


U.S. Department of Energy

Briefing on Water

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Office of Fossil Energy
November 30, 2016

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Three overarching themes

Mitigation (Emissions Reduction)

- *ALL OF THE ABOVE Energy Strategy*
- Efficiency, Renewables, Nuclear, Gas
- Coal with CCS/CCUS

Adaptation and Resilience

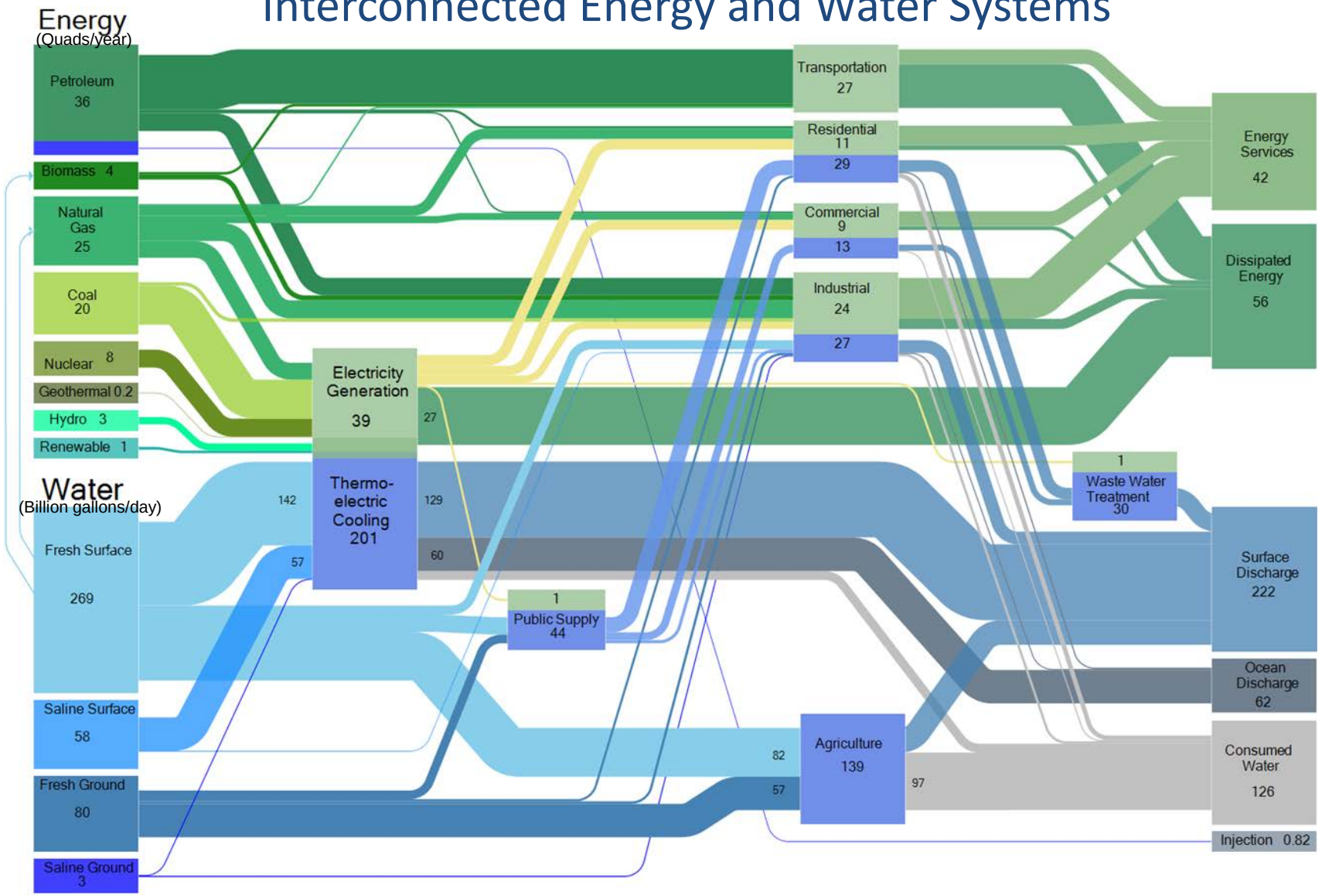
- Smart, reliable grid
- Key infrastructure investments

International Partnerships

- China and Asia
- Coordinated Intl. Efforts

Sankey Diagram: Contiguous U.S.

Interconnected Energy and Water Systems



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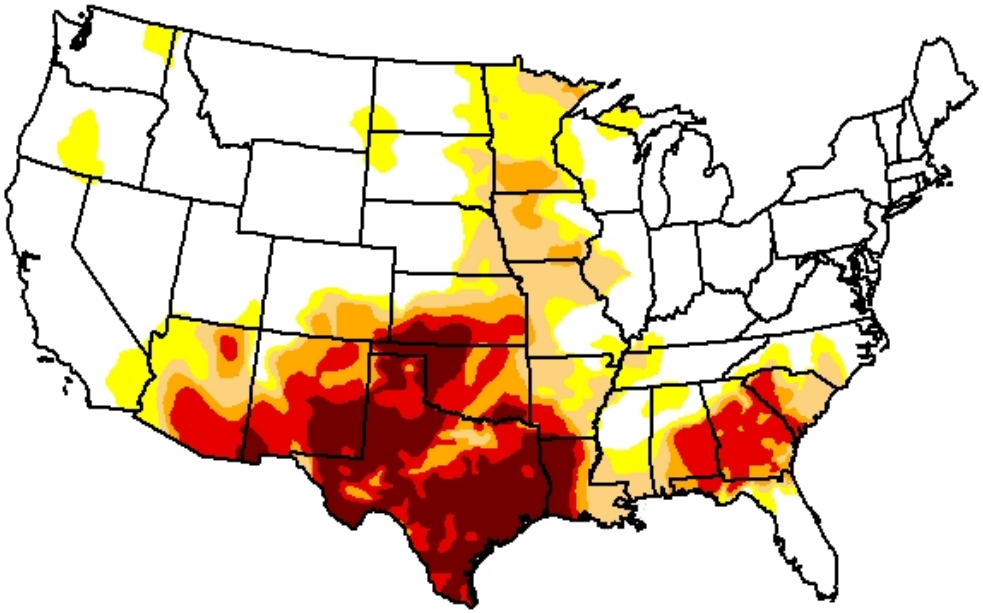
http://www.energy.gov/sites/prod/files/2014/07/f17/Water Energy Nexus Full Report July 2014.pdf

U.S. Drought Monitor
CONUS



November 8, 2011

(Released Thursday, Nov. 10, 2011)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	55.82	44.18	33.16	23.99	17.50	8.78
Last Week 11/1/2011	56.98	43.02	32.56	24.35	17.73	8.86
3 Months Ago 8/9/2011	55.01	44.99	32.86	24.74	18.48	11.46
Start of Calendar Year 1/4/2011	60.50	39.50	21.74	8.50	2.60	0.00
Start of Water Year 9/27/2011	56.45	43.55	29.13	23.44	17.80	11.37
One Year Ago 11/9/2010	61.47	38.53	16.51	6.44	1.37	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author(s):
Brian Fuchs
National Drought Mitigation Center

http://droughtmonitor.unl.edu/

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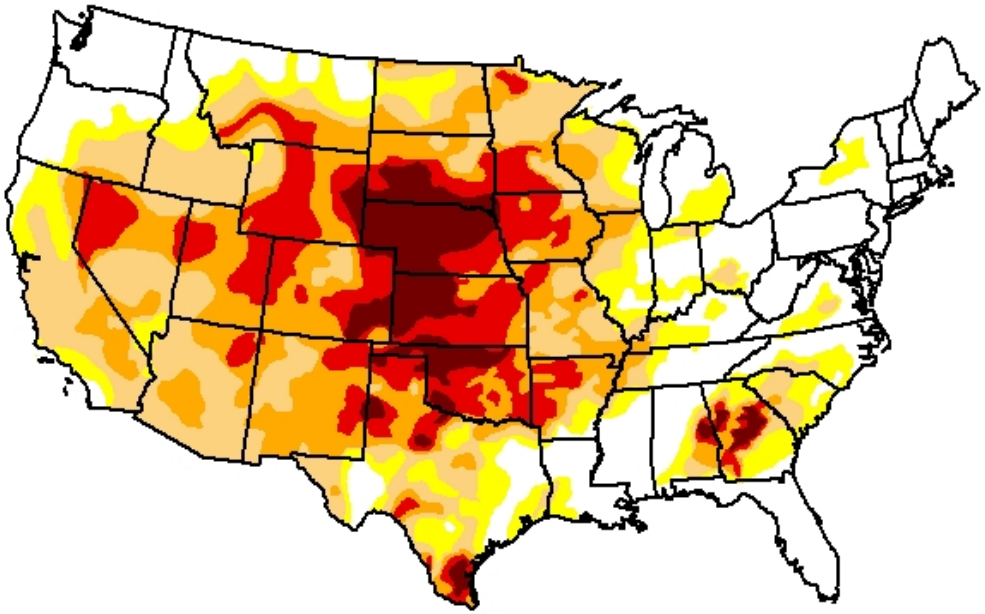
U.S. Drought Monitor
CONUS



November 6, 2012
(Released Thursday, Nov. 8, 2012)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	27.48	72.52	59.48	38.05	19.36	6.18
Last Week 10/30/2012	27.12	72.88	60.16	38.27	19.04	5.88
3 Months Ago 8/7/2012	21.86	78.14	62.46	46.01	24.14	4.21
Start of Calendar Year 1/3/2012	50.41	49.59	31.90	18.83	10.18	3.32
Start of Water Year 9/25/2012	23.41	76.59	65.45	42.12	21.48	6.12
One Year Ago 11/8/2011	55.82	44.18	33.16	23.99	17.50	8.78

Intensity:

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Author(s):
David Miskus
NOAA/NWS/NCEP/CPC

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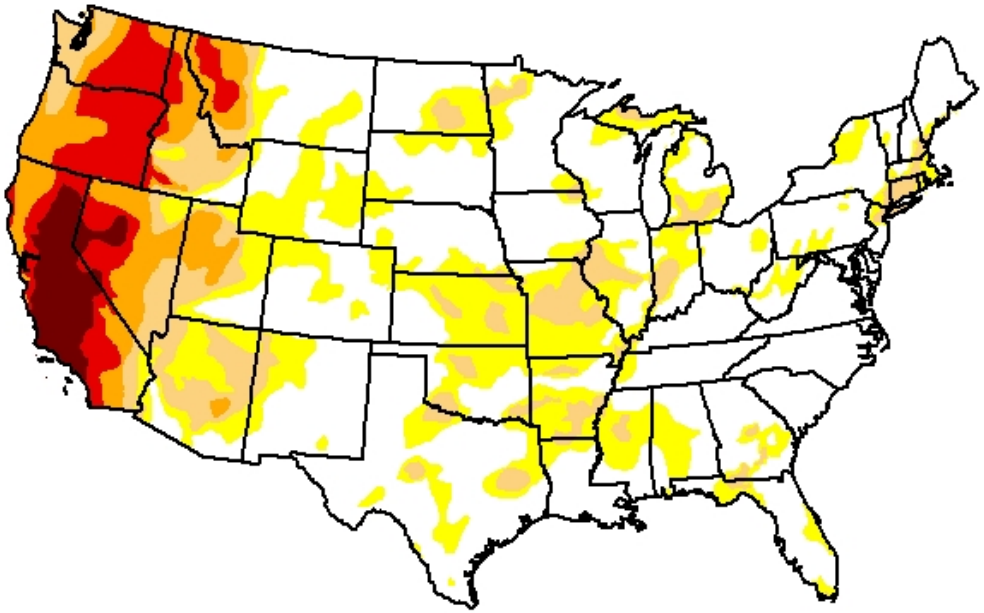
U.S. Drought Monitor
CONUS



November 3, 2015
(Released Thursday, Nov. 5, 2015)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	51.84	48.16	26.17	15.46	8.84	2.72
Last Week *10/27/2015*	46.24	53.76	30.27	17.21	10.34	3.00
3 Months Ago *8/4/2015*	57.71	42.29	27.13	17.44	8.79	2.83
Start of Calendar Year *12/30/2014*	53.20	46.80	28.68	16.93	8.96	2.54
Start of Water Year *9/29/2015*	44.91	55.09	31.36	20.09	11.45	3.00
One Year Ago *11/4/2014*	54.74	45.26	29.86	17.70	8.91	3.81

Intensity:

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David Miskus
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/

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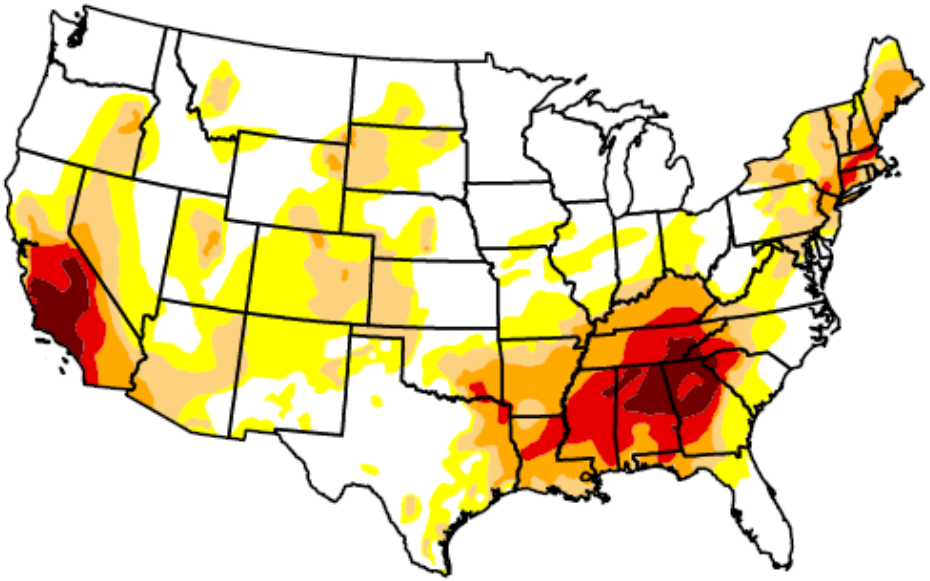
U.S. Drought Monitor
CONUS



November 22, 2016
(Released Wednesday, Nov. 23, 2016)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	45.00	55.00	31.14	17.07	8.26	2.73
Last Week *11/15/2016*	48.01	51.99	30.13	14.44	6.40	2.36
3 Months Ago *8/23/2016*	54.63	45.37	19.42	7.41	2.70	1.11
Start of Calendar Year *12/29/2015*	66.99	33.01	18.74	11.56	6.28	2.70
Start of Water Year *9/27/2016*	53.60	46.40	18.96	8.10	3.20	1.16
One Year Ago *11/24/2015*	61.55	38.45	21.90	14.83	8.42	2.70

Intensity:

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Author(s):
Richard Heim
NCEI/NOAA

http://droughtmonitor.unl.edu/

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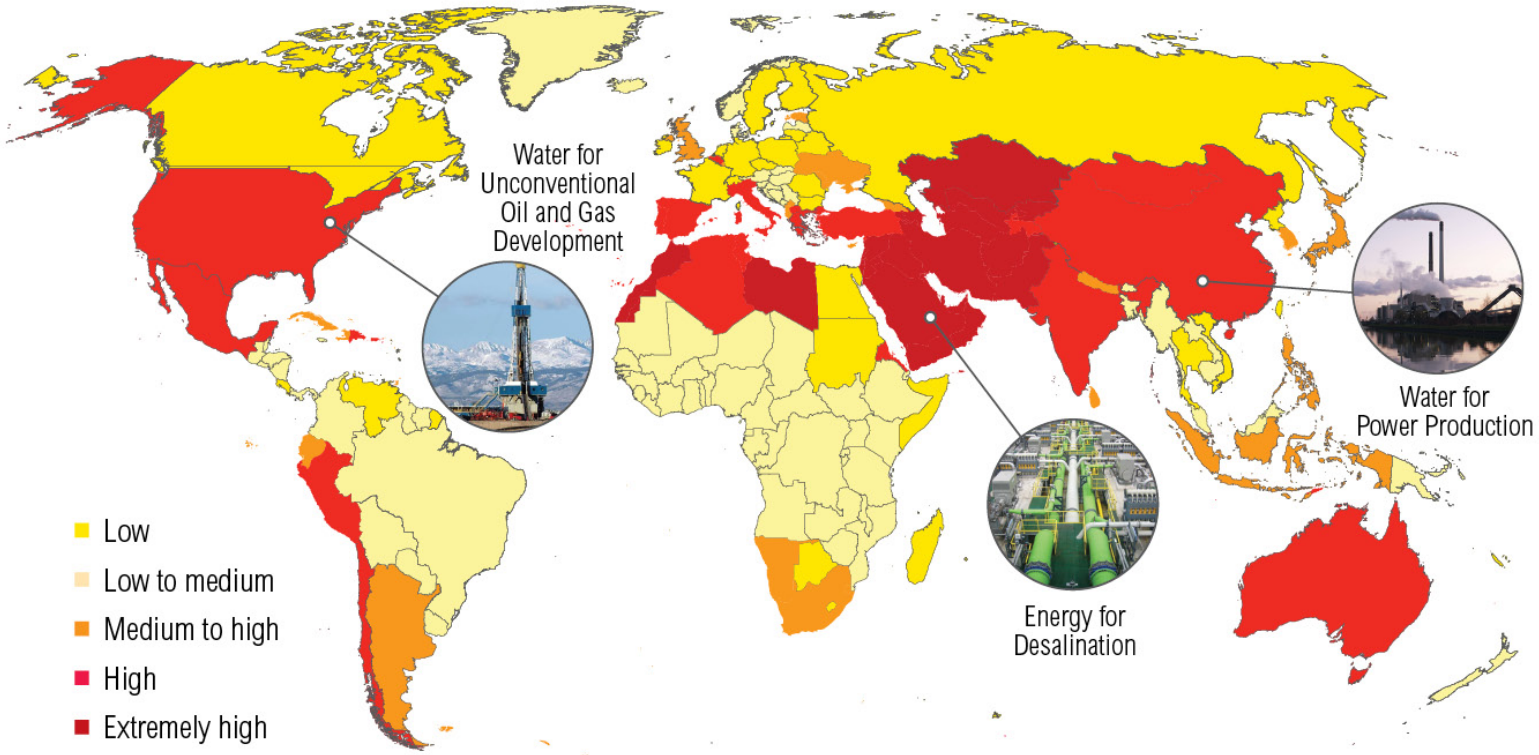
Projections of Water Stress in 2020 under Business-as-Usual Climate and Socioeconomic Scenarios, by Country



Note: Water stress is the ratio between total water withdrawals and available renewable surface water in a subcatchment.
Source: Water stress projections from WRI Aqueduct (Luo, Young, and Reig 2015).

www.wri.org/publication/water-energy-nexus

WORLD RESOURCES INSTITUTE

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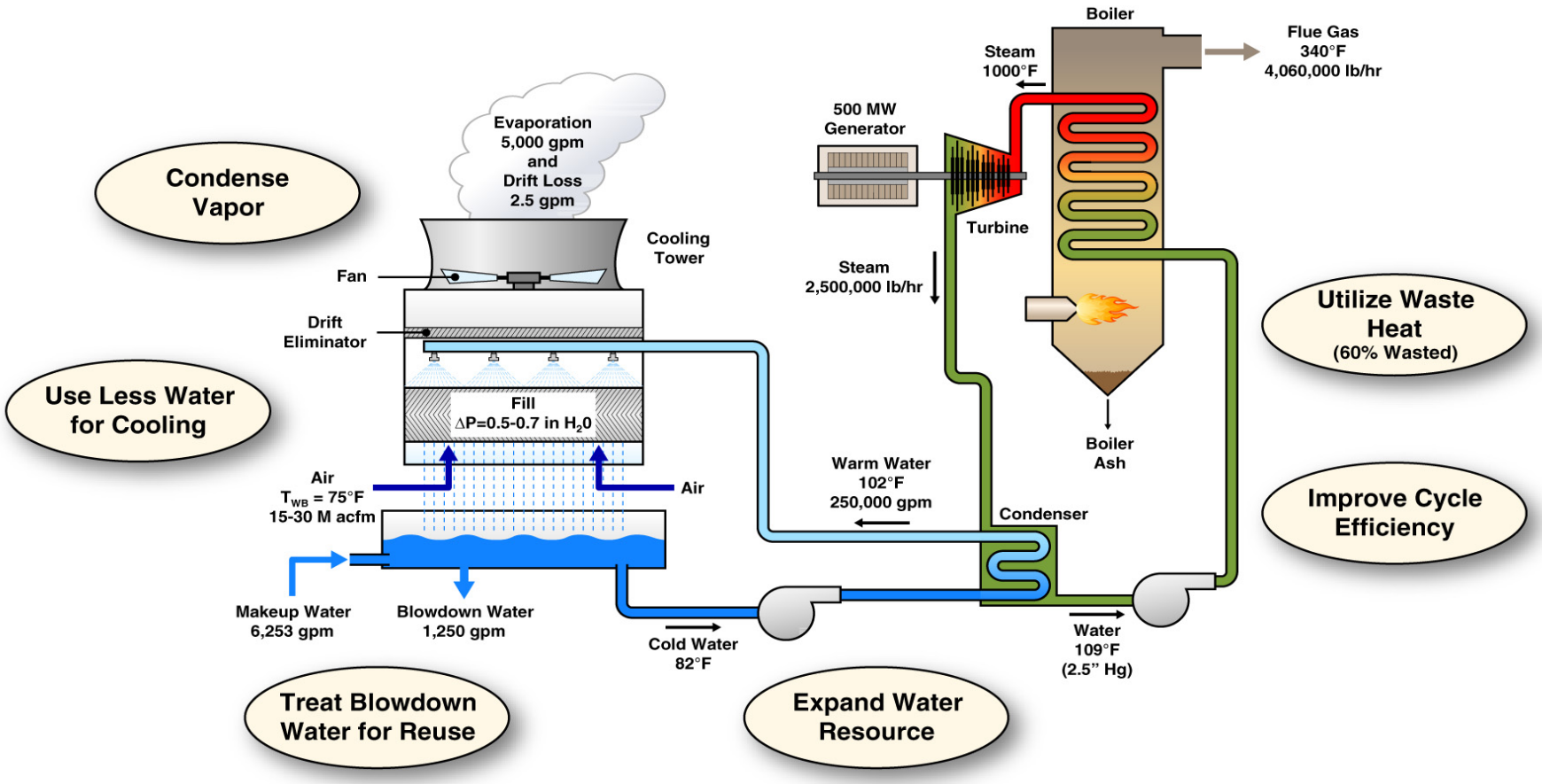
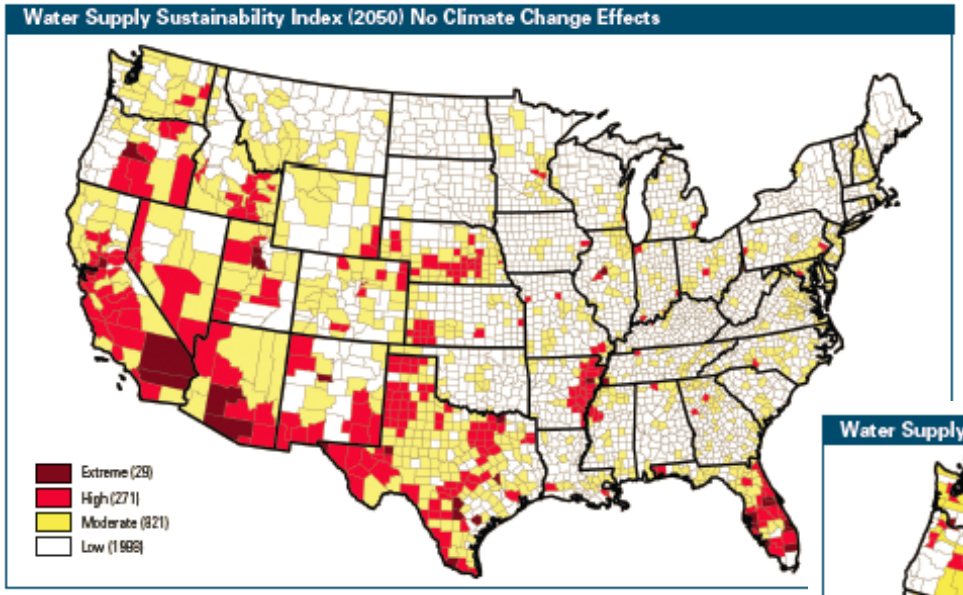
Water Research Opportunities



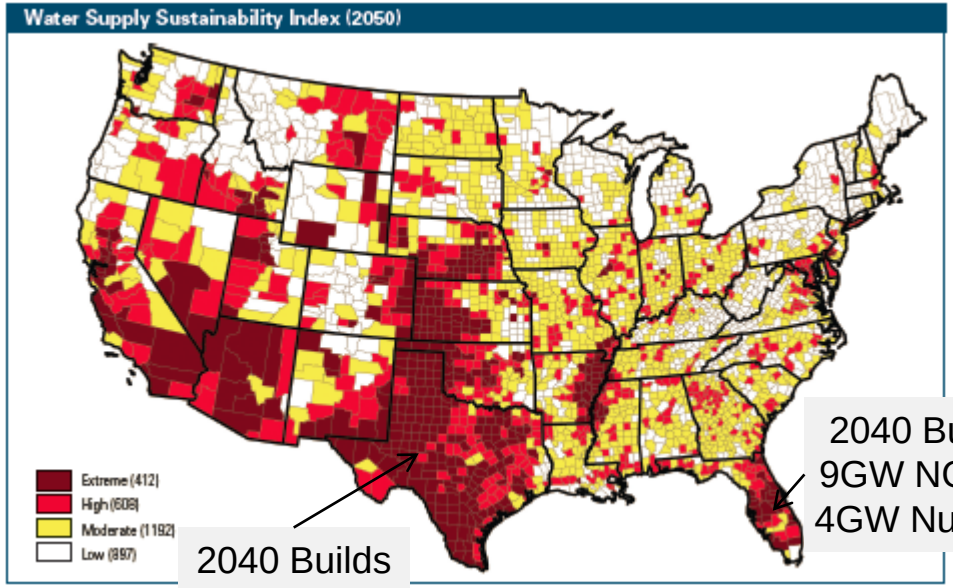
<u>Innovation Priorities</u>: Advancing cooling technologies, and applying novel water treatment and waste heat concepts to improve efficiency and reduce water use

Courtesy Dr. Jessica Shi at EPRI

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

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National Resources Defense Council: http://www.nrdc.org/globalWarming/watersustainability/

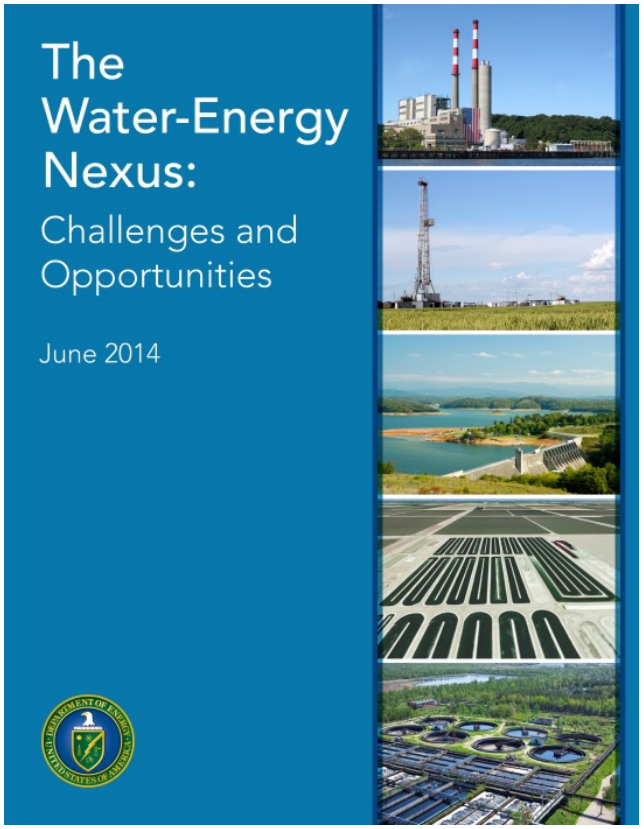
NETL

Energy-Water Nexus: DOE's Role

- DOE has strong expertise in technology, modeling, analysis, and data and can contribute to understanding the issues and pursuing solutions across the entire nexus.

- Our work has broad and deep implications
  - User-driven analytic tools for national decision-making supporting energy resilience with initial focus on the water-energy nexus
  - Solutions through technology RDD&D, policy analysis, and stakeholder engagement

- We can approach the diffuse water area strongly from the energy side
  - Focus on our technical strengths and mission
  - Leverage strategic interagency connections



Download the full report at energy.gov

DOE 2015 Water-Energy Nexus Roundtables

Technology RDD&D opportunities and actions:

- Water efficiency
- Substitutes for water
- Advances in water treatment
- Net-zero wastewater treatment

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Water-Energy Technology Team Strategic Pillars

- Optimize the freshwater efficiency of energy production, electricity generation, and end use systems
- Optimize the energy efficiency of water management, treatment, distribution, and end use systems
- Enhance the reliability and resilience of energy and water systems
- Increase safe and productive use of nontraditional water sources
- Promote responsible energy operations with respect to water quality, ecosystem, and seismic impacts
- Exploit productive synergies among water and energy systems

CERC Protocol

- CERC Protocol Signed in Nov. 2009
- Calls for Joint U.S.-China Clean Energy Research Center (Virtual, not Physical)
- CERC Goals:
  - Spur Innovation of Clean Energy Techs
  - Diversify Sources of Energy Supply
  - Improve Energy Efficiency
  - Accelerate Transition to Low-Carbon Future
  - Avoid the Worst Consequences of Climate Change
- Three Areas for Initial Cooperation – Clean Coal; Clean Vehicles; and Efficient Buildings
- Joint Work Plans Signed in Jan. 2011
- Announced New Area on Energy & Water, November 2014
- Open to Other Areas in the Future

Presidents Obama and Xi Jinping announced extension of CERC from 2016 to 2020 and expanded scope to include water related aspects of energy production and use.

U.S.-China CERC: Energy and Water FOA Overview

The United States Department of Energy (DOE) solicited applications for the formation of a Consortium to pursue five identified R&D topics at the nexus of energy and water. These topics are:

1) Water use reduction at thermoelectric plants -- FE
2) Treatment and management of non-traditional waters -- FE
3) Improving sustainable hydropower design and operation -- EERE
4) Climate impact modeling, methods, and scenarios to support improved energy and water systems understanding -- SC
5) Data and analysis to inform planning, policy, and other decisions -- EPSA

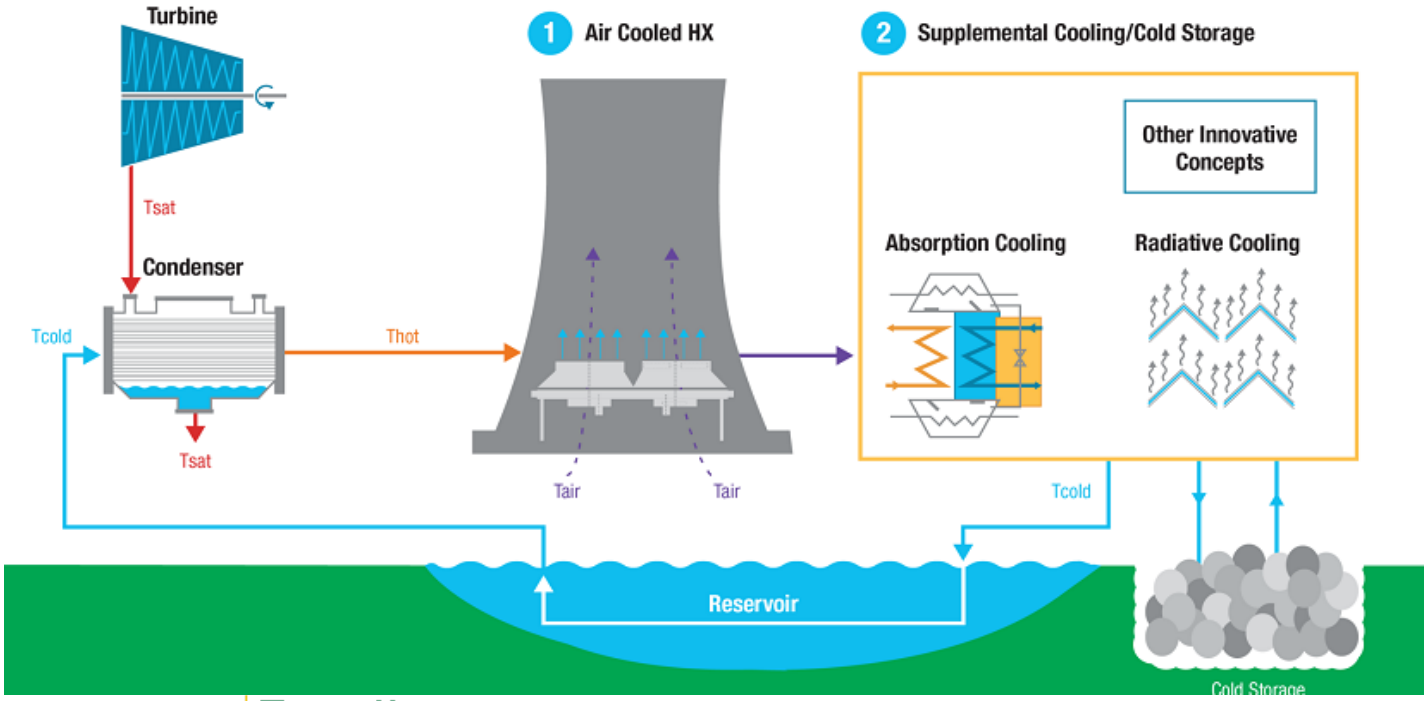
The Consortium that is funded through this solicitation forms a new technical track under the U.S.-China Clean Energy Research Center, which is a bilateral initiative to encourage R&D collaboration and accelerate technology development and deployment in both countries. DOE funding will support the U.S. Consortium. In parallel, and with equivalent resources, Chinese funding will support a counterpart Chinese Consortium.

ARPA-E: Dry Cooling for Electricity Generation

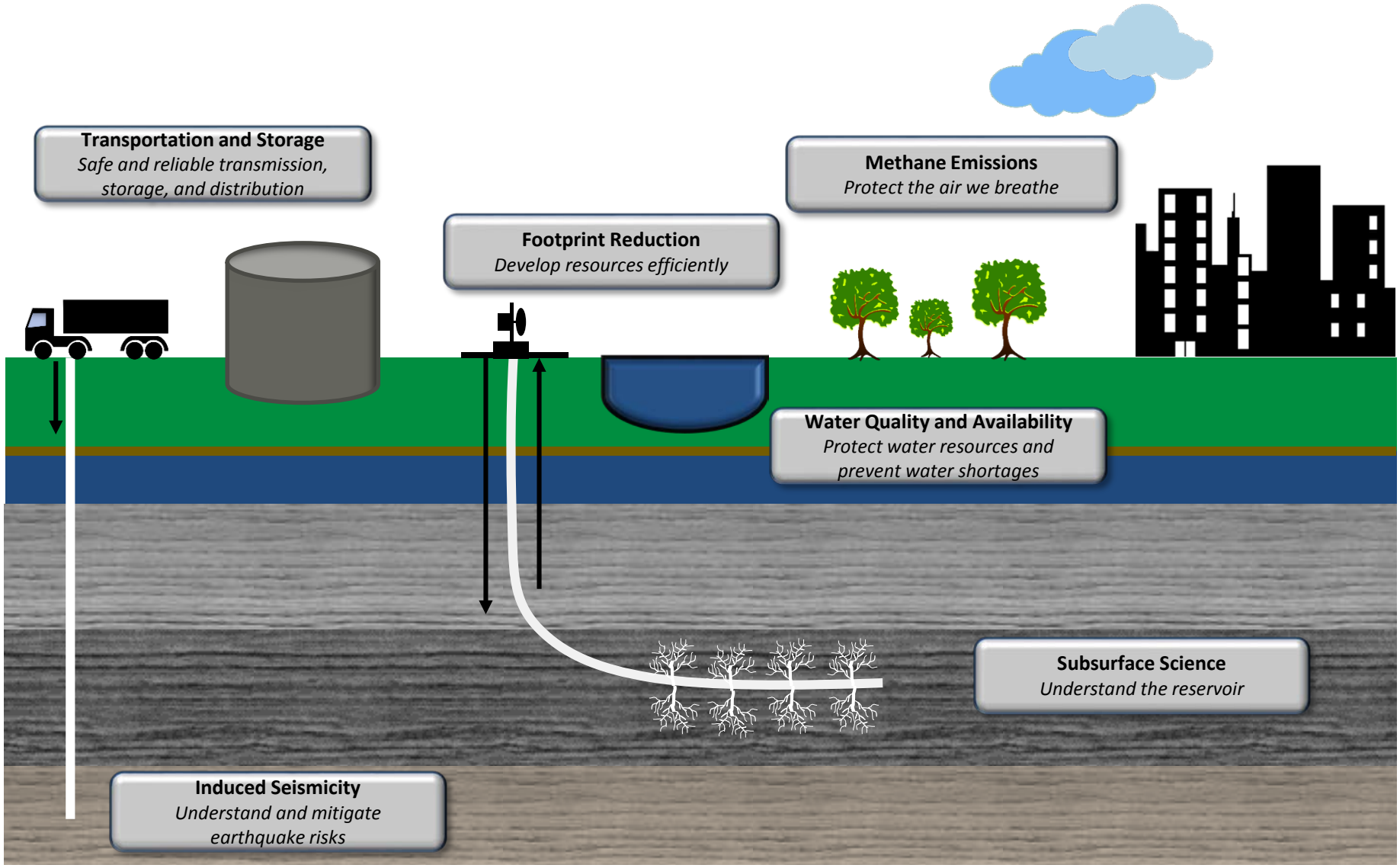
ARPA-E's Advanced Research in Dry Cooling (ARID) Research Solicitation is funding 14 projects for a total of $30 million:

- Air-cooling heat exchangers (3 projects)
- Sorption & other supplemental cooling (4 projects)
- Radiative cooling and cool storage (3 projects)
- Flue gas H_2O recovery & cool storage (2 projects)
- Combined ACC & cool storage (2 projects)

Sample Indirect Dry-Cooling System that Satisfies ARID Program Objectives

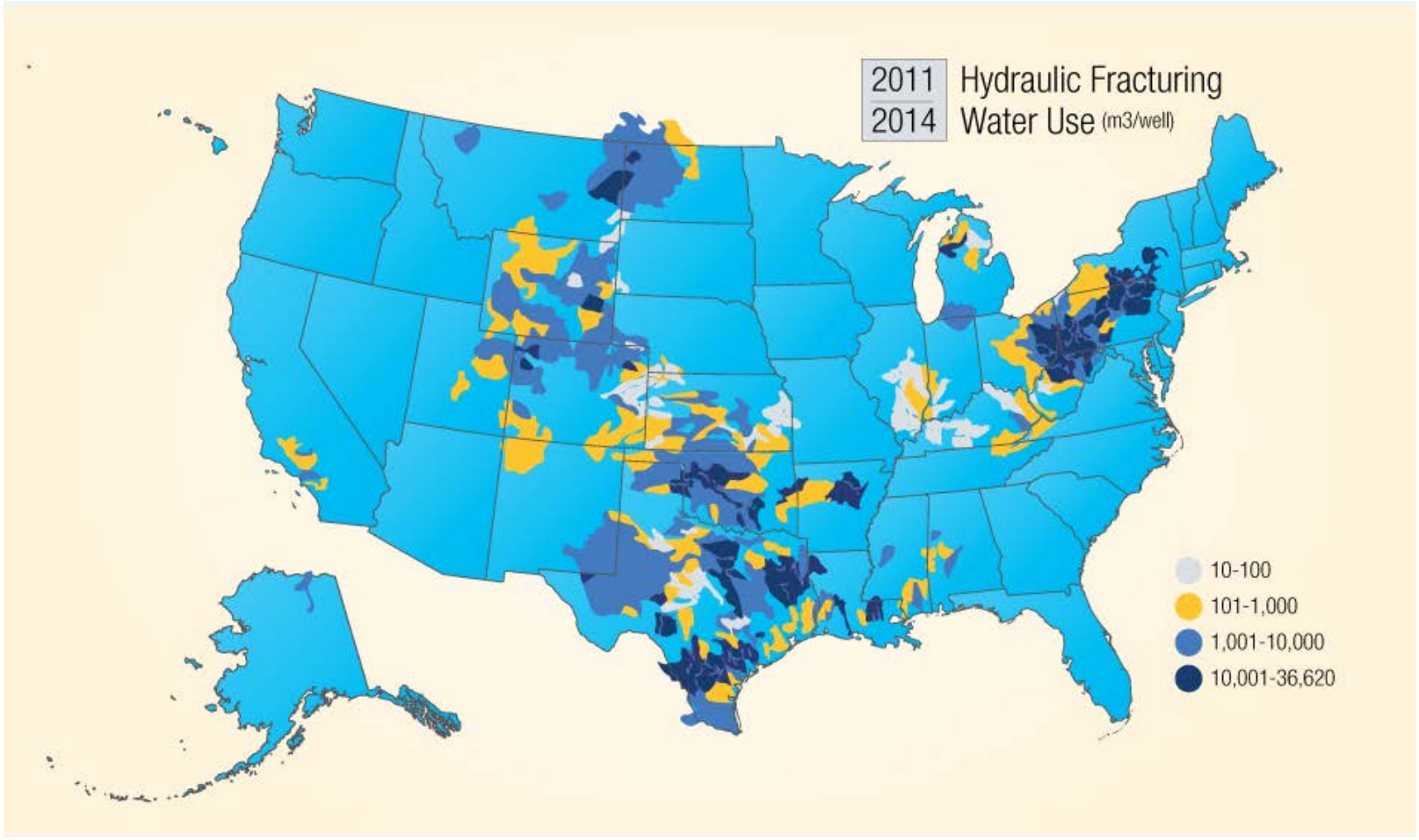


OFFICE OF OIL AND NATURAL GAS
RESEARCH & DEVELOPMENT SCOPE



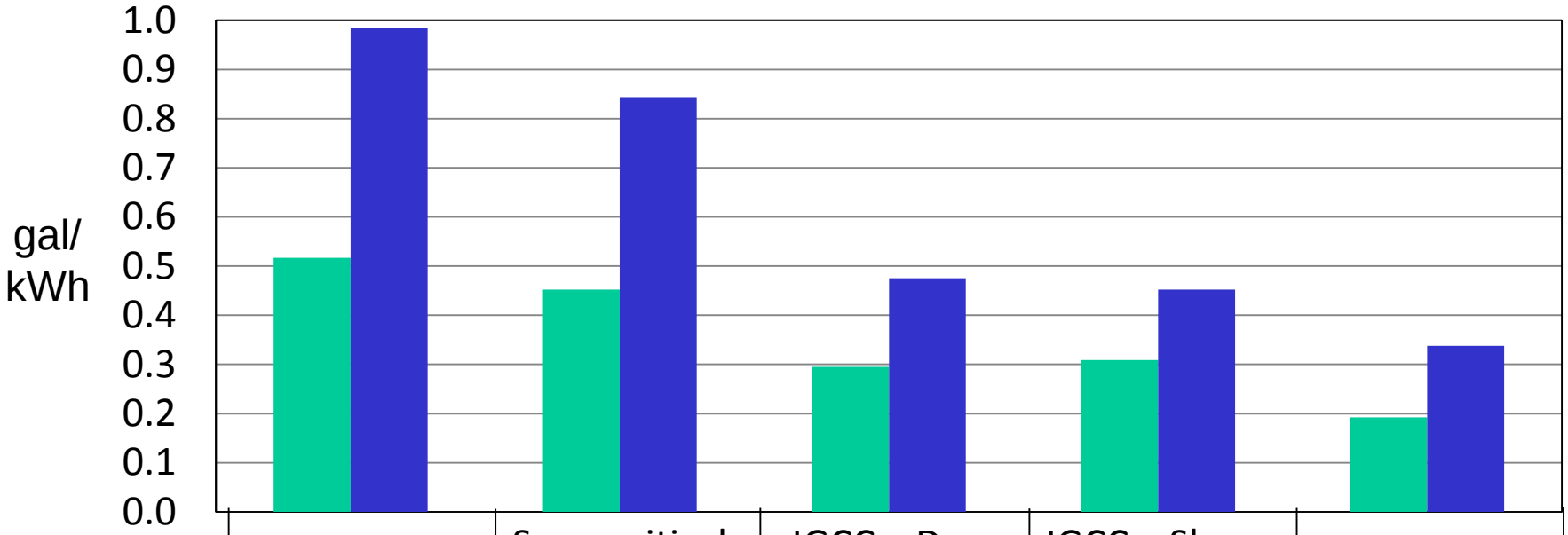
WATER USE IN HYDRAULIC FRACTURING

2011-2014 Hydraulic Fracturing Water Use Per Watershed



Source : U.S. Geological Survey

Water and Carbon Capture Impact



	Subcritical pc	Supercritical pc	IGCC – Dry Feed	IGCC – Slurry Feed	NGCC
No Capture	0.52	0.45	0.30	0.31	0.19
With Capture	0.99	0.84	0.48	0.45	0.34
% Increase	91	87	61	46	76

Source: Gerdes, K.; Nichols, C. *Water Requirements for Existing and Emerging Thermoelectric Plant Technologies*; DOE/NETL Report 402/080108; U.S. Department of Energy National Energy Technology Laboratory: Morgantown, WV, 2009.

Water and Carbon Storage

- Water resources
  - Protect drinking water sources
  - Minimize brine mobilization

- Proper site characterization and selection along with monitoring, verification, and accounting and appropriate regulatory compliance will ensure these goals are met.

CCS Extracted Water

- Water quality is site-dependent:
  - Influenced by reservoir lithology, regional geology, and the presence of hydrocarbons
- Potential CCS extracted water constituents:
  - Dissolved minerals and salts
  - Trace metals
  - Dissolved organic compounds (including hydrocarbons)
- Management strategies:
  - Reinjection
  - Minimal treatment for beneficial use
  - Substantial treatment for beneficial use

Brine Extraction Storage Test (BEST) Projects

Prime	Project Title
ISGS	Brine Extraction & Treatment Strategies to Enhance Pressure Management & Control of CO2 Plumes in Deep Geologic Foundation.
EPRI	Gulf Coast Field Demonstration at a Flagship Power Plant Site: Assessment of Opportunities for Optimal Reservoir Pressure Control, Plume Management and Produced Water Strategies
U of Wyoming	Field Demonstration of an Active Reservoir Pressure Management Through Fluid Injection and Displaced Fluid Extraction at Rock Springs Uplift, a Priority Geologic CO2 Storage Site for Wyoming
UT Austin	Pressure Management and Plume Control Strategies through a Brine Extraction Storage Test (BEST) at the Devine Test Site (DTS) in Texas
EERC	Developing and Validating Pressure Management and Plume Control Strategies in the Williston Basin Through a Brine Extraction and Storage Test (BEST)

Water Research Opportunities

- **Advanced / Novel Heat Transfer and Cooling Systems**
  - *Wet, Dry, Hybrid*
  - *Incremental & Step Change Improvements*
  - *Advanced Manufacturing of Recuperators for Combustion Turbines*
- **Water Treatment and Reuse**
  - *Economic Pathways for Zero Liquid Discharge*
  - *Treatment of high TDS Waters (promote greater Water Reuse – collaboration with CS)*
  - *Majority of NETL R&D Currently Focused in this Area*
- **Process Efficiency and Heat Utilization:**
  - *Pathways for produce more power per unit of water withdrawn, consumed, and treated*
  - *Utilization of Low-Grade Heat*
  - *Bottoming Cycles*
- **Data, Modeling and Analysis**
  - *Tools to enable regional and plant level decision making*
  - *Develop a National Water for Energy Atlas*
- **Breakthrough or Out of the Box**
  - *Low / No water FE based Systems, Distributed Generation, Grid Upgrades*

Thank You