WATER SECURITY GRAND CHALLENGE

Abundance Through Innovation

Kickoff Webinar

October 8, 2019

U.S. DEPARTMENT OF ENERGY

Agenda

Introduction

Goal 1: Launch desalination technologies that deliver cost-competitive clean water

Goal 2: Transform the energy sector's produced water from a waste to a resource

Goal 3: Achieve near-zero water impact for new thermoelectric power plants, and significantly lower freshwater use intensity within the existing fleet

Goal 4: Double resource recovery from municipal wastewater

Goal 5: Develop small, modular energy-water systems for urban, rural, tribal, national security, and disaster response settings

Cross-Cutting

Q/A

INTRODUCTION

What is a Grand Challenge?

A Grand Challenge is a big, difficult problem that, if solved, would bring significant benefits to society. Grand Challenges often include the following important characteristics:

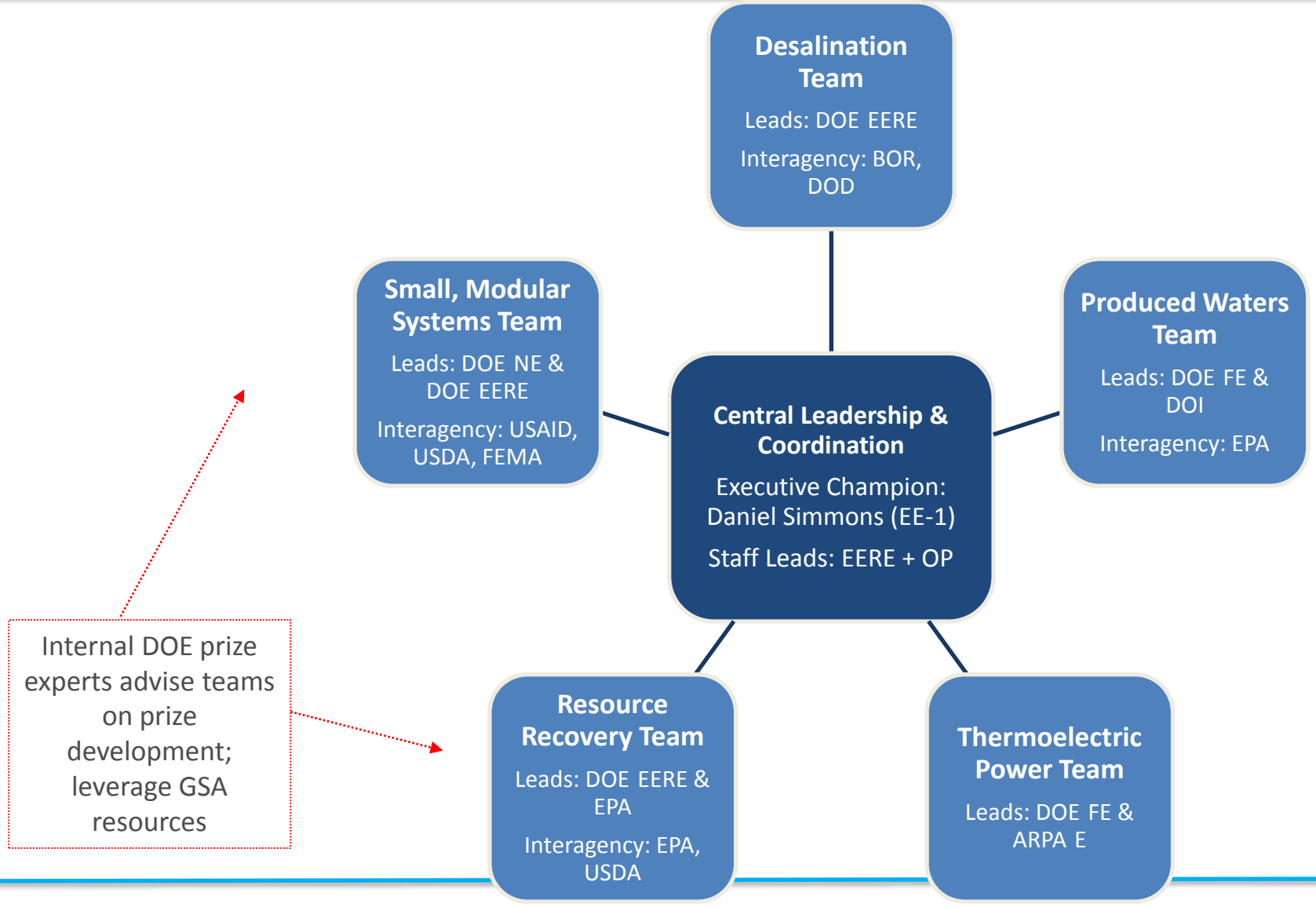
- Feature a measurable end-point that is highly ambitious but achievable
- Drive the need for collaboration between multiple disciplines, some of which do not normally interact
- Are too big to be undertaken by one or even a few organizations
- Capture the imagination of the public, thereby facilitating strong support for the resources required to achieve the goals

Characteristics adapted from NNI Grand Challenge FAQs http://www.nano.gov/node/1522

The Water Security Grand Challenge

Advance transformational technology and innovation to meet the global need for safe, secure, and affordable water. By 2030:

- Launch desalination technologies that deliver cost-competitive clean water.
- Transform the energy sector's produced water from a waste to a resource.
- Achieve near-zero water impact for new thermoelectric power plants, and significantly lower freshwater use intensity within the existing fleet.
- Double resource recovery from municipal wastewater.
- Develop small, modular energy-water systems for urban, rural, tribal, national security, and disaster response settings.



Cross-cutting, interagency teams have been formed to:

- Develop new prize proposals
- Advance our understanding of key barriers and opportunities in each goal area
- Coordinate and inform future R&D and related activities
- Assemble and analyze relevant data
- Identify and pursue high-impact partnerships
- Track and coordinate communications opportunities

Contact Information

Water Security Grand Challenge

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https://www.energy.gov/eere/water-security-grand-challenge

GOAL 1:

Launch desalination technologies that deliver cost-competitive clean water

Team Lead Presenter: Avi Shultz

American-Made Challenge: Solar Desalination

Objective: Demonstrate cost-effective solar thermal desalination technologies for specific markets and applications.

What?

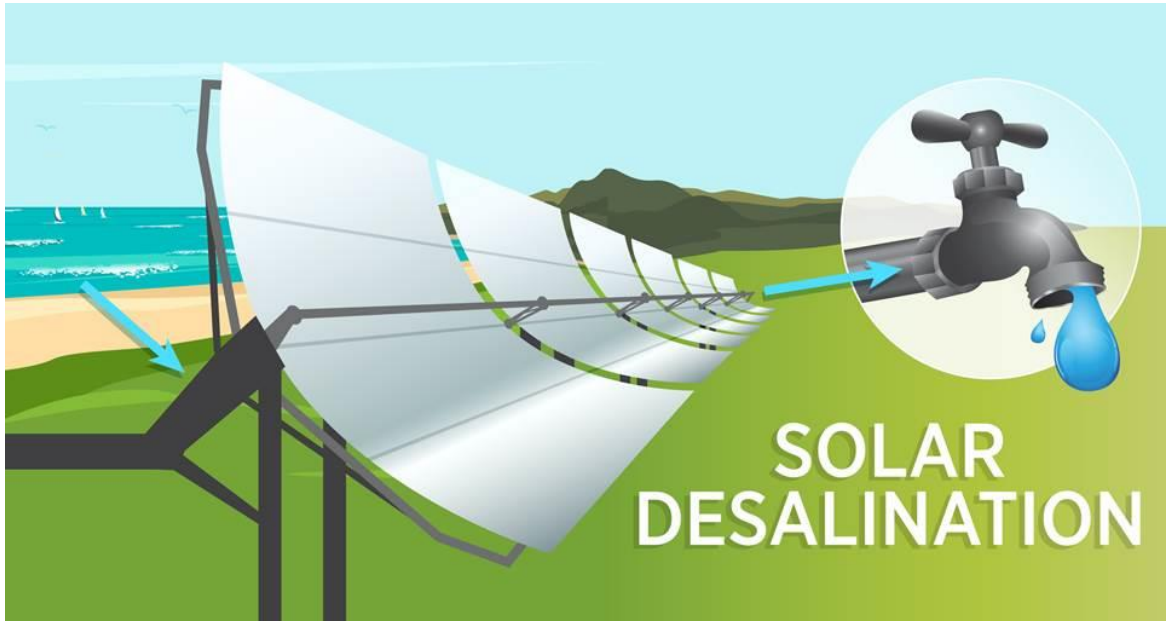
- This prize is a series of contests designed to accelerate technology innovation through the design, development, and demonstration of desalination systems that use sun power to generate fresh water from salt water.
- The fresh water produced can be used for agriculture, industry, and for municipal supply.

Prize Structure and Features:

- The prize provides innovators a pathway from initial concept to technical design, to prototype, to field-tested systems that provide clean, accessible water using solar as the primary energy source.
- The prize will seek to connect technology innovators to potential customers and test facilities

Sample Metrics:

- Thermal Efficiency ($kWh_{thermal}/m^3$ product water)
- Recovery Ratio ($V_{product\ water}/V_{brine}$)
- Continuous Operations (Continuous hours of water production)
- Solar Efficiency (kWh_{solar}/m^3 product water)
- Projected levelized cost of heat (LCOH) and water (LCOW)



https://energy.gov/eere/solar/american-made-challenges-solar-desalination-prize

GOAL 2:

Transform the energy sector's produced water from a waste to a resource

Team Lead Presenter: Elena Melchert

OIL & GAS PRODUCED WATER SITUATIONAL ANALYSIS

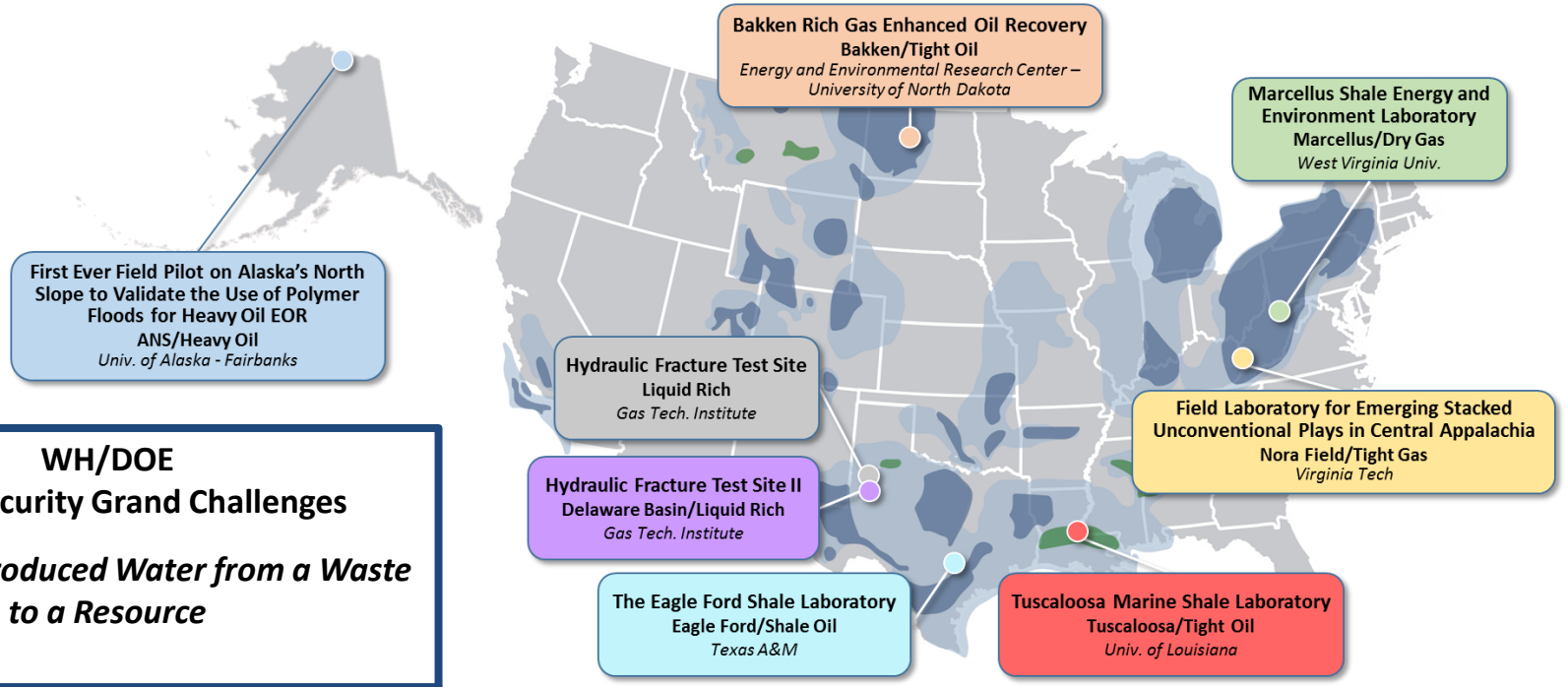
DOE Energy Water Desal Hub

Early-stage R&D for treating salinity in non-traditional water sources

EPA Produced Water Study 2019

GWPC States Produced Water Report 2019

Chevron Prize $25K



WH/DOE
Water Security Grand Challenges

Transform Produced Water from a Waste to a Resource

FY 2019
Produced Water Treatment Projects
$4.5 million

U.S. DEPARTMENT OF ENERGY | Fossil Energy
OFFICE OF OIL & NATURAL GAS

WATER SECURITY GRAND CHALLENGE
Abundance Through Innovation

OIL & GAS PRODUCED WATER RESEARCH PORTFOLIO

ALMOST 60 PROJECTS WITH A TOTAL VALUE OF OVER $100 MILLION

- Water management challenges and options are usually site and region specific.
- Partners include: state institutions, other federal agencies, national laboratories, universities, and the private sector.
- Research includes:
  - Wellbore integrity
  - Reducing freshwater use
  - Beneficial use of treated water

URTeC: 2886718 *Produced Water Treatment R&D: Developing Advanced, Cost-Effective Treatment Technologies* Erica Folio, Olayinka Ogunsola, Ph.D., Elena Melchert, Evan Frye; U.S. Department of Energy, Office of Fossil Energy, Office of Oil and Natural Gas

SYMPOSIUM: ***Application of Solid-Liquid Separation Technologies for Treatment of Produced Water***

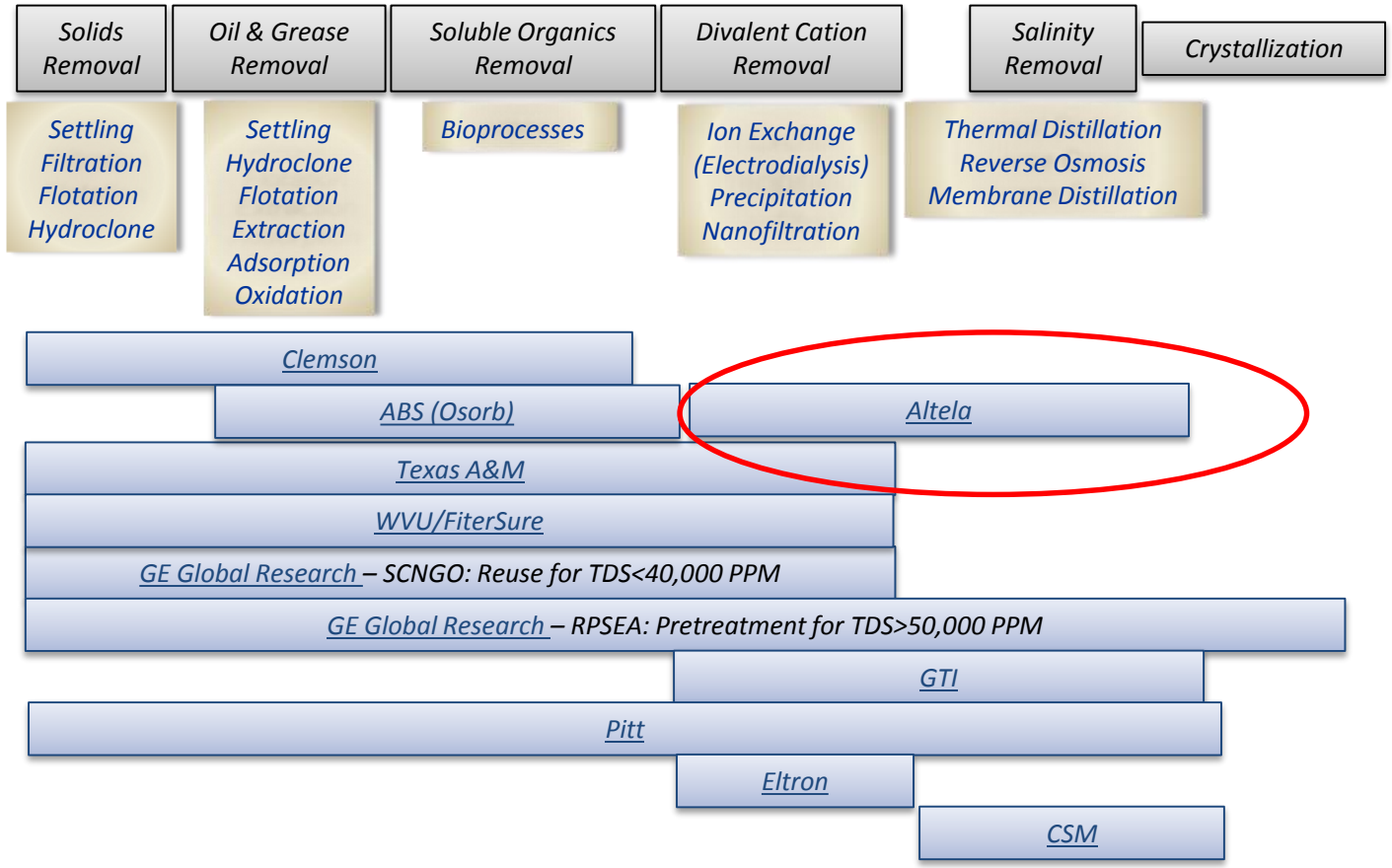
Olayinka Ogunsola, Ph.D.

American Institute for Chemical Engineers, Pittsburgh Nov. 2018

Category	Number of Projects	Total Value* (MM$)
Water treatment technology development	25	33.4
Basic science and risk assessment	8	**5**
Other (e.g., beneficial use, water chemistry, induced seismicity, volume reduction)	7	19.4
Water management tool development.	6	8.4
Improved annular isolation	5	19.2
Environmental impact reduction	3	14.3
Non-water fracturing fluid	3	7.6
Enhanced water disposal options	2	2.1
	59	**109.4**

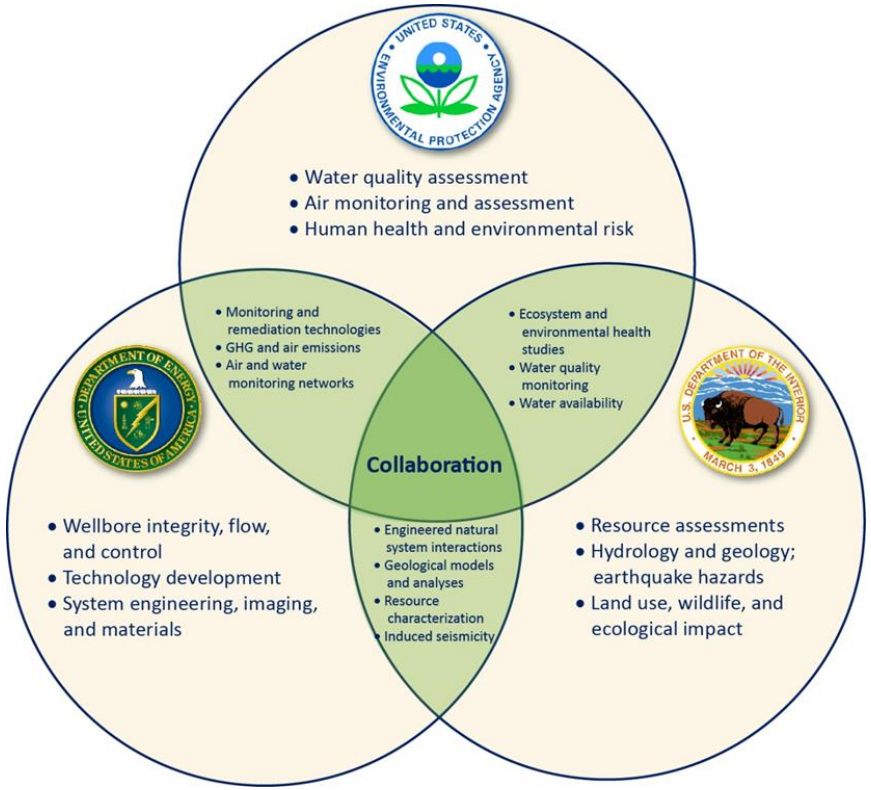
**Average partner cost share is about 30%,DOE funding about 70%*

PRODUCED WATER TREATMENT R&D PORTFOLIO ACCOMPLISHMENTS

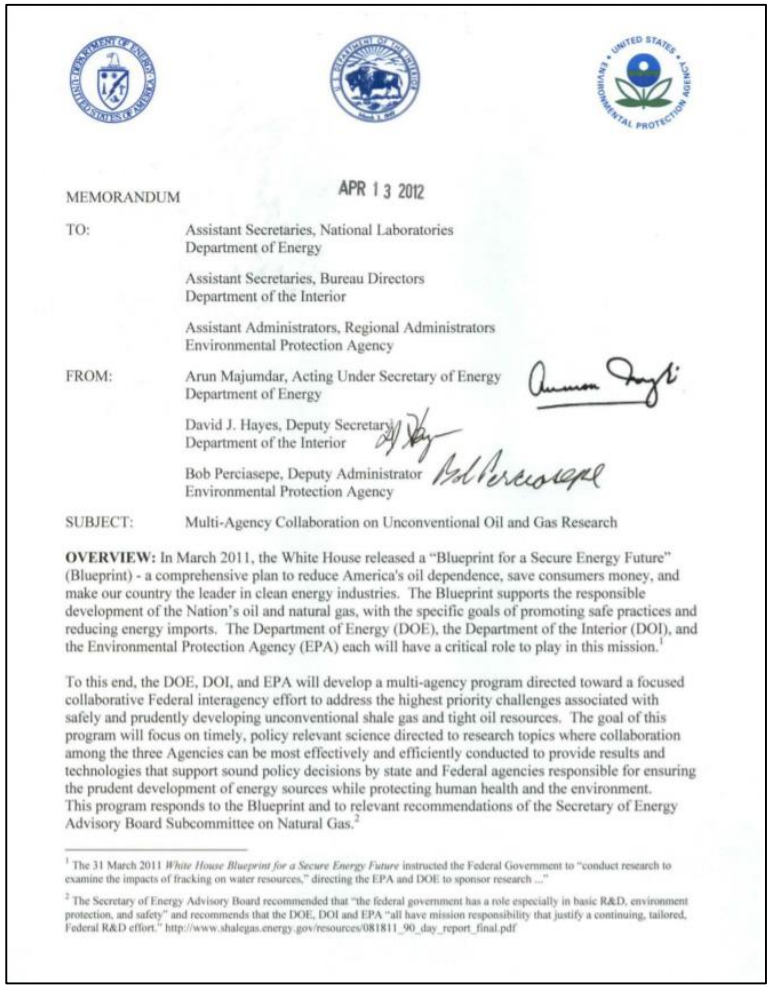


MULTI-AGENCY MEMORANDUM OF AGREEMENT

SEAB 2011: hydraulic fracturing



2012



MEMORANDUM

APR 13 2012

TO: Assistant Secretaries, National Laboratories
Department of Energy

Assistant Secretaries, Bureau Directors
Department of the Interior

Assistant Administrators, Regional Administrators
Environmental Protection Agency

FROM: Arun Majumdar, Acting Under Secretary of Energy
Department of Energy

David J. Hayes, Deputy Secretary
Department of the Interior

Bob Perciasepe, Deputy Administrator
Environmental Protection Agency

SUBJECT: Multi-Agency Collaboration on Unconventional Oil and Gas Research

OVERVIEW: In March 2011, the White House released a "Blueprint for a Secure Energy Future" (Blueprint) - a comprehensive plan to reduce America's oil dependence, save consumers money, and make our country the leader in clean energy industries. The Blueprint supports the responsible development of the Nation's oil and natural gas, with the specific goals of promoting safe practices and reducing energy imports. The Department of Energy (DOE), the Department of the Interior (DOI), and the Environmental Protection Agency (EPA) each will have a critical role to play in this mission.[1]

To this end, the DOE, DOI, and EPA will develop a multi-agency program directed toward a focused collaborative Federal interagency effort to address the highest priority challenges associated with safely and prudently developing unconventional shale gas and tight oil resources. The goal of this program will focus on timely, policy relevant science directed to research topics where collaboration among the three Agencies can be most effectively and efficiently conducted to provide results and technologies that support sound policy decisions by state and Federal agencies responsible for ensuring the prudent development of energy sources while protecting human health and the environment. This program responds to the Blueprint and to relevant recommendations of the Secretary of Energy Advisory Board Subcommittee on Natural Gas.[2]

[1] The 31 March 2011 *White House Blueprint for a Secure Energy Future* instructed the Federal Government to "conduct research to examine the impacts of fracking on water resources," directing the EPA and DOE to sponsor research ..."

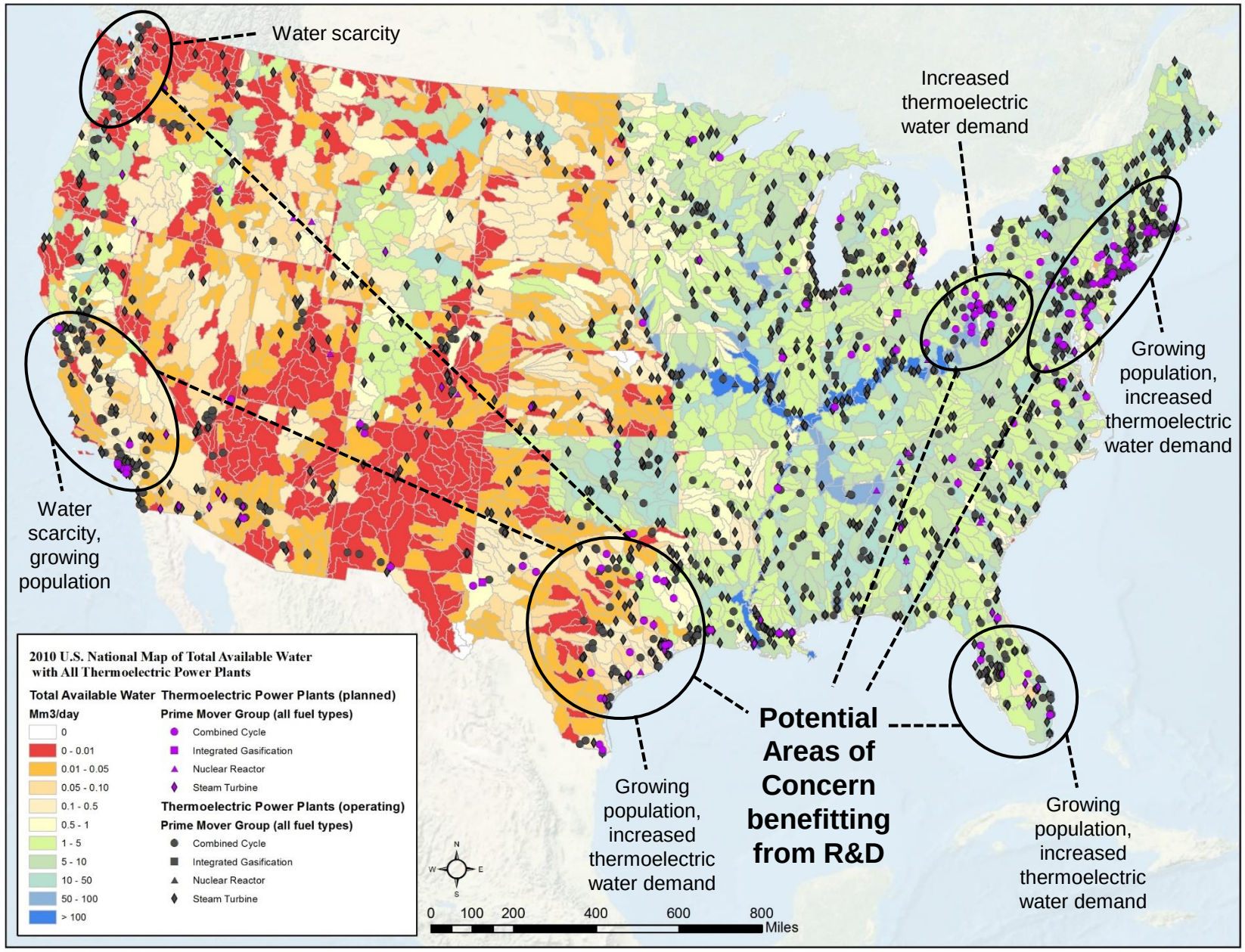
[2] The Secretary of Energy Advisory Board recommended that "the federal government has a role especially in basic R&D, environment protection, and safety" and recommends that the DOE, DOI and EPA "all have mission responsibility that justify a continuing, tailored, Federal R&D effort." http://www.shalegas.energy.gov/resources/081811_90_day_report_final.pdf

GOAL 3:

Achieve near-zero water impact for new thermoelectric power plants, and significantly lower freshwater use intensity within the existing fleet

Team Lead Presenters: Robie Lewis, Madhav Acharya

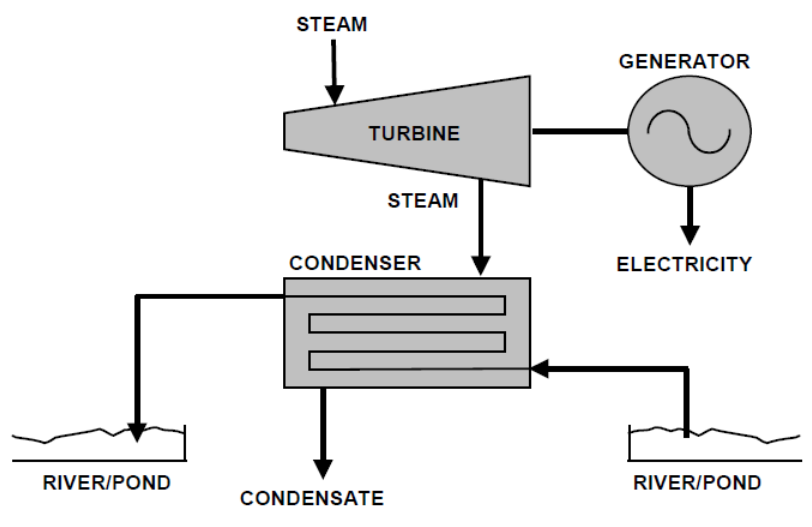
National Relevance



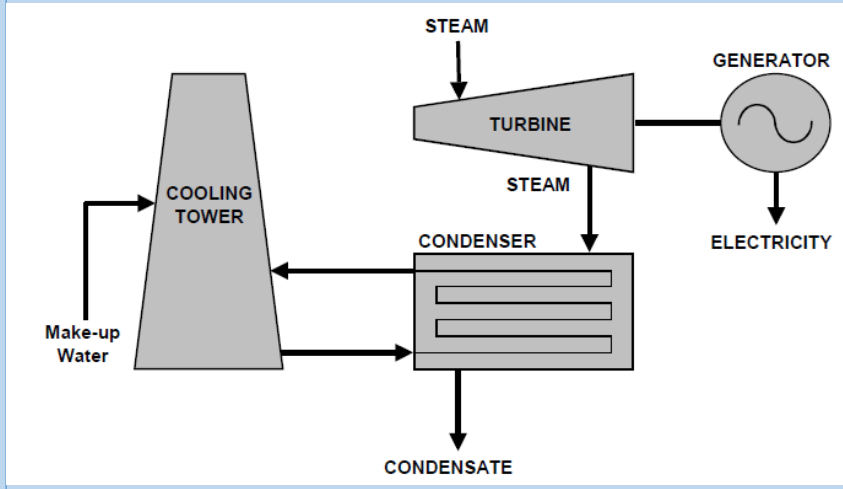
Source: NETL 2018 Water Brief

- As planned thermoelectric power grows to keep up with demand, more effective water management may help maintain low operating costs and avoid increased water stress.
- In water constrained areas, thermoelectric power is looking to utilize technologies such as waterless plants employing dry cooling technologies to help alleviate current water stress.

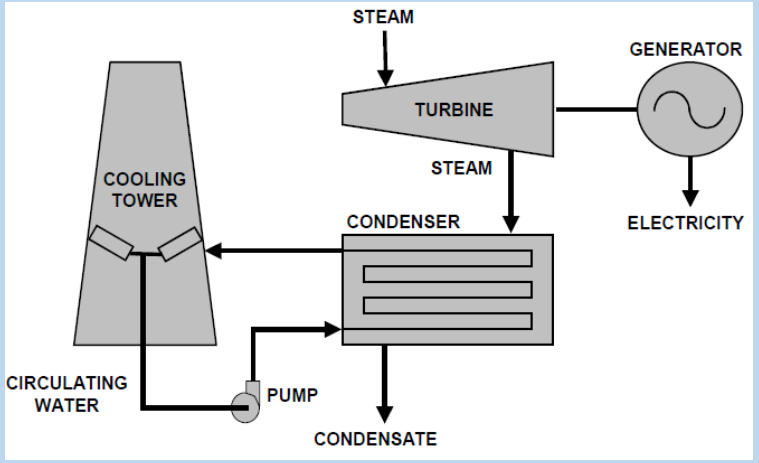
Choice of Technology Impacts Water Use and Consumption



Once-through



Closed Loop

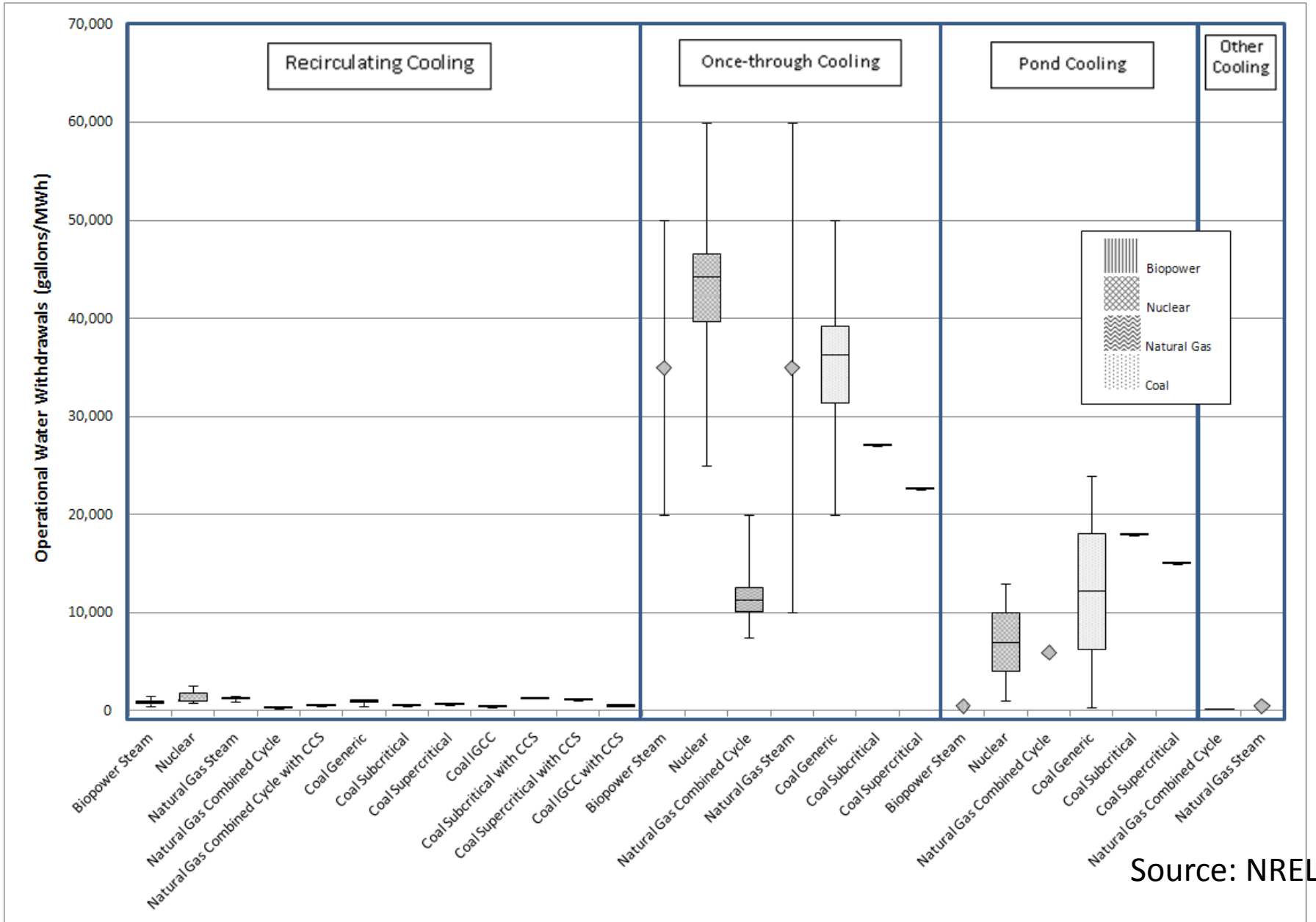


Dry Cooling

Power Provider	Gallons Evaporated per kWh at Thermoelectric Plants	Gallons Evaporated per kWh at Hydroelectric Plants	Weighted Gallons Evaporated per kWh of Site Energy
Western Interconnect	0.38 (1.4 L)	12.4 (47.0 L)	4.42 (16.7 L)
Eastern Interconnect	0.49 (1.9 L)	55.1 (208.5 L)	2.33 (8.8 L)
Texas Interconnect	0.44 (1.7 L)	0.0 (0.0 L)	0.43 (1.6 L)
U.S. Aggregate	0.47 (1.8 L)	18.0 (68.0 L)	2.00 (7.6 L)

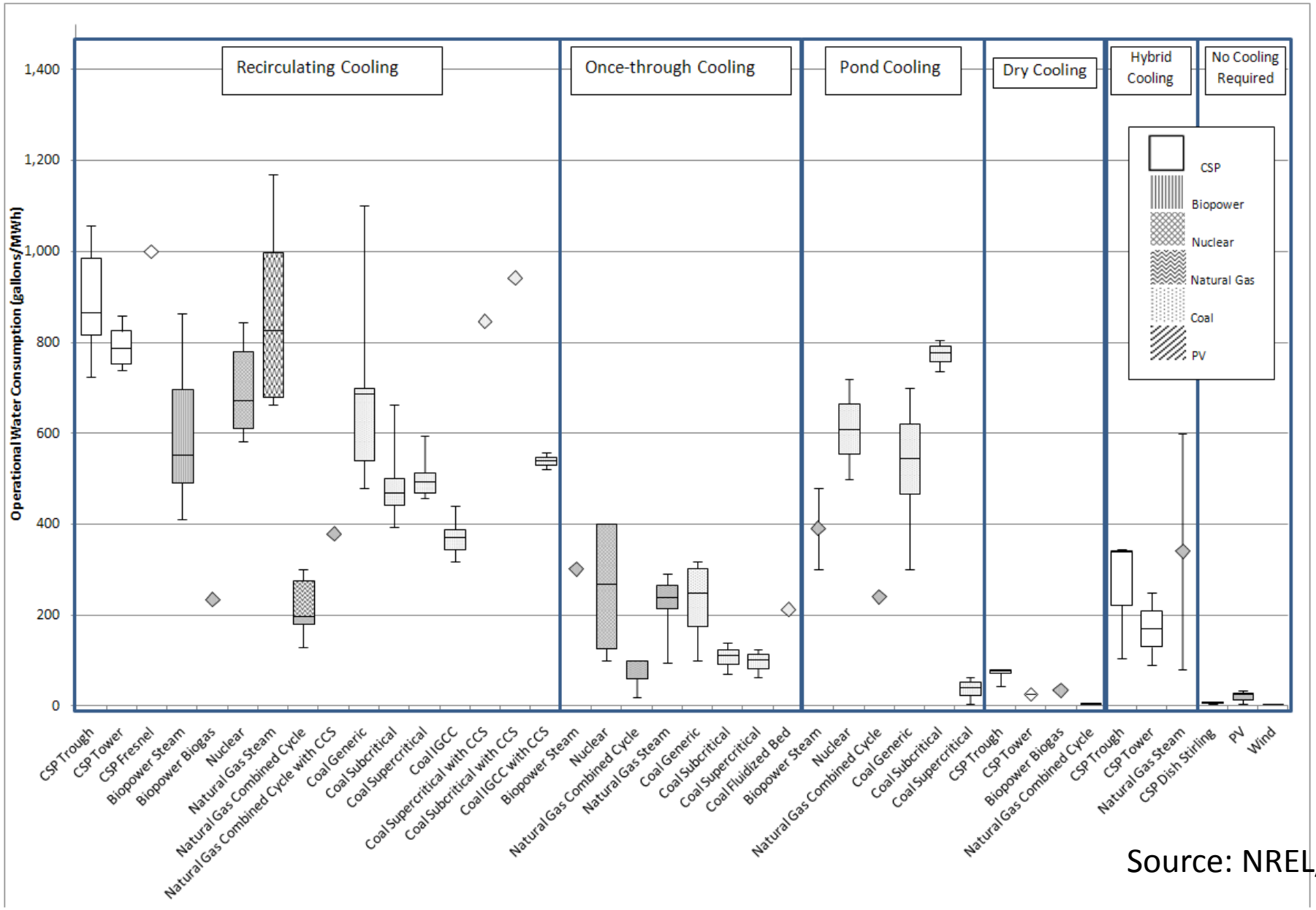
Source: NREL/TP-550-33905

Water Withdrawal by Generating Source/Cooling Type



Source: NREL/TP-6A20-50900

Water Consumption by Generating Source/Cooling Type



Source: NREL/TP-6A20-50900

Promising Prize Topic from Workshop

Develop new cooling technologies that significantly reduce water use while maintaining/increasing thermal efficiencies and reducing parasitic loads

- Are there new equipment designs that could provide more cost-effective heat transfer with lower water use?
  - Possibilities could include combining the use of new geometries, materials, and coatings
  - Innovations are possible in both wet or dry cooling

Cooling is the major water draw from within the power sector. Technologies do exist to reduce water in cooling applications, but come with an energy/cost penalty or have not been demonstrated at scale.

Opportunity to build on recent R&D investments by DOE programs to help reduce this penalty.

Recent R&D Activities

Within DOE –

- EERE-AMO: Materials in Harsh Environments, Additive Manufacturing
- ARPA-E: ARID Program for Dry Cooling
- FE: Water Management R&D; University Training Programs
  - University Training and Research for Fossil Energy Awards – Modeling Existing Coal Plant Challenges Using High-Performance Computing (CLOSED)
  - Crosscutting Research for Coal-Fueled Power Plants / Area of Interest 2: Coal Power Plant Cooling Technology (CLOSED)
  - Crosscutting Research for Coal-Fueled Power Plants / Area of Interest 2B: Coal Power Plant Dry Cooling Technology (OPEN)
- NE: Ongoing Materials R&D, University R&D Solicitation, Integrated Hybrid Energy Systems
  - Fiscal Year 2019 Consolidated Innovative Nuclear Research (CLOSED)
  - Fiscal Year 2020 Consolidated Innovative Nuclear Research (OPEN)
- OP: Existing Plant Water Usage and Cooling System Selection Behavior

GOAL 4:

Double resource recovery from municipal wastewater

Team Lead Presenter: John Smegal

Wastewater Resource Recovery Prize Competition

Objective: Scale resource recovery through local, systems-based solutions centered around small-to-medium sized wastewater treatment plants

Why?

- Resource recovery is currently taking place among the largest wastewater treatment plants. To achieve scale, need to target the next layer down.
- Recovery technologies exist, but creative, system-wide solutions that link resource providers with customers are in shorter supply.
- Prize will seek to draw out coalitions of partners that may not have taken the time to work together absent a financial incentive.

Prize Structure and Features:

- Two-phases: first, seeks to build library of creative solutions; second, focuses on more detailed and rigorous system design.
- Seeking alignment with public financing programs (e.g. WIFIA, SRF, USDA programs) to facilitate access to capital for successful designs.

Sample Metrics:

- Recovery rate (total resources recovered/total resources present in influent)
- Improvement rate (percent improvement from facility's own baseline)

Anticipated Phases

Phase	Awardees
1—Solutions Library	10
2—Systems Designs	2

Request for Information available at:
https://www.energy.gov/eere/water-security-grand-challenge

Resource Recovery Prize RFI

Links to the FR notice

- https://www.energy.gov/eere/amo/articles/advanced-manufacturing-office-issues-request-information-water-security-grand
- https://www.federalregister.gov/documents/2019/09/23/2019-20541/notice-of-request-for-information-rfi-on-water-security-grand-challenge-resource-recovery-prize
- https://eere-exchange.energy.gov/Default.aspx#FoaId8f081ae7-9469-4c42-b34a-d8f92eec38c4

GOAL 5:

Develop small, modular energy-water systems for urban, rural, tribal, national security, and disaster response settings

Team Lead Presenter: Jon Carmack

Goal 5: Proposed Small, Modular Systems Prize Summary

Objective: Develop fuel-agnostic "energy-water in a box" solutions that are modular, portable, reliable, and cost effective

Why?

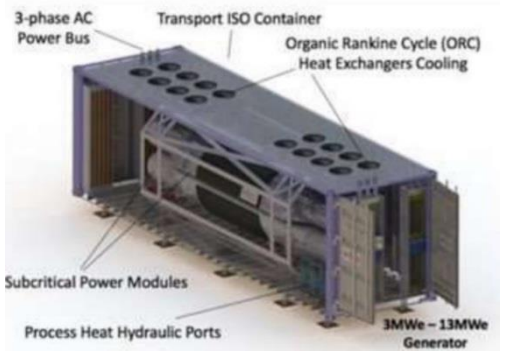
- Small, modular energy-water systems have the potential to serve areas where energy and/or clean water is scarce, expensive, or challenging to obtain, such as islands, rural areas, and communities affected by a disaster.
- But innovation is needed to improve the cost-effectiveness of linked energy-water systems and test performance in a range of use-cases.
- A Department-level prize across all applied energy offices could capture the public's imagination, draw a range of innovators, and lead to ground-breaking new solutions.

Prize Structure and Features:

  - Begin with a multi technology, ideation prize to identify promising concepts and business plans across 3 use cases: 1) Response and Recovery; 2) Water Scarce Developing Nations; 3) Remote and Island Communities. Prize outcomes would provide information to multiple DOE program offices and agency partners to plan future investments.
  - Launch in FY 19/FY 20.

Sample Metrics (will vary by use case):

- Portability and speed to deploy
- Continuous operation with low maintenance
- Cost effectiveness



Goal 5 Team Representatives

- DOE Nuclear Energy
- DOE EERE
- DOE ARPA-E
- USAID
- DHS-FEMA

Estimated Budget

Activity	Notional Timing	Notional Prize $
1—Ideation Prize	120 Days	TBD
2—Subsequent Activities Informed by Ideation Prize	TBD	TBD

Cross-Cutting

Presenter: Melissa Klembara

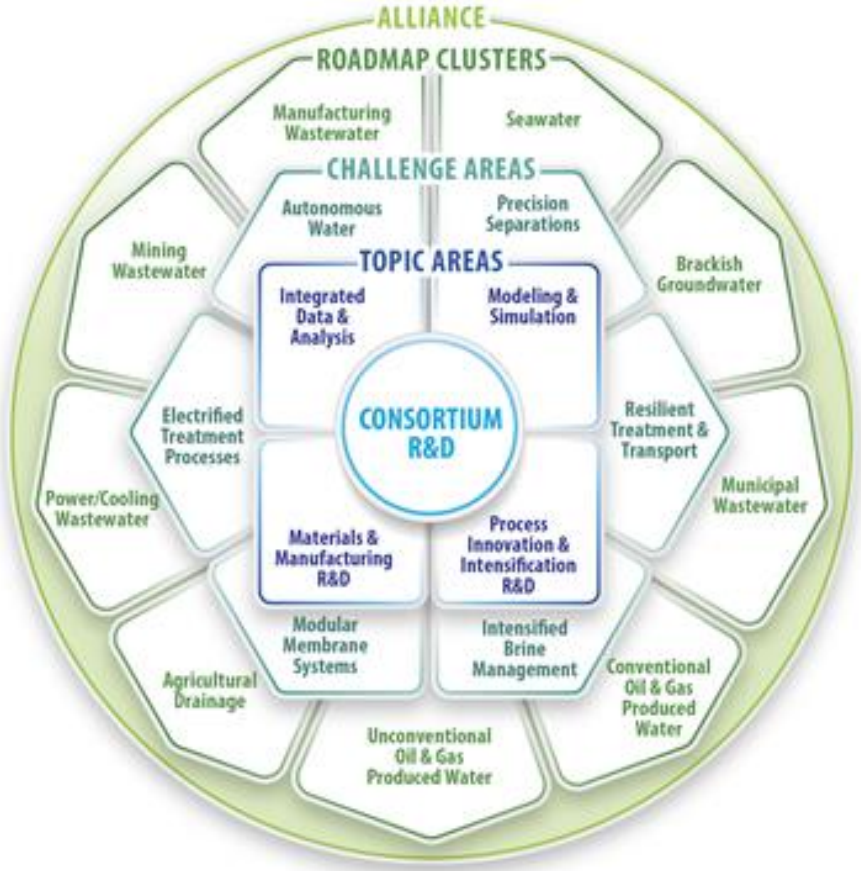
Energy-Water Desalination Hub

- DOE's $100-million Energy-Water Desalination Hub will focus on early-stage R&D for energy-efficient and cost-competitive desalination technologies for treating non-traditional water sources for multiple end-use applications.

- The Hub will be led by the National Alliance for Water Innovation (NAWI), a public-private partnership with more than 35 members and over 180 organizations led by Lawrence Berkeley National Laboratory in collaboration with National Energy Technology Laboratory, National Renewable Energy Laboratory, and Oak Ridge National Laboratory.

- NAWI will pursue distributed desalination and water use enabled by Autonomous, Precise, Resilient, Process-Intensified, Modular and Electrified (A-PRIME) water treatment technologies.

The Hub will address all 5 Water Security Grand Challenge goals.



For more information: https://www.nawihub.org/about
Or contact Melissa.Klembara@ee.doe.gov

Thank You

Questions???

Contact Information

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Energy-Water Desalination Hub

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