The Energy-Water Nexus: A Case Study of the Arkansas River Basin

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WESTERN RESOURCE ADVOCATES
Project Introduction

**Goal 1:** Assess water demands for municipal needs, electricity generation, and agriculture in the Arkansas River Basin in 2015 and 2030

**Goal 2:** Recommend alternatives to reduce water demands – municipal conservation, energy efficiency, and renewable sources of energy
Outline

• Municipalities
• Electricity Generation
• Agriculture
• Climate Change
• Conclusions
Background: The Arkansas Basin

Source: CWCB, Statewide Water Supply Initiative
Background: Water Withdrawals in the Arkansas Basin

Withdrawals, 2000

Public Supply  Domestic Self-Supply  Industrial Self-Supply  Irrigation  Thermoelectric Generation
Municipalities
Municipalities

Population Growth → Increased Demand

Population, Arkansas Basin Counties

Year

Population Growth

2015

2020

2025

2030

2035

2000

2005

2010

1995

0

200,000

400,000

600,000

800,000

1,000,000

1,200,000

1,400,000

1,600,000
Municipalities

BAU Scenario
- Efficiency improvements based on plumbing standards and efficiency programs in place today
Municipalities: Potential for Improved Efficiency

System-Wide Water Use

Gallons per person per day (gpcd)

Colorado Springs, CO  Front Range Cities: Median Water Use  Aurora, CO  Albuquerque, NM  Tucson, AZ
Municipalities

Alternate Scenarios

- Efficiency 1:
  - SFR indoor water use efficiency
  - Efficient irrigation of turfgrass or 45% of customers install moderate xeriscaping

- Efficiency 2: Water use efficiency in all sectors

![Graph showing Municipal Water Consumption in the Arkansas Basin with BAU, Efficiency 1, and Efficiency 2 scenarios.]

![Images of green landscapes and a driveway being watered.]
Electricity Generation
Electricity: Background

- Water use for electricity generation
  - Conventional generation
  - Alternatives
Electricity: Background

Water Intensity of Electricity Generation

- Conventional Generation
- Emerging Technologies
- Renewables

Types of generation include:
- Coal, steam
- Oil/gas, steam
- Combustion turbine
- Coal, IGCC
- Coal, PC, with carbon capture
- NGCC, with carbon capture
- Solar CSP, wet cooling
- Solar CSP, dry cooling
- Solar PV
- Wind
- Biomass, steam plant, wet cooled
- Improved biomass-based steam plant, wet cooled
- Geothermal, binary, dry cooling
- Geothermal, binary, hybrid cooling
- Geothermal, binary, wet cooling

Gal/MWh
Background: Electricity Generation, 2006

~21,000 AF of water

15,000,000 MWh

Coal
Natural Gas
Wind
Hydro
Electricity Generation: Business As Usual (BAU)

Resource Portfolios Under BAU

- Holcomb Station Expansion

- MWh

- 2006, 2015, BAU, 2030, BAU

- Efficiency
- CHP
- Other Renewables
- Wind
- Solar
- Geothermal
- Coal
- Natural Gas
- Hydropower
Electricity Generation: Alternate Scenarios

- Replace the proposed coal plants with energy efficiency, renewables, natural gas, and combined heat and power
Electricity Generation: BAU and Alternate Scenario

Resource Portfolios Under BAU and an Alternate Scenario

- Efficiency
- CHP
- Other Renewables
- Wind
- Solar
- Geothermal
- Coal
- Natural Gas
- Hydropower

MWh

2006
2015, BAU
2015, Alternate
2030, BAU
2030, Alternate
Water Use

Water Use, Electricity Production

Volume (AFY)

2006 2015 2030

BAU
Alternate
Electricity: Renewable Potential

Total Capacity: 96 GW
Electricity: Renewable Potential

Total Capacity: 26 GW
Agriculture
Agriculture

• Recent trends: declining agricultural land use; water conversions

• Ethanol boom/high crop prices $\rightarrow$ increased pressure to use marginal crop lands for farming

• The Arkansas River Compact = no new water available for new farmland in the basin in Colorado

• Conservation Reserve Program lands with groundwater rights (Kansas) could potentially be put back into production
Ethanol: Biorefinery Locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Production Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas Basin (excluding Ark. Basin)</td>
<td>72 Mgal/yr</td>
</tr>
<tr>
<td>Kansas</td>
<td>403 Mgal/yr</td>
</tr>
<tr>
<td>Colorado</td>
<td>125 Mgal/yr</td>
</tr>
</tbody>
</table>

Source: Renewable Fuels Association 01.24.08
Water Use: Ethanol

Processing:
4.2 Gallons of Water

1 Gallon of Ethanol =

Irrigation: 1000 - 1200 Gallons of Water
Agriculture

• Conservation Reserve Program
  – Pays rents to farmers on marginal croplands
  – Contracts expire every 10 – 15 years

• What will happen to this land?

• Depends on:
  – Farm Bill
  – Crop prices

• But… *Most* land is going back into production, if the farmer has resources available.
Agriculture

- Water consumption if 50% of CRP land in the Kansas portion of the basin goes back into production
Climate Change

- Recent study looked at 49 GCM simulations
- Projects a more arid Southwest, with the droughts of the past becoming the norm. La Niña/dustbowl type events are on top of higher average temperatures and rates of evapotranspiration.

Source: Seager et al., 2007
• Water consumption if 50% of CRP land in the Kansas portion of the basin goes back into production and climate change increases water losses from irrigated land.
Summary
Context: Competing Demands

Water Consumption: Business As Usual

AFY (thousand)

Sustainable Yield

Agriculture  Municipal  Energy  Ethanol  Climate Change: ET
Context: Competing Demands

Water Consumption: Alternate Scenario

AFY (thousand)

2005 2015 2030

Agriculture Municipal Energy Ethanol Climate Change: ET

Sustainable Yield
Other Factors/Uncertainties

• Municipalities
  – Growth rates
  – Economic trends

• Electricity
  – Capital cost of renewables
  – Operating cost
    • Fuel prices
  – Risk of GHG regulation
  – Transmission Needs

• Agriculture
  – Farm policies
  – Crop prices
Policy Recommendations

1. Integrated planning

2. Accelerate water and energy conservation

3. Accurately value energy and water in utility planning processes

4. Decentralized solutions
   • Rainwater harvesting
   • CHP, solar PV

5. “Water Smart” fuel and renewable portfolio standards
Policy Recommendations

6. Be creative!

• How can new water systems reduce their GHG emissions?
• Where do the synergies exist?
• What are our “lost opportunities” today?
Conclusions

• Competition for limited water resources in the Arkansas Basin will increase

• Long range planning in the municipal and energy sectors can reduce water demands – through investments in municipal water use efficiency, energy efficiency, and renewable sources of energy

• These measures will be increasingly important, considering the impacts of climate change

• A comprehensive policy on agriculture and ethanol development – one that addresses water resources – will be most important
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