National Energy Technology Laboratory

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Why and what we do...

• Utilize domestic resources for abundant, low cost power
• Design, develop, and demonstrate highly efficient and environmentally benign power and fuel systems.
• Perform and manage research, development, and demonstration projects in the areas of resource utilization, equipment for energy conversion, separation processes, and approaches to carbon capture & storage.

Department Of Energy
National Energy Technology Laboratory

DOE Mission: Ensure America’s security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions

NETL Mission: Advance energy options to fuel our economy, strengthen our security, and improve our environment

Why and what we do...

• Water
  – Essential, Ubiquitous, & Pervasive
• Water, Food/Land, & Energy are connected
• Water Management for Fossil Energy Based Systems

Overview

• Water
  – Essential, Ubiquitous, & Pervasive
• Water, Food/Land, & Energy are connected
• Water Management for Fossil Energy Based Systems

Sankey Diagrams

Useful accounting for Water-Energy Efforts

• Develop State based Sankey Diagrams
• Water Energy Nexus Team, NETL, and LLNL
• Improve and update data/inputs
• Address gaps in water and energy

Water Withdrawals and Consumptive Use

Thermo-electric Power Large User of Water, Relatively Small Consumer

<table>
<thead>
<tr>
<th>Source: Estimated Use of Water in the United States in 1995, USGS Circular 1298, 1998</th>
<th>Withdrawals (Mgal/day)</th>
<th>Consumptive Use (Mgal/day)</th>
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<tr>
<td>Other</td>
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</tr>
<tr>
<td>Nuclear</td>
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Water Balances Associated with Deep Gas

State Level Assessment

Objective
- Develop Sankey diagrams to illustrate water usage in shale gas/oil extraction by state

Strategy
- Initially focus on water usage for Appalachian Basin unconventional shale gas/oil extraction
- Identify best sources of water supply and disposition data by state (OH, PA, WV)
- Gather data and develop rationale for quantifying data inputs required for Sankey diagrams by state
- Develop methodology for updating as new data becomes available

Sankey Diagram: Pulverized Coal Plant 500 MW

SOA Environmental Controls
With No CO₂ Capture

with CO₂ Capture

90% Potential Increase in Withdrawal

Current Water Demands Do Not Appear Sustainable in Many Parts of the U.S.

EIA’s AEO 2014 shows that the most water constrained areas, FL and TX will see significant population growth and power plant builds by 2040

Low Water Footprint Technologies

Distributed Generation Fuel Cell Impacts on CO₂ Emissions and Water Use

If EIA’s 2040 projected NGCC builds were replaced with a more efficient DG SDPC system there could be significant water and CO₂ savings in water constrained areas.
Changes in Capacity Imply Changes in Water Use

Life Cycle Water Use for Power Generation

Improving Data and Models

• Collaboration with Sandia National Laboratory
  – Build from prior work at SNL on water for water states
  – Eastern states data will be merged with existing western states data into aggregate database including detailed supporting metadata
• Develop a Water Atlas
  – Build from data collection and estimation efforts
  – Build tools/model to support analysis, planning, and prioritization
• Collaborate with Other DOE Offices and Agencies
  • ARPA-e, USGS, USDA, Other

NETL’s History in Water Management

• Sponsored workshops focused on power plants and water with SNL
• Long-standing R&D programs in water related to coal, oil & natural gas development and use
• NETL has sponsored over 60 projects focused on water in both the coal and oil & gas programs since 2000
• R&D has included:
  – Thermoelectric water use/management
  – Systems, trends, and life-cycle analyses
  – Advanced treatment/detection technology
  – Produced water treatment and reuse
  – Unconventional oil and shale gas-water interface
  – Geological carbon storage

Water Reuse and Recovery

• ~81% power plants have municipal wastewater available within 10 miles
• Advanced treatment necessary, costs $0.91 - $1.32 (in 2009$/kgal) vs. $0.74 for river withdrawal and the city water costs of $2.95 (in 2009$/kgal)
• Economics and availability make this water source second to river withdrawal and widely used

Thank You

Questions

Office of Fossil Energy

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