HOW WATER TREATMENT DRIVES REGIONAL POWER DEMANDS AND WHAT CAN BE DONE ABOUT IT

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Population Centers

Source: Nasa.gov
Water Demand 2005/2030

The Shift in Demand is West and South
Consumptive Losses

The Critical areas are West and South
Over stressed Aquifers

The Critical Areas are Great Plains Breadbasket and South

Light blue: Standard aquifers
Dark blue: Rivers and lakes
Green: Alluvial and glacial aquifers
Red: Stressed aquifers
Yellow: Impacted aquifers

U.S. Department of the Interior
http://www.nationalatlas.gov
WaterCAMPWS
http://www.watercampws.org
Future Shortages

Generally Areas where Growth is Expected
Options For New Water Supplies

- Conjuctive use
- Regenerated water supplies
  - Reclaimed water
  - Multiple pass cooling
  - Concentrate reuse
- Alternative Supplies
  - Desalination
  - IPR
- Purchase water rights
Increasing Levels of Treatment increases Power Consumption in developed areas.

<table>
<thead>
<tr>
<th>Water Treatment Processed</th>
<th>Power (MW)/MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeration/HSP/wells</td>
<td>1.4</td>
</tr>
<tr>
<td>Lime Softening</td>
<td>2.3</td>
</tr>
<tr>
<td>Nanofiltration 125 psi</td>
<td>2.7</td>
</tr>
<tr>
<td>LPRO &gt;200psi FL RWS</td>
<td>3.3</td>
</tr>
<tr>
<td>Secondary Pure OX</td>
<td>3.4</td>
</tr>
<tr>
<td>Reuse</td>
<td>3.0</td>
</tr>
<tr>
<td>Seawater desal</td>
<td>13.0</td>
</tr>
</tbody>
</table>
Projected Future Power Generation

So Where is the Power for Water Treatment Coming From?
Hydroelectric

Most of the west has critical shortages as does the south

Source: Water Energy Resources of the United States with Emphasis on Low Head/Low Power Resources (p. 47), U.S. Department of Energy
Thermoelectric Water Use

Coincides with Many Critical Water Supply Areas
Coal Fired Plants in US

Located in Many Current Critical Areas

Coal-fired power plants in the United States

Courtesy: Platts Data source: Platts Energy Advantage and POWERmap.
Natural Gas Power

Located in Some Critical Water Supply Areas

Nuclear Plants

Located in Many Current Critical Water Supply Areas
## Water Demands for Power

<table>
<thead>
<tr>
<th>Power Plant Technology</th>
<th>Cooling Demand G/MWhr</th>
<th>Other Use or Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal Fired</td>
<td>50,000</td>
<td>500</td>
</tr>
<tr>
<td>Coal - IGCC</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Natural Gas - Open Loop</td>
<td>20,000</td>
<td>1000</td>
</tr>
<tr>
<td>Nuclear - Open Loop</td>
<td>60,000</td>
<td>minimal</td>
</tr>
<tr>
<td>Nuclear - Closed Loop</td>
<td>1000</td>
<td>100</td>
</tr>
<tr>
<td>Geothermal</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Wind</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0</td>
<td>minimal</td>
</tr>
</tbody>
</table>
Water Use by Power Type

- **Coal Fired**: 50,000 gallons per MWh
- **Coal - IGCC**: 0 gallons per MWh
- **Natural Gas - Open Loop**: 20,000 gallons per MWh
- **Nuclear - Open Loop**: 60,000 gallons per MWh
- **Nuclear - Closed Loop**: 2,000 gallons per MWh
- **Geothermal**: 20,000 gallons per MWh
Water/power Conflict Areas

Idaho opposes 2 PP because of impact on aquifer

Opposition to PP because of impact of water intake structure on Lake Michigan aquatic life

Georgia Power loses bid to take water from Chattahoochee R. for PP cooling

Low water on Missouri R. leads to decreased efficiency at PP

Figure IV-2. Examples of Energy-Water Conflicts

DOE 2006
Solutions?

- Biofuels?
- Wind?
- Solar?
- Biomass?
- Others?
Biofuel Production?

Growth Proposed in Current Critical Areas with Creates a Direct Conflict
## Fuel Development Needs

<table>
<thead>
<tr>
<th>Fuel/Process</th>
<th>Water Need</th>
<th>Water Use (MGD) water/MWh</th>
<th>Gallons of Water/gallon of fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil/Gas Refining</td>
<td>refining</td>
<td>20 to 70</td>
<td>1.5</td>
</tr>
<tr>
<td>Oil/Gas Extraction</td>
<td>extraction</td>
<td>6 to 10</td>
<td>1.5</td>
</tr>
<tr>
<td>Oil/Shale</td>
<td>refining</td>
<td>3 to 30</td>
<td>2</td>
</tr>
<tr>
<td>Oil sands</td>
<td>extraction</td>
<td>50 to 150</td>
<td>3</td>
</tr>
<tr>
<td>Biofuels - Ethanol</td>
<td>Growing fuel stock</td>
<td>10,000 - 100,000</td>
<td>1000</td>
</tr>
<tr>
<td>Biodiesel Process</td>
<td>Growing fuel stock</td>
<td>15 to 20</td>
<td>1</td>
</tr>
<tr>
<td>Biofuel - Soy</td>
<td>Growing fuel stock</td>
<td>200,000</td>
<td>6500</td>
</tr>
<tr>
<td>Biomass conversion</td>
<td>Growing fuel stock</td>
<td>50 to 350</td>
<td>4</td>
</tr>
</tbody>
</table>
Wind Power

Located in Great Plains/RM Critical Areas

United States - Annual Average Wind Speed

Solar Options

Located in South and West Critical Areas
Biomass – A Better Option?

Located in Many Developed or Critical Areas
Landfill Biomass

Located in Many Developed Areas
BioMass – Methane WWTP

Located in Many Developed Areas
Energy Costs for Water and Wastewater Treatment Plants are Significant

- Often among the largest user on power grid
- Must provide service 24/7
- Power demands cannot be shifted
- Back-up usually provided – leads to load agreements
Methane at WWTPs..

- Power Use
  - Sludge
    - Digester
      - Energy Capture
        - New Jobs
  - Regional Solution
    - New Jobs
  - Reduced Grid Power Demand
    - Capital Saving
      - Energy Subsidies
        - New Jobs
      - Ag solution
        - Customer KWhr Power Savings
        - Increased Yield
For a 100 MGD plant, incoming solids are equal to 80 tons/d. Sludge from Clarifier is 1% solids. Gravity Thickener sludge is 2-4% solids. Digester converts half solids to methane and rest is 4% solids. Belt press converts to 20-24% solids. Belt press will be 45 tons/d solids.
Identification of Energy Conservation Improvements (ECIS- WWTPs)

- Equipment - Fine Bubble Diffusers
- Equipment – Turbo Blowers
- Equipment - Automatic DO Control (2 mg/L)
- Operation – Auto. DO Setpoint Control (0.5 mg/L)
- Operation – Most Open Valve Blower Control vs. Pressure Setpoint
Whole system design approach needed to maximize efficiency

Blower Technology ± 20%

Diffusers ± 20%

Controls ± 20%
Project Savings ECIs @ 5 WWTPs

- City of Boca Raton WWTP
- South Central Regional WWTP
- Seacoast Utilities PGAWWTP
- East Central Regional WWTP
- Palm Bch Co Southern Regional WWTP

- MOV Control vs. Pressure Setpoint
- Automatic DO Setpoint Control (0.5 mg/L)
- Automatic DO Control (2 mg/L)
- Upgrade to Turbo Blowers
- Fine Bubble Diffusers
Proposed Water Treatment Cost for SE FL ->

- For 600 MGD of Wastewater RO’ed = $6 B capital
- Power Cost @ 3 MW/MGD = 1.8 GW power supply needed
- For 250 MGD of saltwater sources RO’ed = $4.5 B
- Power cost @ 5 MW/MGD = 1.25 GW needed

- Wind option is limited, PV panels are billions..
- WWTPs could produce 25% of this power
Conclusions

- Water and Wastewater Treatment Plants are major Power Users
- New Water Sources = more treatment
- Increased levels of Treatment increase local power demands considerably
- Growth in power demands are unlikely to be satisfied by the current power plants
- Insufficient water supplies are available in most growth areas
Conclusions

- Power grid is unlikely to provide enough transmission capacity to satisfy increased local power demands due to increased treatment.
- New power plants will be required in places with limited traditional power capacity for treatment in areas with currently overstressed limited water in south and west.
- Biofuel development conflicts with water supplies.
However...

- Untapped wastewater potential exists from easy solutions
- Untapped methane form landfill and WWTP biomass is available near developed areas
- Untapped Solar and Wind are available in most potential growth areas that have over-stressed water supplies
- Wind/solar and water treatment are not incompatible
Going Forward....

- WWTPs offer significant opportunities to reduce power off the grid, but the incentives to invest in technology are lacking as is capital.
- Water Plants have much fewer opportunities.
- Site Specific for PV, Wind.
- Incentives needed for green power (wind, PV) – federal exist, but not power industry.
- Multiple uses should be encouraged.
Questions?
Example of a Potential Problem
Historical SE Florida Water System
Modern System

- The surface water flows in many directions but primarily east/west
- Faster runoff = less percolation
- Faster runoff = less ET
Meanwhile Demands Increase
Floridan Aquifer Desalination is the Answer?

- Floridan
- Ocean
Regional Solution?

Recharge the Everglades w/ RO treated water to Recharge the Biscayne Aquifer
Regional Wastewater Disposal Participation

- Reverse Osmosis
- Ultraviolet
- Advanced Oxidation
- **HUGE CARBON**
- **FOOTPRINT**
  $$$$$$$$$$$$$$$$$$$$

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