbon footprint and water usage through nothing other than metering of our systems.

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