SANDIA NATIONAL LABORATORIES

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Sandia National Laboratories Energy and Water Program

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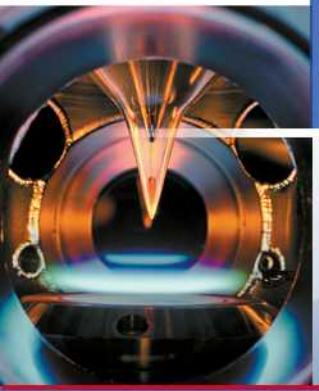


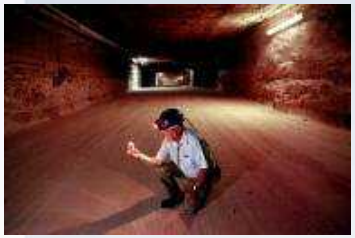
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

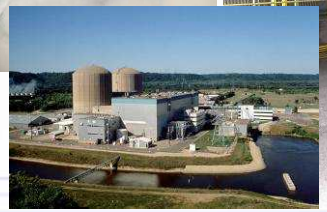
Sandia National Laboratories

Sandia is Organized into Three Strategic Management Groups

Integrated Technologies and Systems
Three Management Units

- *Energy, Resources, and Nonproliferation*
- *Homeland Security & Defense*
- *Defense Systems & Assessments*



Nuclear Weapons
One Management Unit

- *Nuclear Weapons*

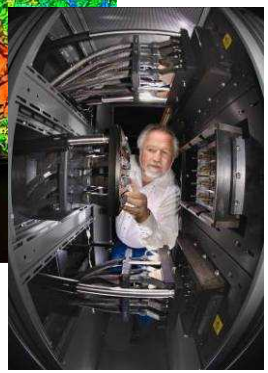



Laboratory Transformation
Two Management Units

- *Integrated Enabling Services*
- *Science, Technology, and Engineering*







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Energy Resources and Nonproliferation

National Nuclear Security Administration

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Objective Of The Fuel And Water Systems Program

Provide systems perspective and critical technological solutions for fuel and water that help assure:

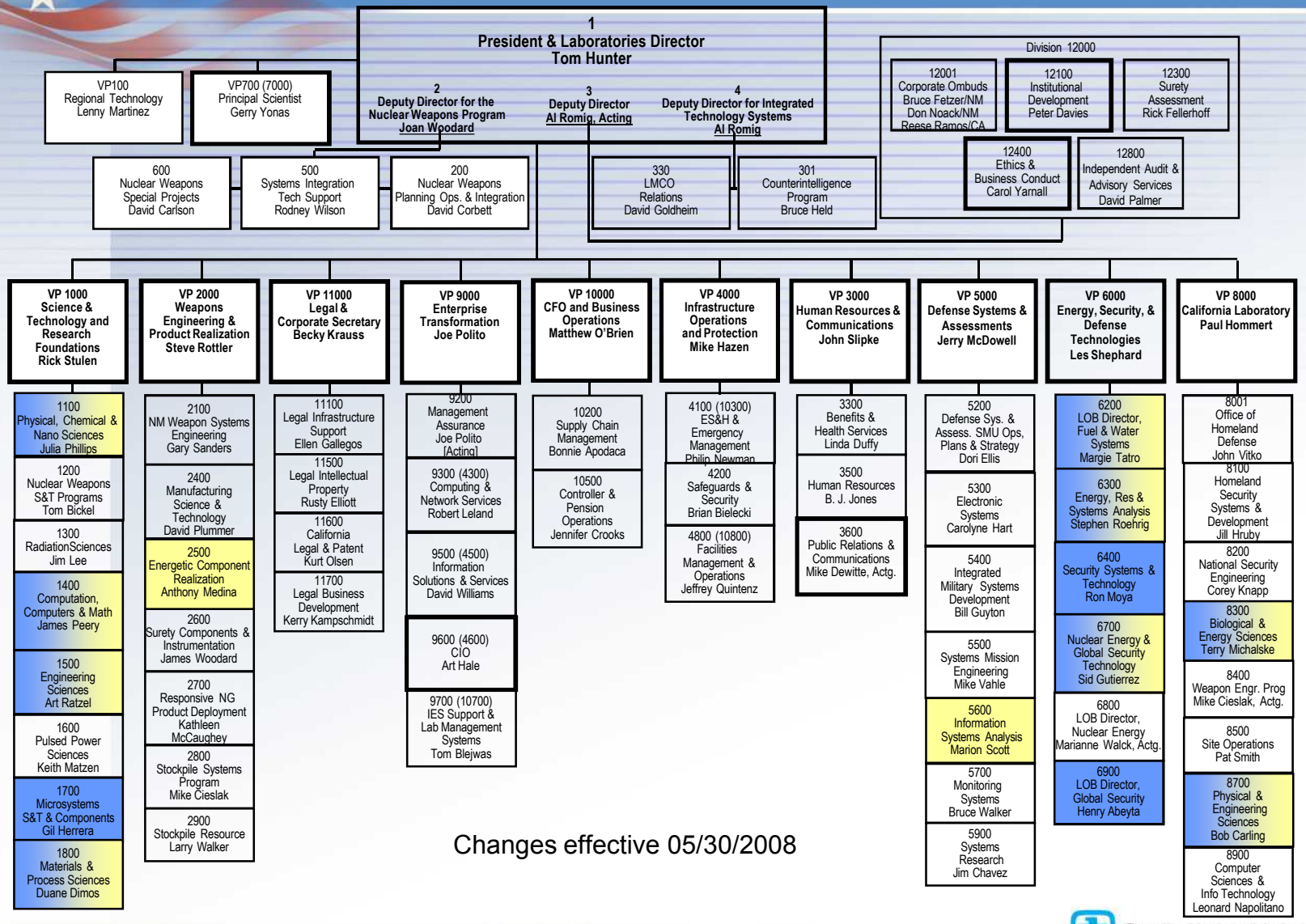
Secure and sustainable supply;

Safe and resilient delivery infrastructure; and

Clean and efficient use of resources.

- Safe
- Secure
- Reliable
- Sustainable
- Cost Effective
- Integrated Systems

Water And Energy Programs Reach Across Sandia



Changes effective 05/30/2008

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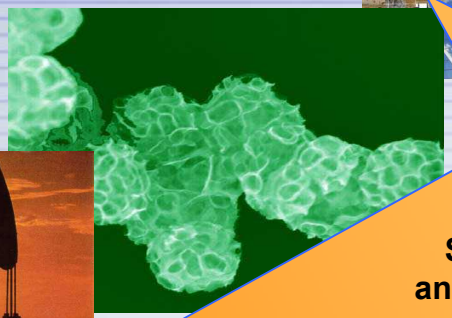
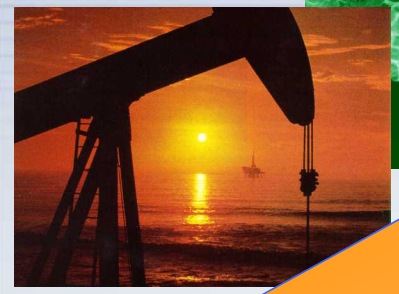
Enabling Options For Fuels While Improving Efficiency

FUTURE





Hydrogen

Synfuels and Biofuels

Coal to Liquids and Biodiesel

Expand and extend petroleum while managing carbon

Improve Efficiency & Understand Entire System

TODAY

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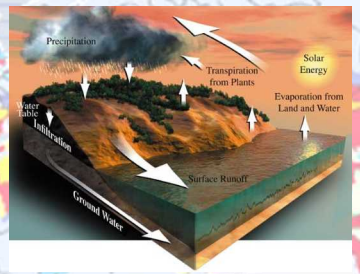
Sandia's Water Program Has National And International Impact In Four Focus Areas

Treatment Technologies

Modeling & Management



Security Systems

Energy-Water

Sandia National Laboratories

But, We Have No Illusions Of Having Impact Without Key Partnerships

bp · NETL · Los Alamos NATIONAL LABORATORY · Strata Production Company · ExxonMobil · ConocoPhillips · bhpbilliton · PETROBRAS · KERR-McGEE CORPORATION · Chevron · KINDER MORGAN · New Mexico Tech SCIENCE-ENGINEERING-RESEARCH-UNIVERSITY

NREL · GE · SES · HALLIBURTON · NOBLE

cea Commissariat à l'Energie Atomique · GENERAL ATOMICS · IAEA · INL Idaho National Laboratory · Los Alamos NATIONAL LABORATORY · United States Nuclear Regulatory Commission · ATM

LUMILEDS LIGHT FROM SILICON VALLEY · CABOT · Pacific Northwest National Laboratory · CREE · DOW CORNING · PHILIPS · COLOR KINETICS

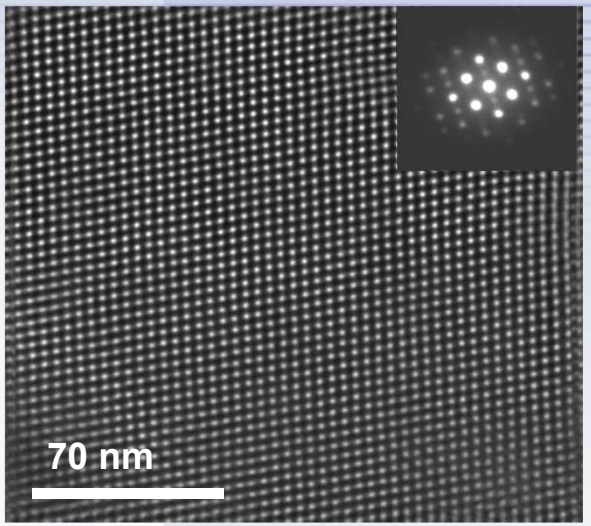
The University of Texas at Austin · Texas Tech · Oak Ridge National Laboratory · Argonne National Laboratory · Berkeley Lab · BROOKHAVEN NATIONAL LABORATORY · Pacific Northwest National Laboratory

Energy Water Modeling:
An Abbreviated Model Demonstration

1. **Decision Support for Integrated Water-Energy Planning: Plant-Level Analysis Model**
   - Similar in spirit to the Feeley et al. (2008) paper;
   - "Water: a critical resource in the thermoelectric power industry. Energy, Volume 33, Issue 1, January 2008, Pages 1-11."
2. **Energy-Water Project Management Research***
   - "Evaluating Saline Aquifers for Combined Carbon Sequestration and Power Plant Cooling Water Needs," 7th Annual CCS conference with NETL & SNL authors
   - Upcoming Conference Paper Presentation, USAEE/IAEE, December '08
3. **Energy-Water Project Management Research: Phase 2***
4. **Regional Water Stress***
5. **Nanofiltration Treatment Options for Thermoelectric Power***

Advanced Desalination Membrane Technologies Can Reduce Energy Use

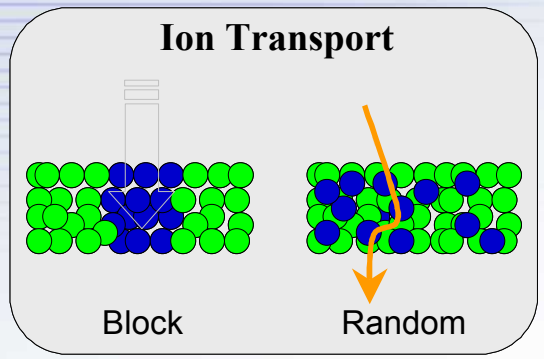
Challenge: ***Energy use is ~40-60% of desalination water cost***
Approach: Create energy efficient ***nano-porous membranes***



Brinker, SNL

Evaporation-induced self-assembled silica

- tunable pore size
- flexible chemical functionality



nano-phase separated di-block copolymers

- high conductivity ion transport in ED and fuel cell membranes
- high chemical and mechanical stability

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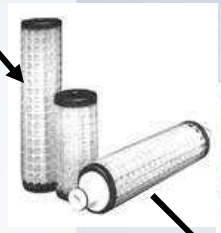
Beneficial Use Of Coalbed Methane Produced Water: Rangel And Rehabilitation

Treat Produced Water from Coal Bed Natural Gas Wells Economically

Removal of Coal Fines, Iron, Organics Precede Desalination, (RO)

Cyclone Separator



Progressive Cartridge Filtration

Ultrafiltration and RO (Reverse Osmosis)

Processing Produced Water, Site Provided & Prepared by ConocoPhillips

Use Treated, Untreated Water in Revegetation Study on the ConocoPhillips Site

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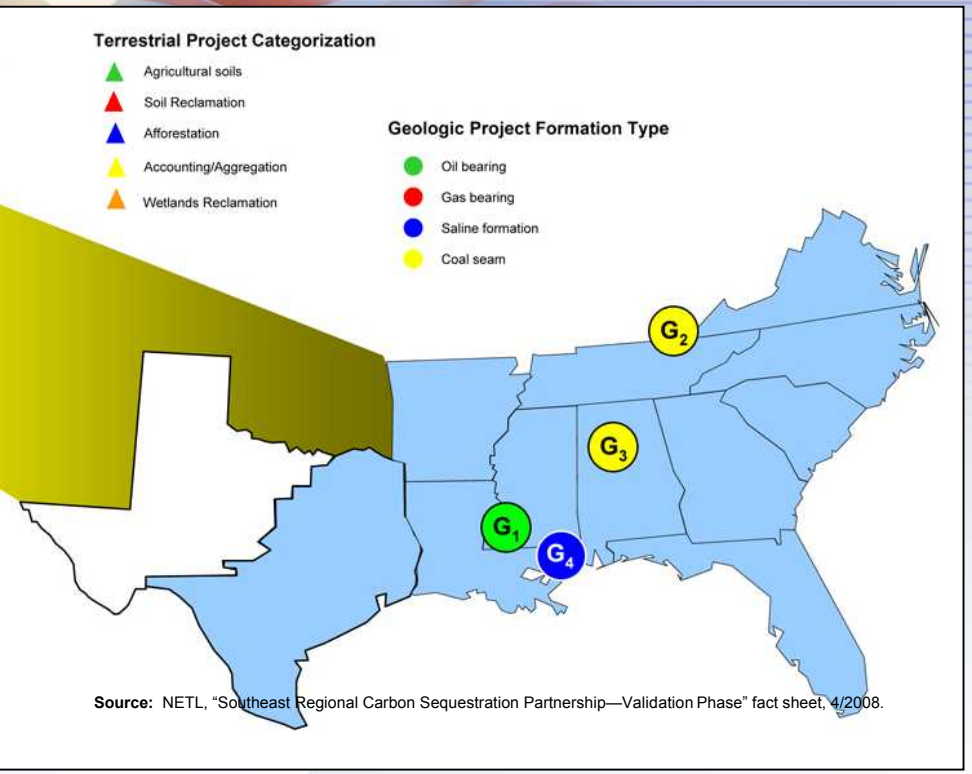
“Regional Water Stress”

Sandia And NETL Working Together On Site Selection – Dovetailing With SECARB Region

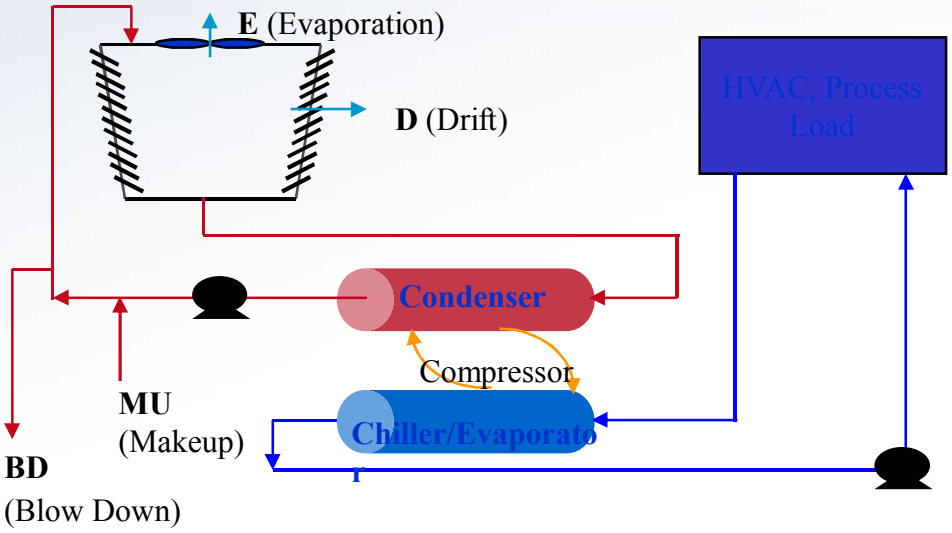


Source: NETL, “Southeast Regional Carbon Sequestration Partnership—Validation Phase” fact sheet, 4/2008.

Looking to identify Water Treatment Viability for power plant options (physical and economic)

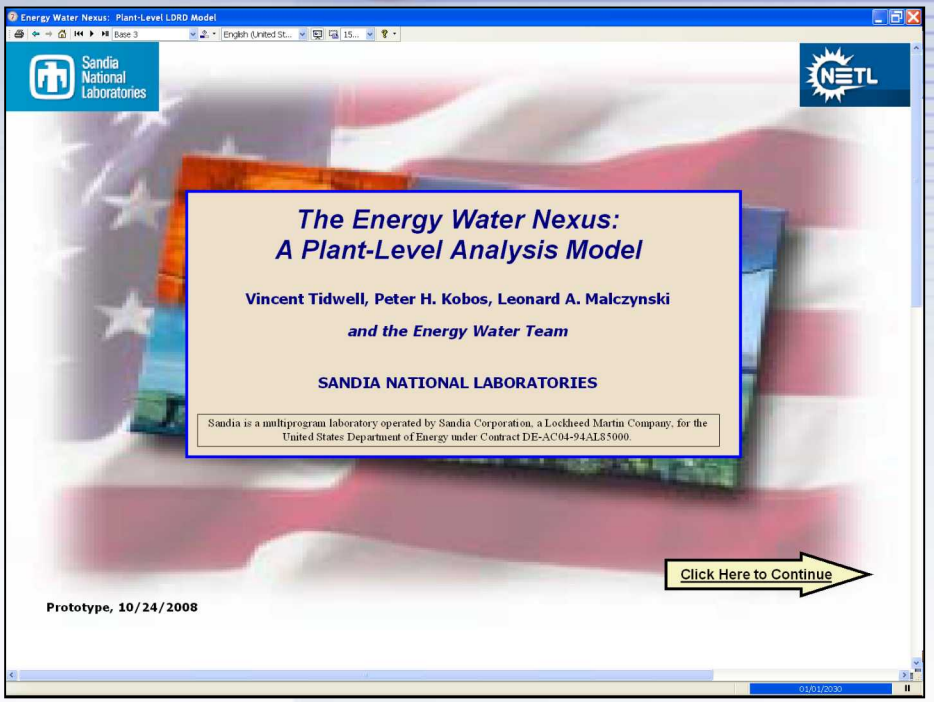
Understanding regional water stress issues and potential solutions within a framework for analysis.

Nanofiltration Treatment Options For Thermoelectric Power Plant Water Treatment Demands



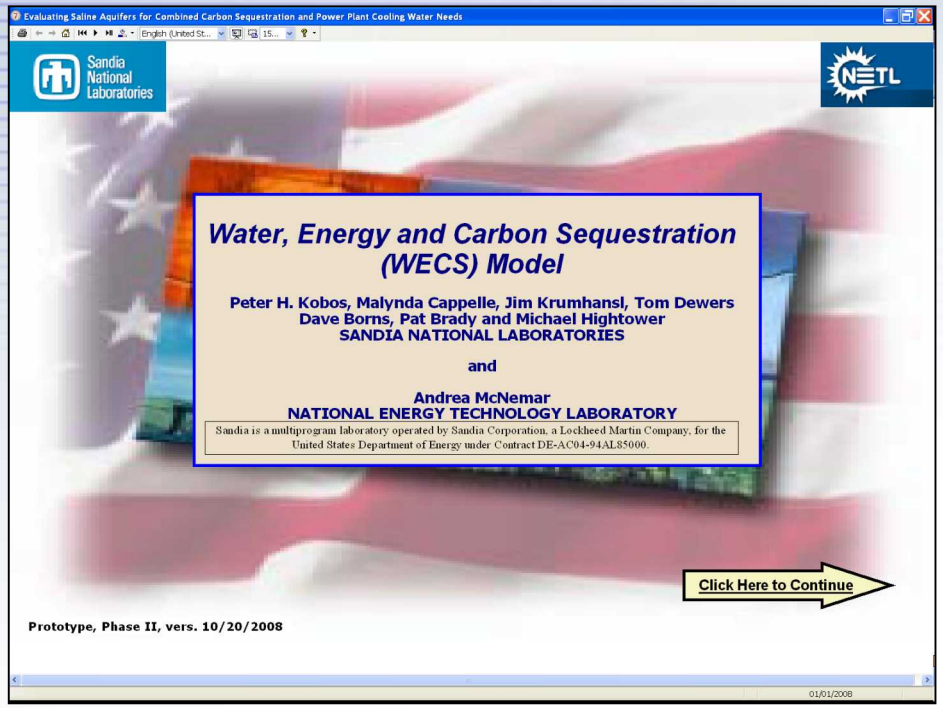
Two Models, One Purpose:

Collaboration on Energy and Water Systems Analysis



Integrated Water-Energy Planning:

"Plant-Level Analysis Model"



Energy-Water Project Management Research:

"Water, Energy and Carbon Sequestration (WECS) Model"

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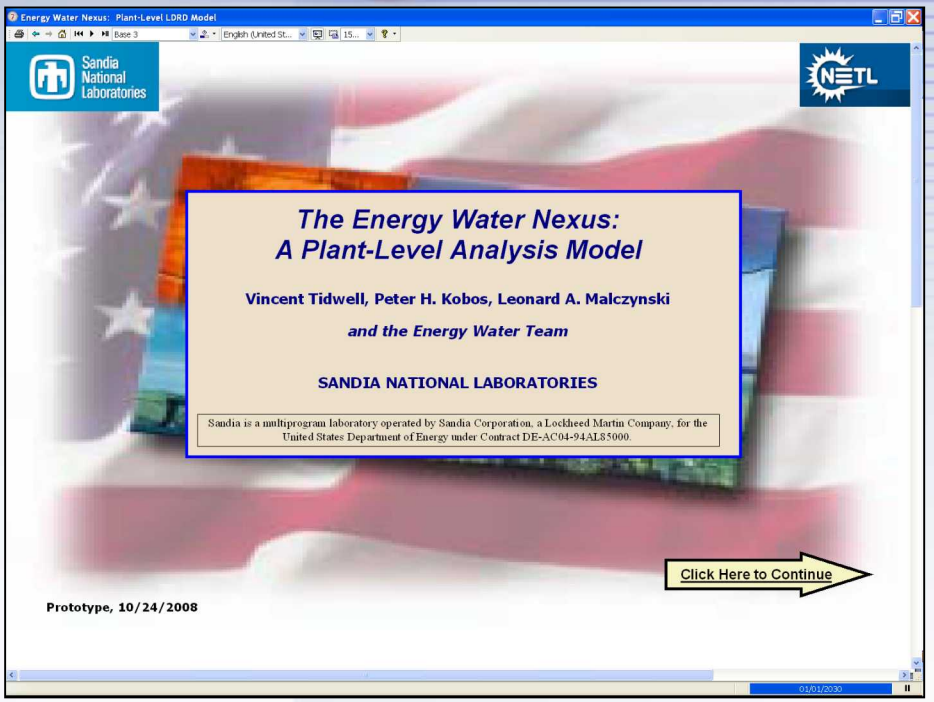
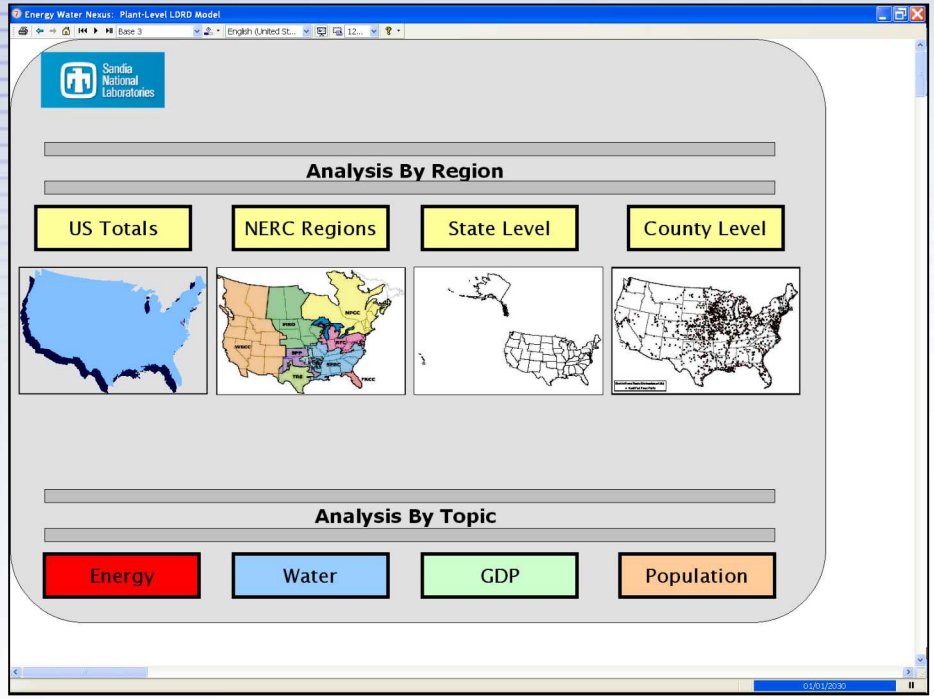
Integrated Water-Energy Planning:
"Plant-Level Analysis Model"





Integrated Water-Energy Planning:
"Plant-Level Analysis Model"

Water Demand by Sector

- *Summaries and Detail: from the National Level to the Power Plant*
- *GDP, Population Growth Changes*
- *Technology Deployment Scenarios*

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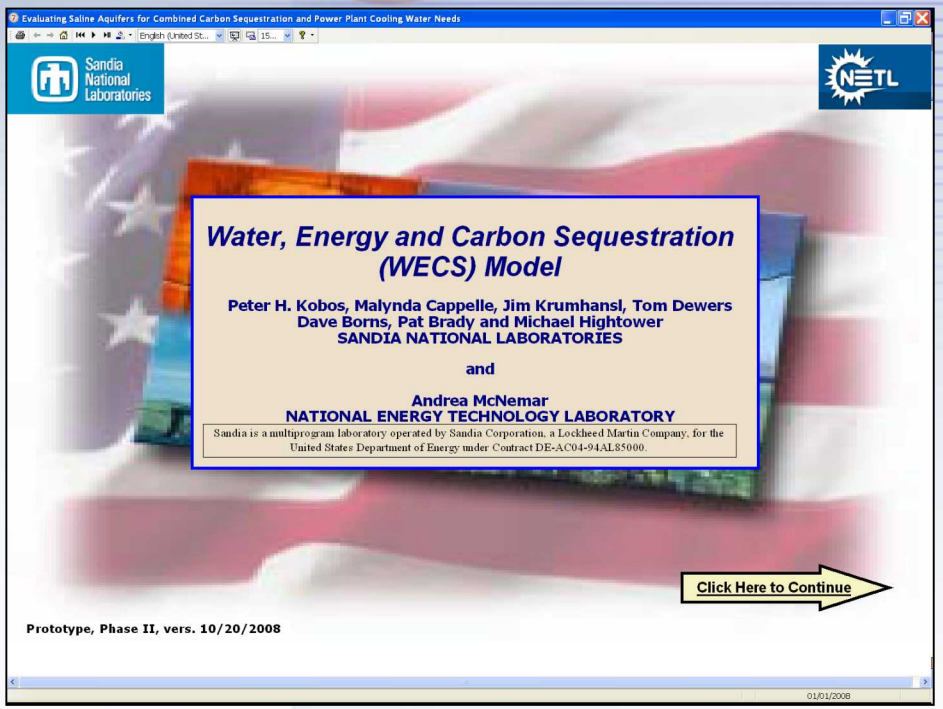
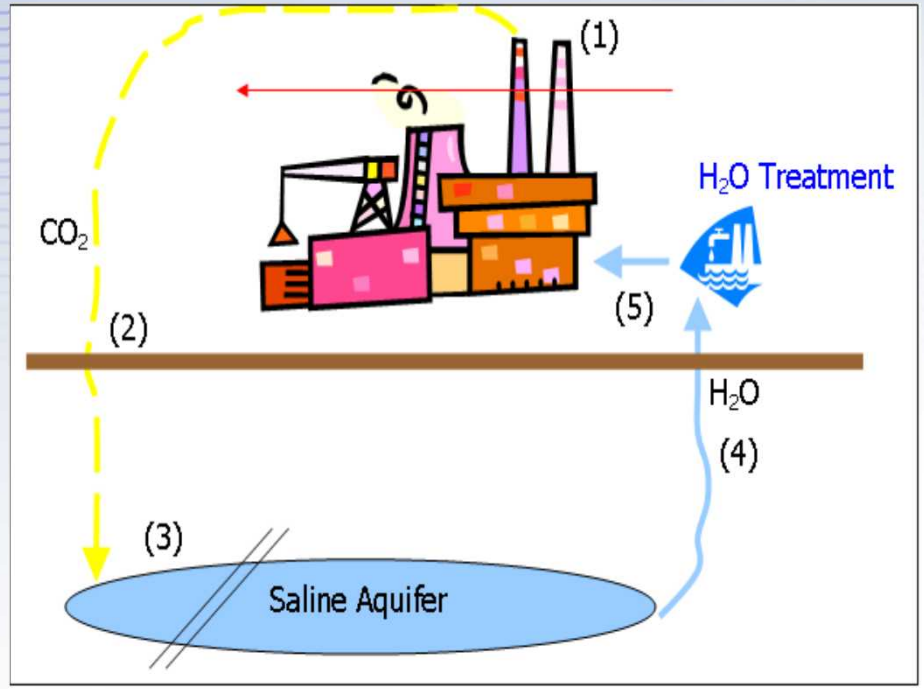
Energy-Water Project Management Research:
"Water, Energy and Carbon Sequestration (WECS) Model"





Energy-Water Project Management Research:
"Water, Energy and Carbon Sequestration (WECS) Model"

Coupled Carbon Sequestration and Water Treatment System

- *Carbon Seq., Geostudies, Water Treatment*
- *Can it Scale up?*
- *Cost, Water and Energy Constraints?*

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Questions & Answers