Water Demand Projections for Power Generation in Texas

Stuart D. Norvell,
Manager, Water Planning Research and Analysis
Texas Water Development Board
Scope of Study

- Discuss and review different types of cooling technologies
- Estimate statewide water use for the industry
- Develop projections for future water use on a state and regional level
Study Authors and Steering Committee

Bureau of Economic Geology

- Dr. Carey King, Dr. Ian Duncan, and Dr. Michael Webber, Bureau of Economic Geology

Steering Committee

- Chris Bisset (retired – American Electric Power)
- Sandra Dannhard and Rick Gangluff of the South Texas Project nuclear facility
- Ted Long of NRG Energy
- Gale Henslee of Xcel Energy
- Gary Spicer of Luminant Power
- Dawn Loller, Wolf Hollow LP

TWDB Project Manager, Stuart Norvell
Water Use for Different Cooling Technologies

- 99% of water used for power generation in Texas comes from surface water sources

- Predominant types of cooling systems in Texas
  - Once through systems
  - Cooling towers
  - Some air-cooled units but limited (3% of generation)
  - A few hybrid air and water systems (<1% of generation)
Type A: Once-through with Reservoir
(Reservoir can serve many purposes: recreation, municipal supply, wildlife habitat, etc.)

Diversion and/or normal river flow

Cooling Reservoir

Withdrawal
Discharge

System Boundary

Precipitation
Natural evaporation
Forced evaporation

Warm water

Cool water

Steam-Electric Plant

Return Flow
South Texas Project
**Type D: Cooling Tower with surface water**

(Surface water can serve many purposes: recreation, municipal supply, wildlife habitat, etc.)

- **System Boundary**
- **Diversion and/or normal river flow**
- **Reservoir or River**
- **Withdrawal**
- **Forced evaporation**
- **Natural evaporation**
- **Cool water**
- **Blowdown water**
- **Return Flow**

**Diagram:**
- Steam-Electric Plant
- Cooling Towers
- Precipitation
- Consumption = forced evaporation
- Withdrawal ~ Consumption
<table>
<thead>
<tr>
<th>Fuel</th>
<th>Prime Mover</th>
<th>Cooling System</th>
<th>Water consumption rate (gallons per kilowatt hours)</th>
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<tbody>
<tr>
<td>Gas</td>
<td>Combined Cycle</td>
<td>Cooling tower</td>
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<tr>
<td>Coal</td>
<td>Steam turbine</td>
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Statewide Water Consumption Estimate for Thermoelectric Generation (Projection Baseline)

- Study Estimate: 444,600 Acre-feet
- TWDB Water Uses Survey: 450,000 Acre-feet

45% Cooling towers
54% Once through
<1% Hybrid Wet Dry
Regional Distribution of Generation and Water Consumption

Generation

Water Consumption

NETGEN_MWH
- 1 - 1000
- 1001 - 10000
- 10001 - 100000
- 100001 - 1000000
- 1000001 - 10000000
- 10000001 - 20000000
- 20000001 - 21500000

AC_FT
- 0.1 - 1
- 1.1 - 10
- 10.1 - 100
- 100.1 - 1000
- 1000.1 - 10000
- 10000.1 - 20000
- 20000.1 - 30000
- 30000.1 - 40000
Projections for Future Thermoelectric Generation Water Use in Texas

- Long-term forecasts (2010-2060)

- Two components
  - Future electricity demand
  - Resultant forecasts of water requirements for the industry

- Key drivers
  - Economic and demographic growth
  - Trends in fuel costs
  - Future mixes of generating technology
  - Policy factors (particularly Federal)
  - Changes in energy efficiency (supply and demand)
Created 8 scenarios to capture uncertainties in supply and demand

- Demands side uncertainty
  - “Status quo”
    - Electrical demand scenario based on ERCOT 2008 forecasts with an annual electricity growth rate of 1.8% and assumes no increases in demand side efficiency
  - “Low energy”
    - Electrical demand scenario based on American Council for an Energy-Efficient Economy report on Texas and assumes demands are offset by 50 million megawatts over the long-term planning horizon (2015 – 2060) through demand side management
Scenarios capturing supply side uncertainty

Volatility in natural gas prices

- **“High natural gas prices”**
  - Assumes gas prices are high enough to prevent natural gas combined cycle (NGCC) plants from dispatching as base load facilities
  - Assumes NGCC plants operate as peaking facilities generating approximately 20% electricity sales

- **“Low natural gas prices”**
  - Assumes NGCC plants form part of base load generation as they do today at 40% of electricity sales
Scenarios capturing supply side uncertainty

Policy uncertainty

- Will federal legislation mandate a carbon tax on the industry and will Texas power plants be economically driven by federal legislation to implement carbon capture and storage (CCS)?

- Higher carbon prices imply a greater potential that CCS will be implemented by the industry

- “With Policy Incentives for Carbon Capture” – Assumes future federal legislation places a “carbon price” and EGUs would implement carbon capture and storage
  - Carbon capture and storage increases water requirements

## Projections methodology (cont.)

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<tr>
<th>Energy efficiency</th>
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<th>Federal Carbon Policy</th>
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Additional assumptions

- Near-term estimates (2010-2015) include planned facilities and those under construction

- Apportioned total Texas thermoelectric water demand according to ratios of each fuel types and generating technology in each county in 2015

- For example, if 10% of natural gas generation in 2015 occurred in Harris County, then projections assume that 10% all future natural gas generation will occur in Harris County

- Renewables will provide 30% of generation by 2060
  - 20% from wind and 10% from concentrated and photovoltaic solar power
Projected Generation through 2060
(megawatt hours per year)

Scenario 3: Status Quo, High Gas Prices with Carbon Capture
Scenario 7: Status Quo, Low Gas Prices with Carbon Capture
Scenario 1: Status Quo, High Gas Prices without Carbon Capture
Scenario 5: Status Quo, Low Gas Prices without Carbon Capture
Scenario 4: Low Energy, High Gas Prices with Carbon Capture
Scenario 8: Low Energy, Low Gas Prices with Carbon Capture
Scenario 2: Low Energy, High Gas Prices without Carbon Capture
Scenario 6: Low Energy, Low Gas Prices without Carbon Capture
Projected Water Use through 2060 (acre-feet per year)

- Scenario 1: Status Quo, High Gas Prices without Carbon Capture
- Scenario 2: Low Energy, High Gas Prices without Carbon Capture
- Scenario 3: Status Quo, High Gas Prices with Carbon Capture
- Scenario 4: Low Energy, High Gas Prices with Carbon Capture
- Scenario 5: Status Quo, Low Gas Prices without Carbon Capture
- Scenario 6: Low Energy, Low Gas Prices without Carbon Capture
- Scenario 7: Status Quo, Low Gas Prices with Carbon Capture
- Scenario 8: Low Energy, Low Gas Prices with Carbon Capture
Regional Distribution of Projected Generation and Water Use

- Again, we assume that new generating capacity grows in relation to where it exists today and where there are planned facilities.
- Wildcard = potential new technology incorporated in long-term projections.
  - Wind
  - Solar
Projected water use in Regional Water Planning Area F (Central West Texas, Midland-Odessa and Surrounding Counties)
Conclusion

- State level projections are fairly straightforward
- Short-term regional level projections for supply are more difficult
- Long-term regional level projections similar to herding cats
Questions or Comments?