Electric Power and Water Resource Sustainability

First Western Forum on Energy & Water Sustainability
University of California, Santa Barbara
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Overview

- Sustainable living standards and sustainable water resources
- Key issues from business perspective, identified through surveys of EPRI members
- Proposed research for power industry
- Estimated benefits
“Ability to meet needs and aspirations of present without compromising ability to meet those of the future” (UN Bruntland Commission, 1987)
Sustainability Requires Capital

- Man-made capital can be increased to meet demand
- Natural capital (waters) not so readily increased
  - To meet resource needs, natural capital must be stable and resilient. Requirements:
    - Resource extraction rates must be less than recharge rates.
    - Waste loads must be less than assimilation capacities.
- Technology is key to sustainability
  - Upgrade man-made capital to conserve natural capital
There is Precedent for Water-Conserving Investment

- Trend in U.S. Thermoelectric Power Water Withdrawal Efficiency
  
  - Strongly downward, due to investment in cooling towers
This Project

- **Title:** Technical/Business Support for Comprehensive Energy/Water Program

- **Objective:** Support development of water sustainability research plan for EPRI
  - National/regional approach, seeking public/private partnerships

- **Project activities:**
  - Reviewed ongoing activities of government/industry working groups
  - Conducted interviews of EPRI members, May- August, 2006
  - Conducted sustainability workshop, EPRI Water & Ecosystems Area Council, Bar Harbor, ME, June 20, 2006
EPRI Member Interviews

- Telephone interviews with strategic decision-makers, about business impacts of water resource sustainability.

- Key questions:
  - Is water an important cost factor in your operations?
  - Are you siting new capacity to meet demand?
  - Is availability of water limiting?
  - Are water discharge issues limiting?
  - Are current regional planning tools sufficient?
  - Can EPRI research help overcome limits?
  - What are your highest priorities for EPRI research?

- Findings: Common themes, and important regional differences
Cost is important, if broadly defined:

- “An important cost from standpoint of engineering, construction, cost to handle, not in terms of charge paid for water (Southeast).”

Availability critical in rapidly growing sunbelt regions:

- “More and more critical, more in terms of availability than cost” (Southeast)
- “Not an important cost factor except when unavailable at any price” (Southwest)

Ancillary costs are drivers where water is abundant:

- “Biggest cost is intake protection, avoiding fish kills” (Great Lakes)
Role of Water in Site Planning Process

BEGIN

Forecast Capacity Needs

Inventory Sites with Fuel and Transmission Capacity

Site 1
- Locate Water Source 1
- Propose Cooling Technology 1

Site 2
- Locate Water Source 2
- Propose Cooling Technology 2

Site 3
- Locate Water Source 3
- Propose Cooling Technology 3

Compare Overall Costs

Select Site, Water Source, and Technology

END
Dry and Hybrid Cooling

- Strong interest (especially in Southwest):
  - “Can always address with hybrid or dry cooling – boils down to economics. Water drives technology and price of energy.”
  - “Looking to move to dry or hybrid – big concern is efficiency and cost. Research to improve would be important.”

- Not competitive where water is abundant:
  - “ Wouldn’t go to dry cooling unless we have to because of cost and lower efficiency.” (Great Lakes)
Dry cooling is more costly, except where water cost is very high.

“Hot weather penalty” accounts for roughly 20% of cooling cost.

350 MW coal burning plant (EPRI, 2004)
Overcoming Hot Weather Penalty

Potential benefits:

- Reduce plant cooling cost by up to $1.5M/year
- Increase net profit margin by roughly 1 percentage point
- Make dry cooling more cost-competitive
Cost of Water – Treatment

For degraded waters, treatment & disposal can be the largest component of cost.
Reducing Cost of Water

- Suppose technology could reduce cost of treatment and use of degraded waters:
  - “Important area: find better ways to use grey water” (Midwest)
  - “Continue to advance the ball on grey water, slugs of inconsistent quality. Interested in efforts to find degraded sources” (Southeast)

- Benefits of reducing cost by $1/kgal comparable to eliminating the hot weather penalty for dry cooling

- Conclusion: Industry-wide potential savings are substantial, if these technologies can be advanced.
Recycling Urban Wastewater

- **POTW effluent is a potential low-cost source:**
  - “Integrating wastewater treatment with power plant needs make sense.” (Great Lakes)
  - “Reuse of treated water would be top priority.” (Midwest)

- **Lower salinity, silica, and hardness than produced waters, so less treatment needed**
  - May need to treat for phosphate, ammonia, bacteria
Urban Wastewater – A Growing Source

- US population growing by about 3,000,000/yr (US Census Bureau)

- Will generate about 60,000 gpm new sewage flows annually (@ 30 gal/day/capita)

- Could cool up to 6,000 MW of new power plants, at 10 gpm/MW.

- This is close to the annual increase in US generating capacity of 7,000 MW (ASCE)
Reducing Water Losses in Cooling

- **Evaporative and blow-down losses**
  - “Reduce water consumption for power generation, front and back end. Need ability to operate at higher cycles of concentration.” (Southwest)
  - “Need for technologies that use less water.” (Great Lakes)
**Magnitudes of Losses**

- **Typical loss rates, cooling tower**
  - About 665 gal/MWh @ 4 cycles of concentration

- **Potential for water savings, by component:**
  - Reducing blowdown (doubling concentrations) can reduce water use by about 90 gal/MWh
  - Evaporative losses are high (480 gal/MWh), with much potential to capture.
  - Scrubbers use less water (25 gal/MWh), offer the least potential for conservation.
Integrated Planning and Water Supply Characterization

- Need better regional planning tools to identify and manage local resources:
  - Need better understanding and outreach on integrated water budget management.” (Midwest)
  - “Decision support tools need better flow forecasts.” (Hydropower generator – multiregional)
  - “Don’t believe tools are sufficient. Better understanding of long-term lake levels would be beneficial.” (Great Lakes)
Proposed Research Topics

■ Engineering and economic analysis
  - Estimate costs and benefits of emerging technologies

■ Improving dry and hybrid cooling
  - Inventory, evaluate, and test (field & pilot) technologies

■ Reducing water losses from cooling towers
  - Inventory, evaluate, and test (field & pilot) technologies

■ Use of degraded water
  - Inventory, evaluate, and test (field & pilot) sources, treatment technologies, and use of municipal wastewater

■ Water resources forecasting and management
  - Evaluate climate variability and hydrological forecasts
  - Refine assessment and management framework
## Estimated Annual Savings for 350MW Plant

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture Evaporation</td>
<td>$870,000</td>
</tr>
<tr>
<td>Reduce Blow Down</td>
<td>$860,000</td>
</tr>
<tr>
<td>Dry Scrubbing</td>
<td>$220,000</td>
</tr>
<tr>
<td>Use of Degraded Waters</td>
<td>$740,000</td>
</tr>
<tr>
<td>Air Cooling</td>
<td>$750,000</td>
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Projected Additions to Electricity Generating Capacity

Source: Annual Energy Outlook 2007, DOE
Illustrative scenario
- Each of the following adopted by 10% of new coal-fired plants:
  - Dry/hybrid cooling
  - Partial capture of evaporation
  - Reduced blowdown
  - Dry scrubbing
  - Use of degraded waters
Summary

- Technologies could decrease operating costs by 1-3%
- Potential aggregate savings from water conservation very large ($100’s of millions)
- Strategic planners have expressed need for these technologies
- Can sustain water resources and meet electric power needs of consumers
Questions?