Water, Electric Power and Growth in Southern Arizona

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The Water-Energy Nexus

Water pumping, treatment, and distribution require energy

Energy production and generation require water

Objective

• The objective of this project is to quantify the energy used for water services in Tucson, AZ.
  – Detail energy use for different water services i.e., water pumping, treatment, distribution etc…
  – Compare energy costs of potable and reused water
  – Discuss implications of findings on sustainability
Case Study: Tucson, AZ

Growth

Tucson Water

- Currently serves 675,000 people
- Over 220,000 potable connections
- 4,500 miles of pipeline
- 51 reservoirs
- 5 wellfields

Projected Water Demand

Water Use Cycle

- Wastewater And Reuse
- Extraction and Conveyance
- Using Water*
- Treatment
- Distribution

* Outside scope of this presentation
Unit Sense

- 1 acre foot of water = 325,851 gallons
- 1 kWh = 1000 watts. Ex: 100 watt lightbulb left on for 10 hours

<table>
<thead>
<tr>
<th>End Use</th>
<th>kWh/Year</th>
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</thead>
<tbody>
<tr>
<td>Total Household</td>
<td>10,656</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>1,239</td>
</tr>
<tr>
<td>Desktop Computer</td>
<td>262</td>
</tr>
<tr>
<td>Coffee Maker</td>
<td>116</td>
</tr>
<tr>
<td>Color TV</td>
<td>137</td>
</tr>
<tr>
<td>Ceiling Fan</td>
<td>50</td>
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</tbody>
</table>

The following results are preliminary:
Conveyance

Ex: 2007 CAP delivery 90,300 AF
= 283,542,000 kWh

3,140 kWh/AF to get to Tucson
Water Extraction

Energy Costs

Water Use Cycle

- Wastewater and Reuse
- Extraction and Conveyance
- Using Water
- Treatment
- Distribution

Energy Costs for Pumping
Direct delivery of CAP water in 1993 and 1994 caused increase in treatment costs.
Weighted Average for three major Tucson area wastewater treatment plants:

1,145 kWh/AF

*21,313 kWh/AF for Mt. Lemmon wastewater treatment
Reclaimed Water System

Water Use Cycle

- Wastewater And Reuse
- Extraction and Conveyance
- Using Water
- Treatment
- Distribution

Reclaimed Water

<table>
<thead>
<tr>
<th>Year</th>
<th>Energy Use (kWh/AF)</th>
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<tbody>
<tr>
<td>1990</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td></td>
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<tr>
<td>2002</td>
<td></td>
</tr>
<tr>
<td>2004</td>
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</tbody>
</table>

Time
Water Use Cycle

Energy Use Numbers

- Wastewater And Reuse: 2,203 kWh/AF
- Extraction and Conveyance: 3,981 kWh/AF
- Using Water: 28 kWh/AF
- Treatment: 355 kWh/AF
- Distribution: 355 kWh/AF
Implications of Findings

- Energy cost of potable water and waste water treatment: \(~5,500\ \text{kWh/AF}\)
- 57\% of energy costs for potable water is CAP
- Energy cost of reused water: \(~6,500\ \text{kWh/AF}\)
- Energy associated with wastewater reuse increases energy costs \(~19\%\)
Future Work

• Continued work with Tucson Water
• Expand work to include other water providers in Arizona
  – Salt River Project
  – Phoenix Water Services
  – Small water providers throughout the state
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Thank you!

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