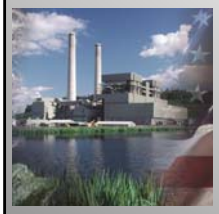


## Water Management for Fossil Energy Systems

Current Activities in Water Management Research and Development

**Susan M. Maley**
*Technology Manager for Crosscutting Research*
*U.S. Department of Energy/National Energy Technology Laboratory*

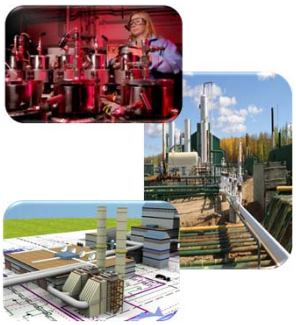
## Department Of Energy
## National Energy Technology Laboratory

**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...

- 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.



## Overview

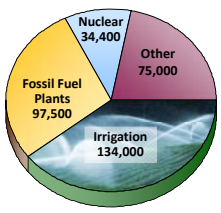
- Water
  - Essential, Ubiquitous, & Pervasive
- Water, Food/Land, & Energy are connected
- Water Management for Fossil Energy Based Systems



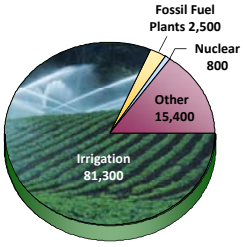
- Data and Information
- Program Planning
- Prioritization of Effort
- Working Together
  - Government
  - Industry
  - R&D Organizations

## Water Withdrawals and Consumptive Use

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




Withdrawals (Mgal/day)

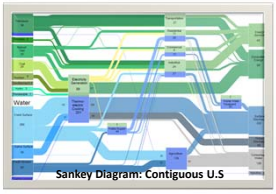



Consumptive Use (Mgal/day)

*Source: "Estimated Use of Water in the United States in 1995," USGS Circular 1200, 1998*

## Sankey Diagrams

Useful accounting for Water-Energy Efforts



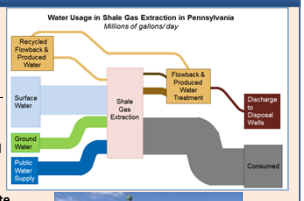

- Develop State based Sankey Diagrams
- Water Energy Nexus Team, NETL, and LLNL
- Improve and update data/inputs
- Address gaps in water and energy

## Water Balances Associated with Deep Gas

**State Level Assessment**

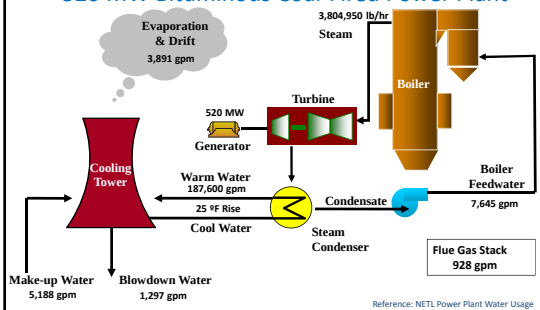
**Objective**
- Develop Sankey diagrams to illustrate water usage in shale gas/oil extraction by state

**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





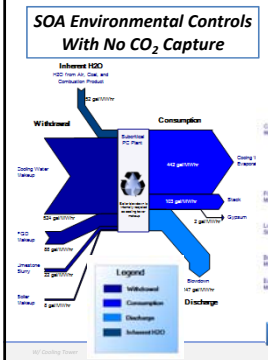

## Water Balance for 520 MW Bituminous Coal-Fired Power Plant

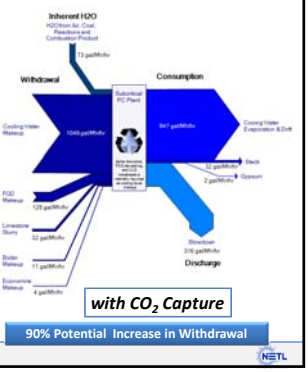



Reference: NETL Power Plant Water Usage and Loss Study, May 2007

## Sankey Diagram: Pulverized Coal Plant 500 MW

***SOA Environmental Controls With No $CO_2$ Capture***



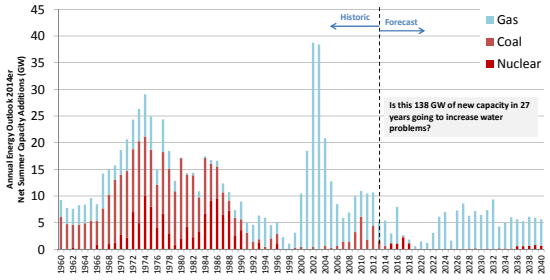




***with $CO_2$ Capture***

**90% Potential Increase in Withdrawal**

## Projected Power Generation Deployments

Example 1: Business as Usual Case - Based on AEO 2014 early release



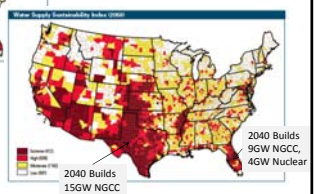

Does not take out retired units

NGCC used ~ 1/3 less water per MW than coal and nuclear steam units

Gas = gas fired combined cycle and steam units

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

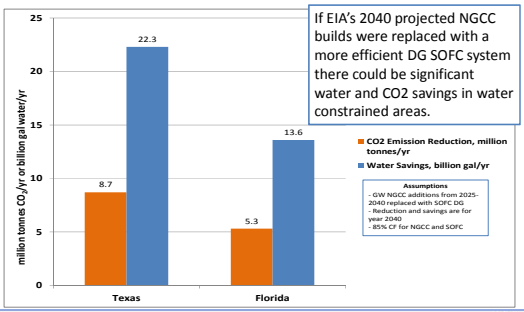
| State | Percent of Counties At-Risk for Water Shortage | Value of Crops Produced in At-Risk Counties ($000s) |
|---|---|---|
| Florida | 96% | 4,803,297 |
| Texas | 98% | 5,333,981 |




**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

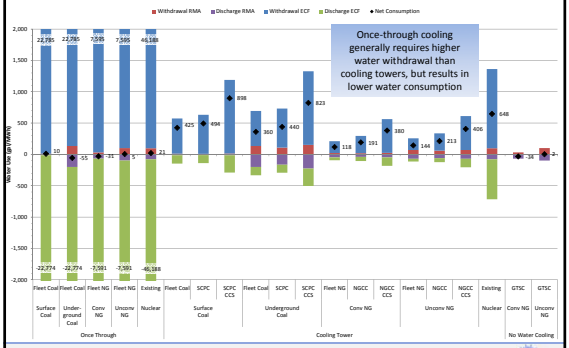
Distributed Generation Fuel Cell Impacts on $CO_2$ Emissions and Water Use




If EIA's 2040 projected NGCC builds were replaced with a more efficient DG SOFC system there could be significant water and CO2 savings in water constrained areas.

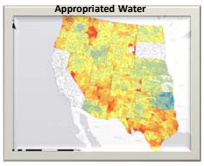
## Changes in Capacity Imply Changes in Water Use

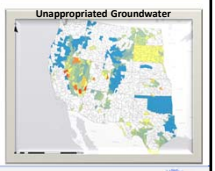
### Life Cycle Water Use for Power Generation




## Improving Data and Models

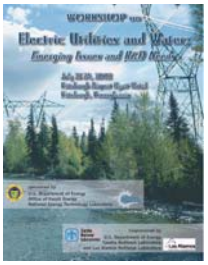
- **Collaboration with Sandia National Laboratory**
  - Build from prior work at SNL on water for water states
  - Eastern states data will be merged with existing western states data into aggregate database including detailed supporting metadata
- **Develop a Water Altas**
  - Build from data collection 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




*NETL's 2003 Electric Utility & Water Workshop*

## Thank You
## Questions

**Susan M. Maley**
**304-285-1321**
*Susan.maley@netl.doe.gov*

*NETL*
*www.netl.doe.gov*


*Office of Fossil Energy*
*www.fe.doe.gov*

**National Energy Technology Laboratory**

**@NETL_News**

## Water Reuse and Recovery

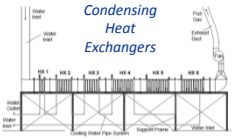
- ~81% power plants have municipal wastewater available within 10 miles
- Advanced treatment necessary, costs $0.91 - $1.32 (in 2009$/kgal) vs. $0.74 for river withdrawal and the city water costs of $2.95 (in 2009$/kgal)
- Economics and availability make this water source second to river withdrawal and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

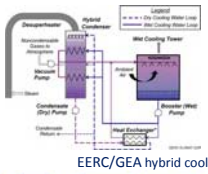
Pilot-scale cooling towers

**Use of Treated Municipal Wastewater as Power Plant Cooling System Makeup Water**

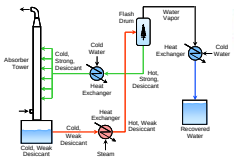
*Carnegie Mellon University*

## Advanced Cooling Technology




EERC/GEA hybrid cooling




Absorption with a Desiccant