Electric Power/Water Sustainability

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Water and Ecosystems

Water Energy Sustainability Symposium
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All mankind is of one author, and is one volume; when one man dies, one chapter is not torn out of the book, but translated into a better language; and every chapter must be so translated...As therefore the bell that rings to a sermon, calls not upon the preacher only, but upon the congregation to come: so this bell calls us all: but how much more me, who am brought so near the door by this sickness....No man is an island, entire of itself...any man's death diminishes me, because I am involved in mankind; and therefore never send to know for whom the bell tolls; it tolls for thee."

John Donne: Meditation XVII
Conceptual Schematic of Sustainability

Essential Relationships of Sustainability

Source: Sustainable Water Resources Roundtable
Water Is a Critical Resource

- Fast growing demand for clean, fresh water
- Population growth
- Increased concern for environmental protection and enhancement
- Unknown impacts of climate variability and change
- All regions of US vulnerable to water shortages
Consequences of Growing Water Demands

- Pressure on electric power industry to reduce water use
- More intensive management of water resources
- Greater integration between water and energy planning
- Emphasis on watershed/regional planning
- Demand for new science and technology to support planning and management needs
Approaches to Reaching Sustainability

• Top down
  – Watershed-based
  – Considers all stakeholder demands
  – Matches aggregate water demands to supply

• Bottom up
  – Facility-based
  – Objectives
    • Increase water use efficiency
    • Conservation
Water Use Efficiency
(Rankine cycle plants are using wet cooling tower)

Water Use by Plant Type

Water use, gal/MWh

- Nuclear
- Coal
- Oil
- Gas
- Simple CT
- Comb. Cycle
- IGCC
- Solar thermal
- Solar PV
- Wind
- Biofuel

Legend:
- Hotel
- Fuel processing
- CT injection
- Inlet air cooling
- Ash handling
- Scrubbing
- Boiler make-up
- Cooling
Generation Plant Strategies to Increase Fresh Water Withdrawal Efficiency

- Dry/hybrid cooling
- Use degraded/reclaimed waters
- Recycle water within plant
  - Increase closed cooling cycles
  - Treat blowdown and reuse
  - Capture vapor in wet cooling tower and stacks
- Increase thermal conversion efficiency
Water Withdrawal Constant Since 1980

Electricity Generation Has Increased by Factor of 15 Since 1950
Quantification of Potential Water Resource Changes: Integrative Approach
Tiered Approach: Water Resource Assessment and Management

- Scoping level analysis
  - Simple indicators
  - Web data bases
  - Applied nationally at county resolution

- Detailed management area water budgets

- Dynamic watershed modeling
Freshwater Withdrawal/Available Precipitation

Total Freshwater Withdrawal, 1995/ Available Precip
percent: number of counties in parentheses

- >= 500 (49)
- 100 to 500 (267)
- 30 to 100 (363)
- 5 to 30 (740)
- 1 to 5 (1078)
- 0 to 1 (614)
Phoenix Groundwater Active Management Area (AMA)

- Mission Statement: Achieving safe-yield through promoting conservation and through the use of renewable water sources.
- Goal: To achieve safe-yield by the year 2025 through the increased use of renewable water supplies and decreased groundwater withdrawals in conjunction with efficient water use.
- One of five in state
- Area: 5646 square miles
- Encompasses six groundwater basins
- Semi-arid: seven inches average annual precipitation
- Major rivers: Gila, Salt, Verde, Agua Fria, Hassayampa
2006 Annual Water Budget (Thousand Acre Feet)

Data source: ADWR (2009)
Drought Assessment: San Juan River Basin

Navajo reservoir
Navajo Reservoir Elevation - 5 Year Drought Scenarios

- D5T0, 45% Reduction
- D5T1, 62% Reduction
- D5T2, 70% Reduction*  
- Min Elev.

Elevation (m)

Year
Concluding Thoughts

- Potential for increased water use efficiency and conservation
- Research can enhance potential and reduce energy and dollar costs
- Relative benefits of individual technologies and practices are site dependent
- Value in creating tool box of technologies and practices
- Bottom up approaches are necessary but not sufficient for sustainability
- Risk management should consider the combined influences of population growth, land use change, technological advances, and climate variability.