AWARE-US and Cumulative R&D Benefits

NETL and Argonne National Laboratory

Water Management for Power Systems

Acknowledgment: "This material is based upon work supported by the Department of Energy research under FWP 1022428 - Task 5

Performer: RIC/SSAE

AWARE-US

NETL and Argonne National Laboratory

Project Description and Objectives

AWARE-US

Project Description

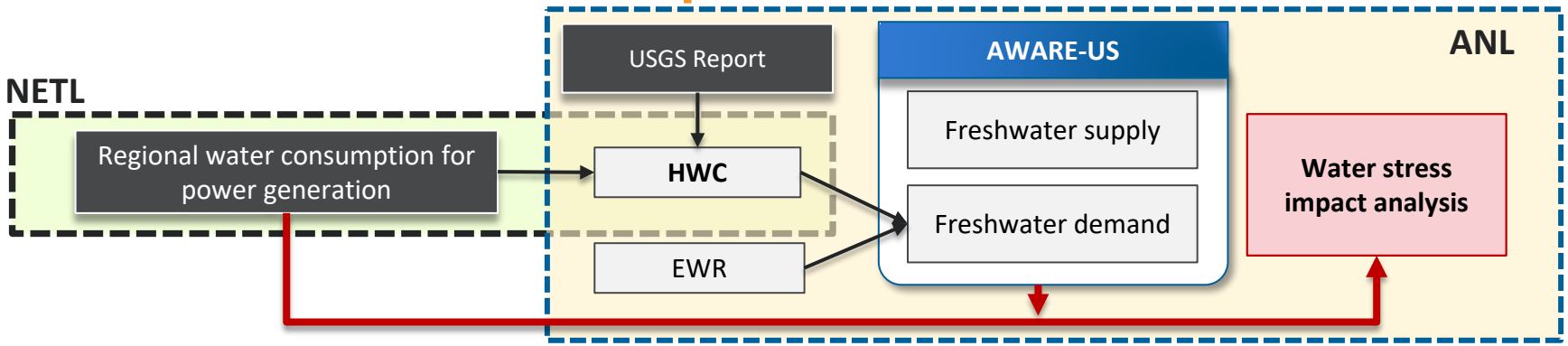
- Partnership with Argonne National Laboratory to quantify water stress at the county level, monthly, with NETL water use factors
- Thermoelectric water consumption was scaled based on Water Scarcity Factors(WSF) to contextualize its impact on available water remaining

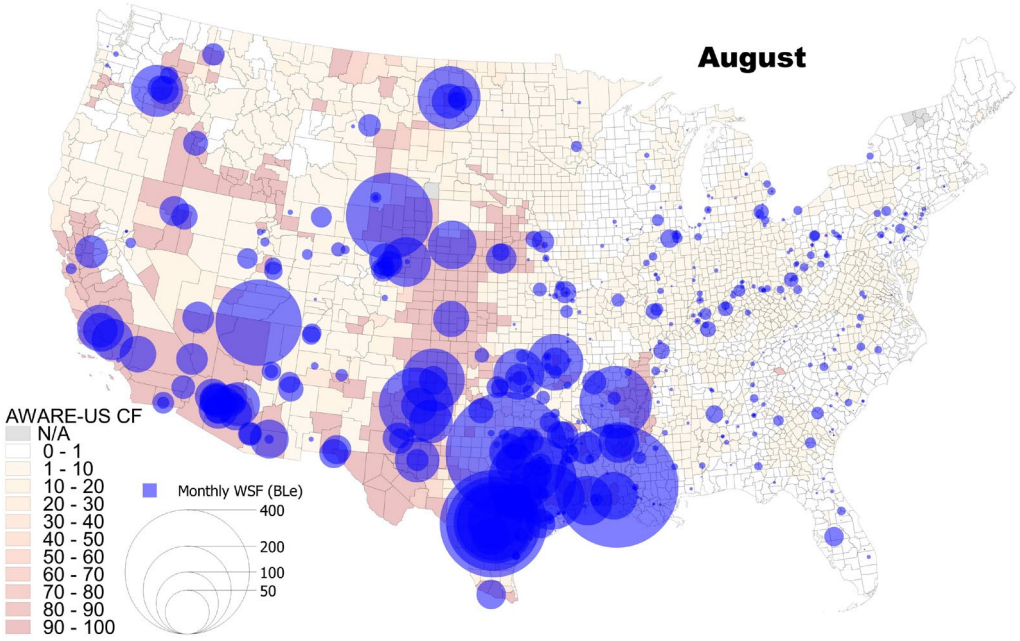
Strategic alignment of project to Fossil Energy objectives

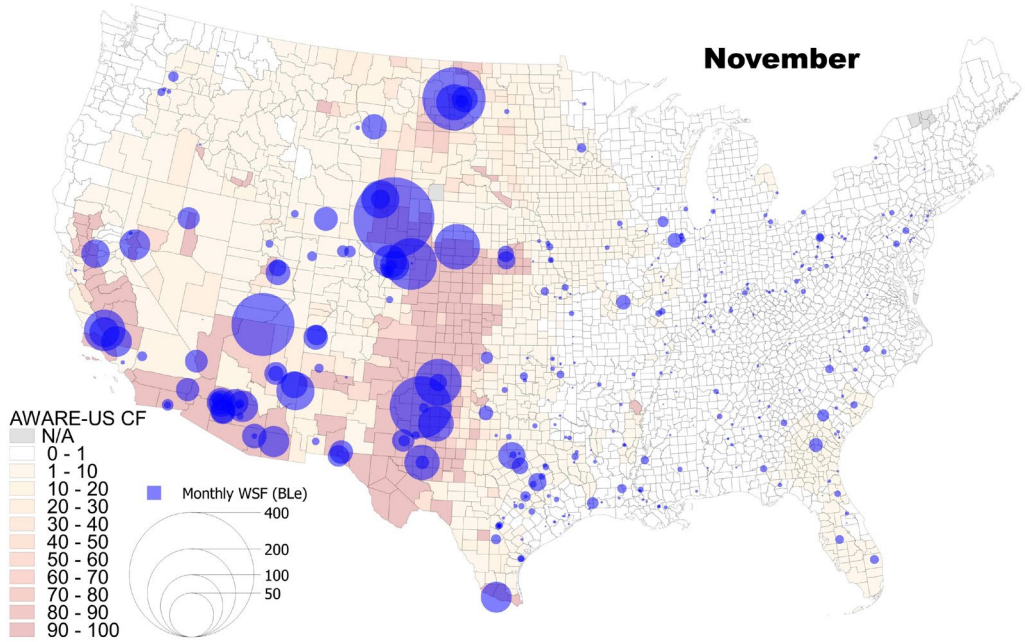
- Water scarcity is an indicator of locations that may benefit from improved water efficiency technologies
- This is a piece of the puzzle that can work with other Fossil Energy tools and models to identify projects, plants, and locations that can benefit from reduced water consumption

Project Description and Results

AWARE-US – Phase I completed work



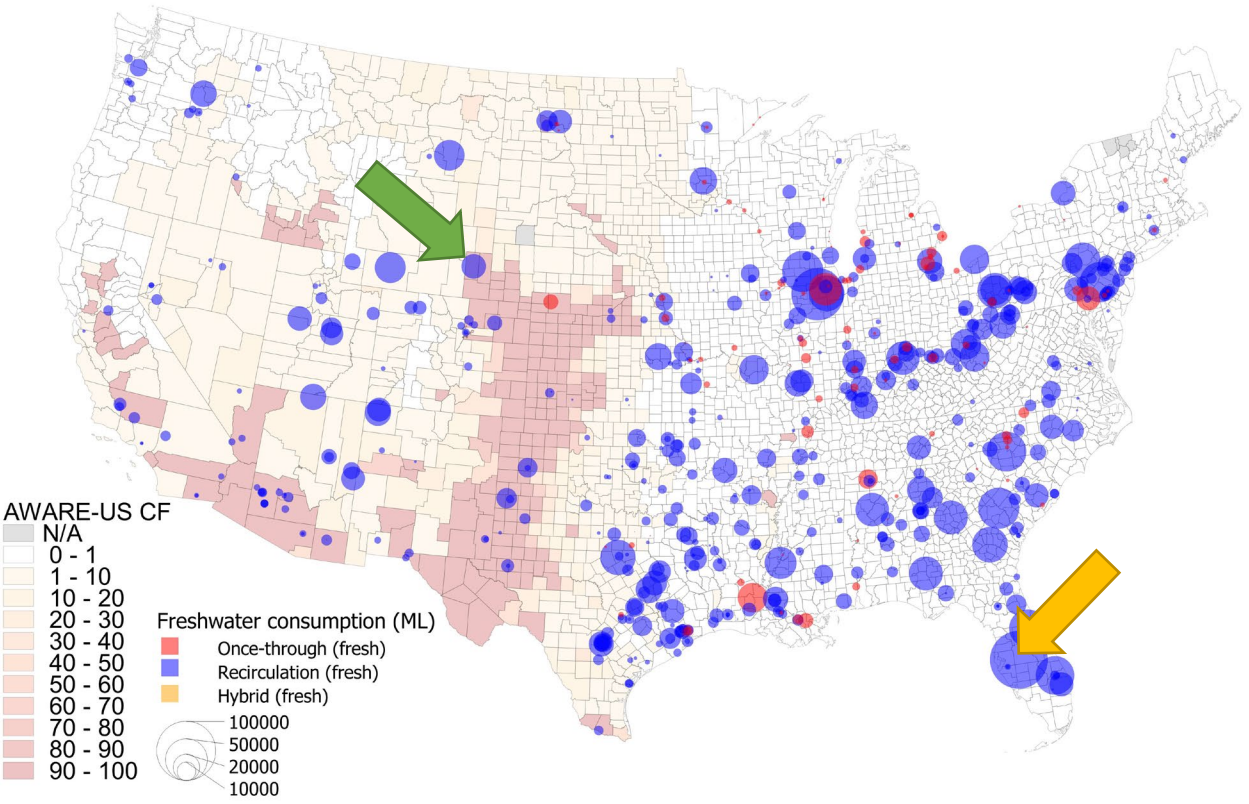


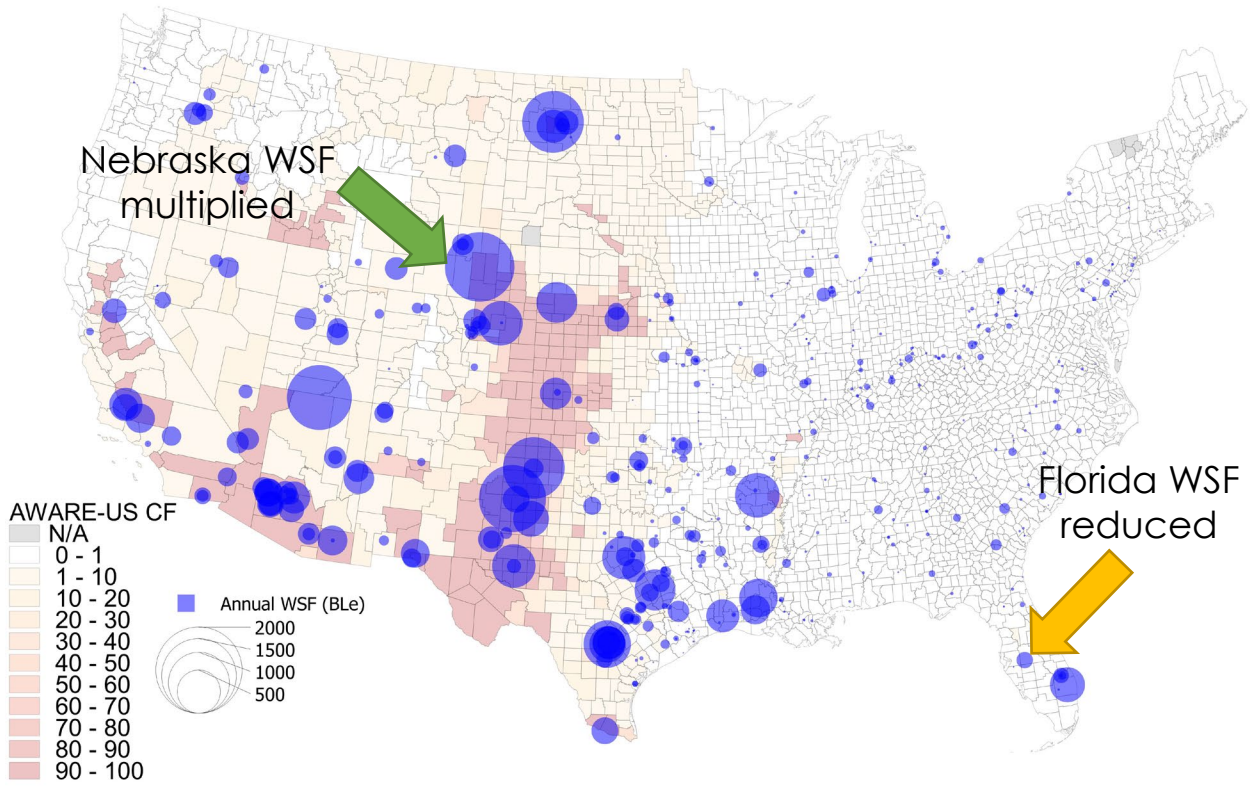


Water Stress by AWARE-US

Thermoelectric Cooling Consumption (Left) vs. Water Stress Impacts (Right)

Larger water stress from thermoelectric demand where AWARE-US WSF is higher





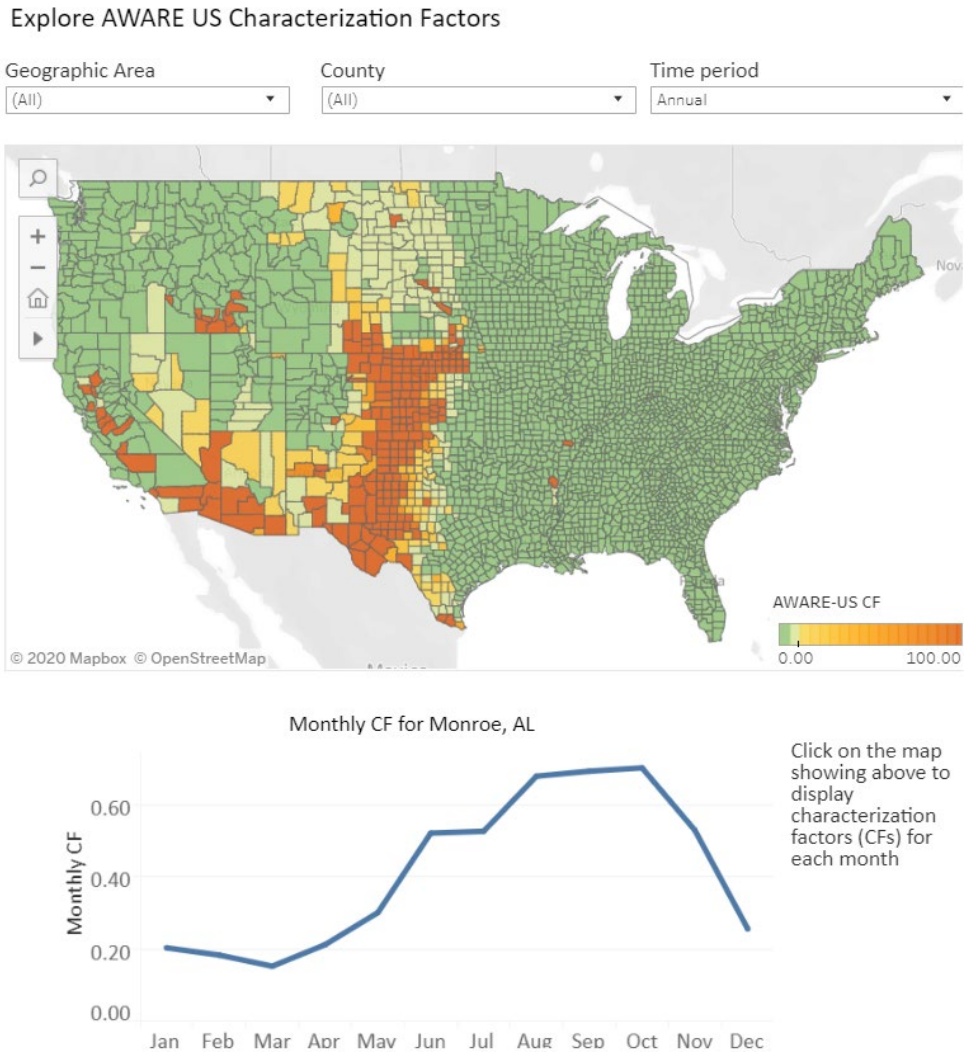
AWARE-US Model

Tableau version

- https://greet.es.anl.gov/aware
- Potential applications to analyze the regional/seasonal water stress.

Excel version

- https://netl.doe.gov/crosscutting/publications
- Baseline AWARE-US with and without the power sector
- Good to analyze the impact of current power sector



Publication and Webinar

Publication - Journal of Cleaner Production

- Lee, Uisung, Joseph Chou, Hui Xu, Derrick Carlson, Aranya Venkatesh, Erik Shuster, Timothy J. Skone, and Michael Wang. "Regional and seasonal water stress analysis of United States thermoelectricity." *Journal of Cleaner Production* (2020): 122234.

Conference Presentations/Papers

- ACLCA 2019; PCC 2019; IWC 2020

Webinar with ANL

- October 2020

Continuing Work

- Task 14G: Plant-level Hydrogen Water Integration Needs for Thermoelectric Facilities

Journal of Cleaner Production 270 (2020) 122234

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Regional and seasonal water stress analysis of United States thermoelectricity

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ARTICLE INFO

Article history:
Received 15 January 2020
Received in revised form
6 April 2020
Accepted 12 May 2020
Available online 1 June 2020

Handling editor: Jun Bi

Keywords:
Water stress
Thermoelectric power
AWARE-US
Water scarcity footprint

ABSTRACT

Most thermoelectric power plants in the United States (U.S.) rely on fresh water for cooling, resulting in significant water consumption. An understanding of the regional and seasonal water stress impact of such water consumption is needed. In this study, we used a U.S. county-level water stress index, Available Water Remaining for the United States (AWARE-US), with facility-level thermoelectric power generation water consumption data, to quantify the regional and seasonal water stress impact of U.S. thermoelectric power plants. Water stress impact was evaluated as water-scarcity footprint (WSF) using monthly AWARE-US data. Results show that most thermoelectric power plants in the United States that use fresh water are in water-abundant regions. Our findings also show that a small fraction of the U.S. thermoelectric generation facilities (13% by power) located in water stressed regions contribute the most water stress impact (88% of the total WSF) caused by thermoelectric power generation in the U.S. Even if fresh water is abundant on an annual basis, many power plants are in counties with seasonal water shortages. Of the 401 counties with thermoelectric power plants using fresh water for cooling, 80 counties in February and 160 counties in August had fresh water withdrawal requirements that exceeded the sustainable fresh water available (availability minus demand or AMD) in that region. This means that 27% and 46% of power generation facilities have difficulty securing sustainable fresh water in February and August, respectively. This study is intended to support water consumption management in existing power plants and guide the deployment of future power plants to mitigate water stress impact.

1. Introduction

Thermoelectric power plants generated about 83% of the electricity in the United States in 2018 (EIA, 2019a). A recent report by the U.S. Geological Survey (USGS) shows that in 2015, U.S. thermoelectric power plants accounted for 34% of total fresh water withdrawals, although actual consumption was only 3% (Dieter et al., 2018). Local fresh water availability has a substantial impact on the operational risk to thermoelectric power plants, which will vary with (1) the local water supply and demand by other sectors and ecosystems, and (2) the water supply requirements for thermoelectric plant cooling. It is essential to understand the power sector's impact on water stress, as this will guide water management for existing power plants and help locate future power plants. Since thermoelectric power plants will continue to play a major role in the U.S. electricity supply, this water stress analysis will help identify water-stressed regions and seasonal perspectives while enabling water availability mitigation strategies to be implemented.

To improve the water sustainability of power generation, it is important to evaluate how cooling technology choice and the location of power plants contribute to regional and seasonal water stress. The withdrawal and consumption of fresh water by power plants can be very different depending on the cooling system. There are two "wet cooling" technologies widely used in thermoelectric power plants: once-through and recirculation cooling.

- Once-through cooling technology withdraws a large amount of water from a water body to absorb heat from the power plant's steam, then discharges the heated water back to the water body

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https://doi.org/10.1016/j.jclepro.2020.122234
0959-6526/

Water Needs and Cumulative R&D Benefits

NETL

Project Description and Objectives

Water Needs and Cumulative R&D Benefits

Project Description

- Forecasts water withdrawal and consumption for thermoelectric power generating fleet
- Quantifies cumulative benefits of NETL funded R&D technologies

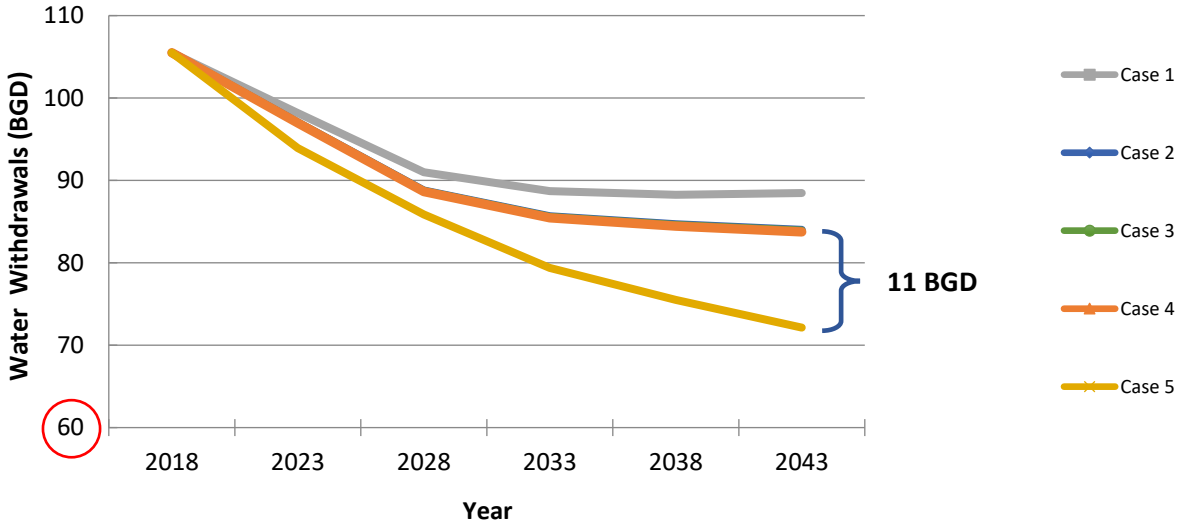
Strategic alignment of project to Fossil Energy objectives

- Analyzes and explores plant water technologies that can reduce the amount of water required for fossil energy operations

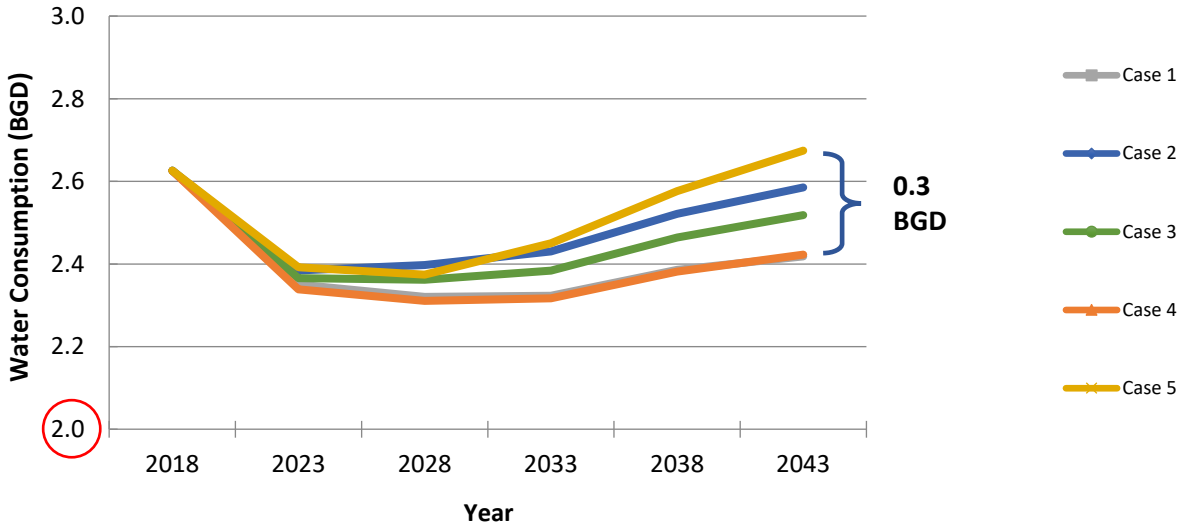
Project Description and Results

Water Needs and Cumulative R&D Benefits

Average Daily National Freshwater Withdrawal for Thermoelectric Power Generation



Average Daily National Freshwater Consumption for Thermoelectric Power Generation



Case Definitions

1 – A + R all proportional

2 – A (100% wet recirculating) + R are proportional

3 – A (90% wet recirculating/10% saline once through) + R are proportional

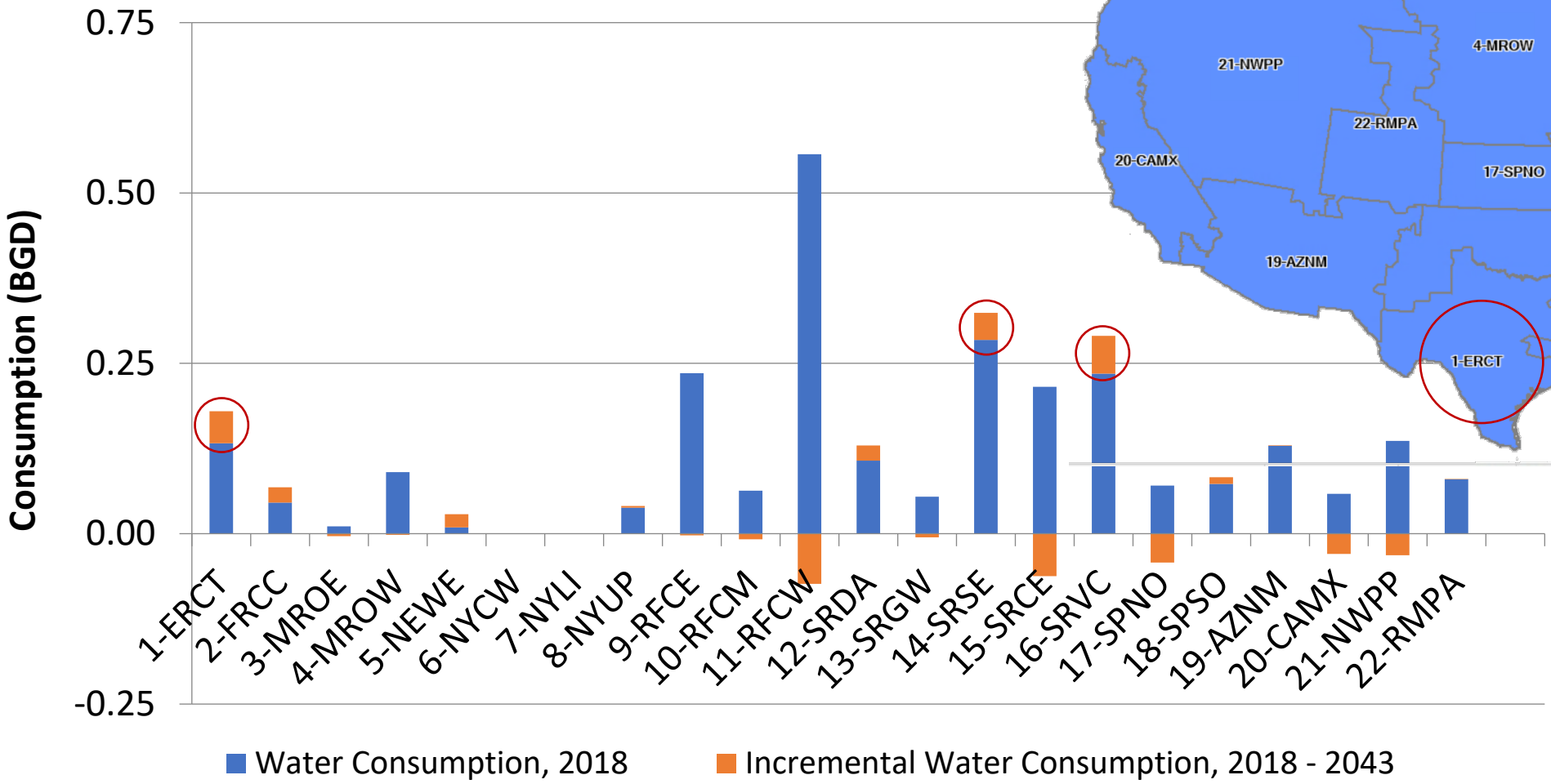
4 – A (75% wet recirculating/25% saline once through) + R are proportional

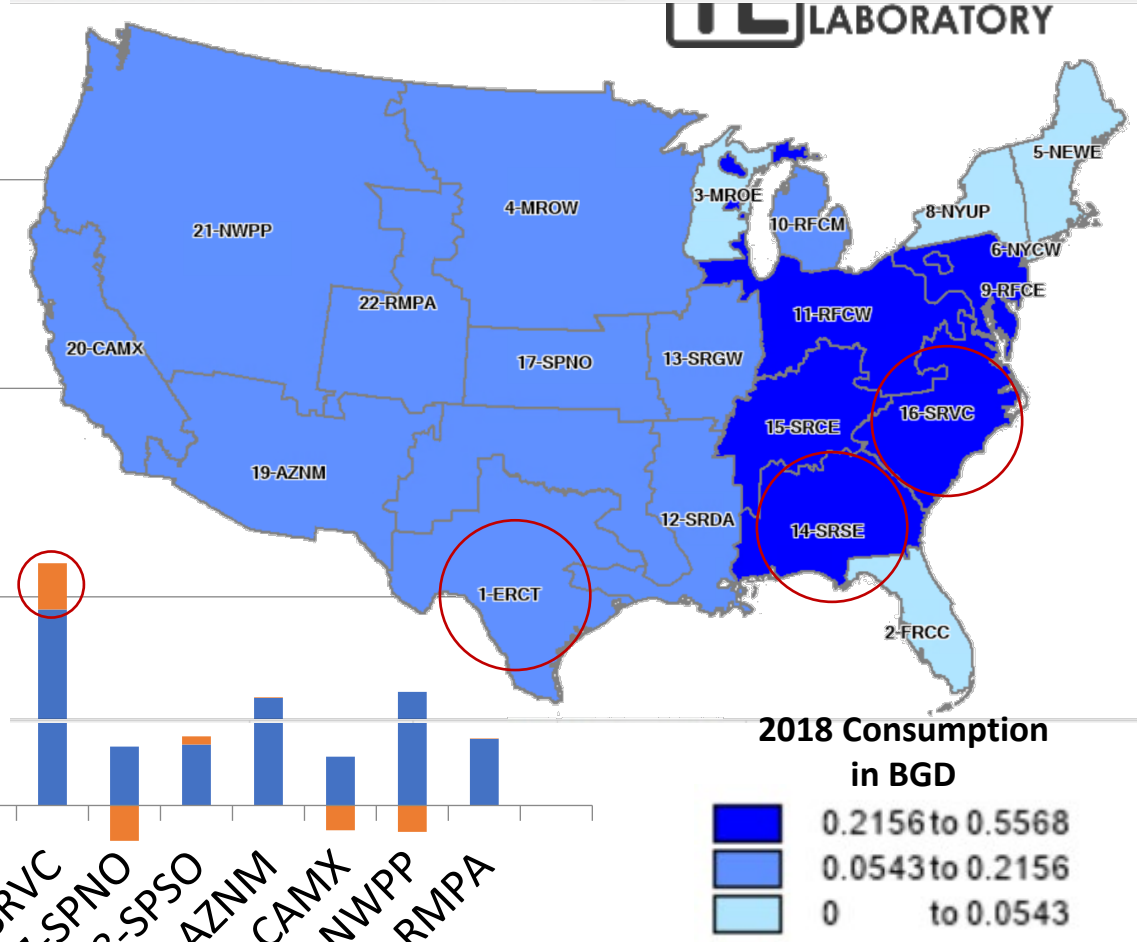
5 – A + R all proportional, 5% of existing freshwater once through retrofitted to wet recirculating every 5 years

- Water Withdrawals in 2043 remain bout the same, except for the cooling tower retrofits case 5
- Water Consumption goes up for case 5 but decreases for cases 3 and 4.
- Difference between Case 1 and Case 2 is largely policy driven

Regional Consumption Results: Base Case

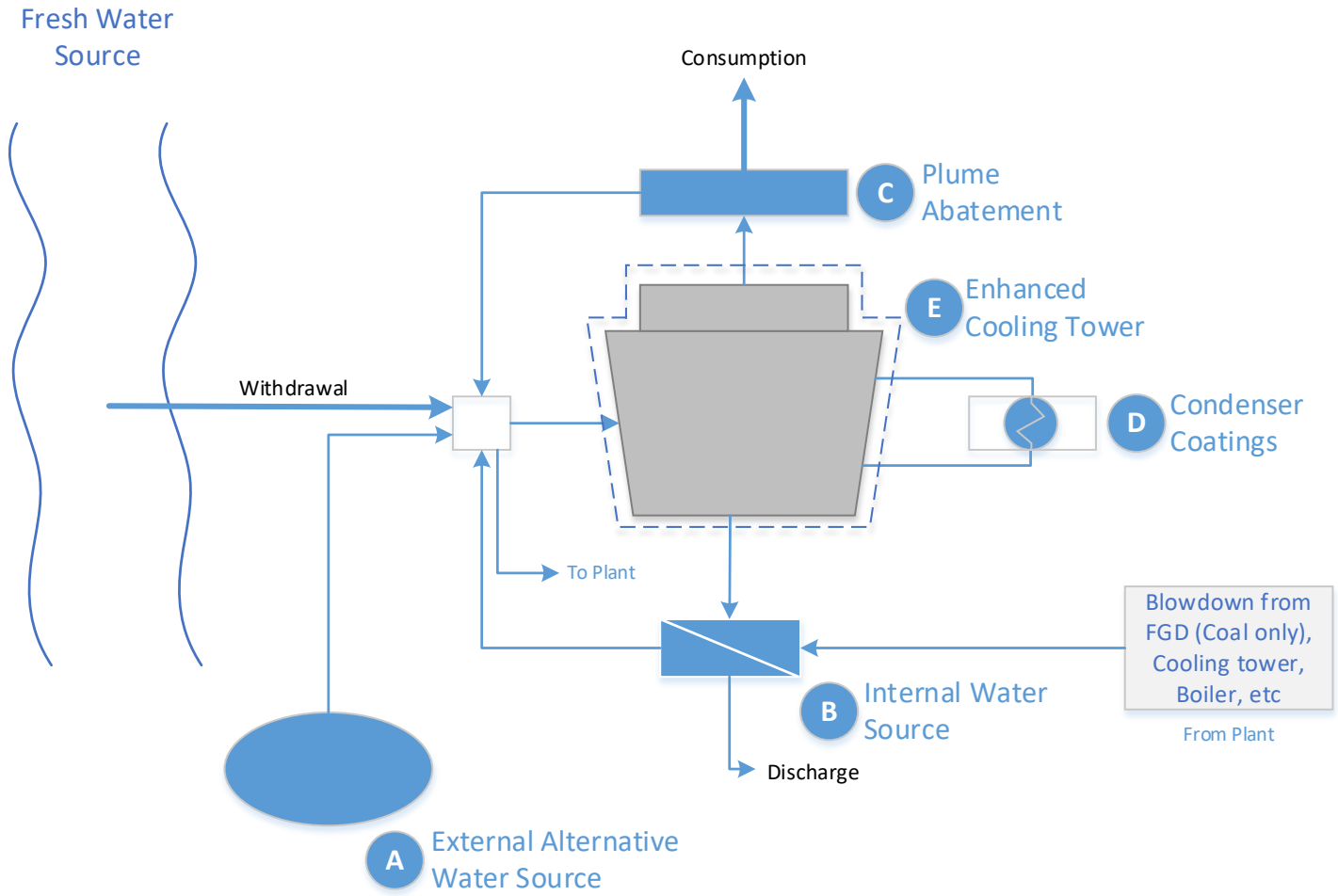
Change from base year





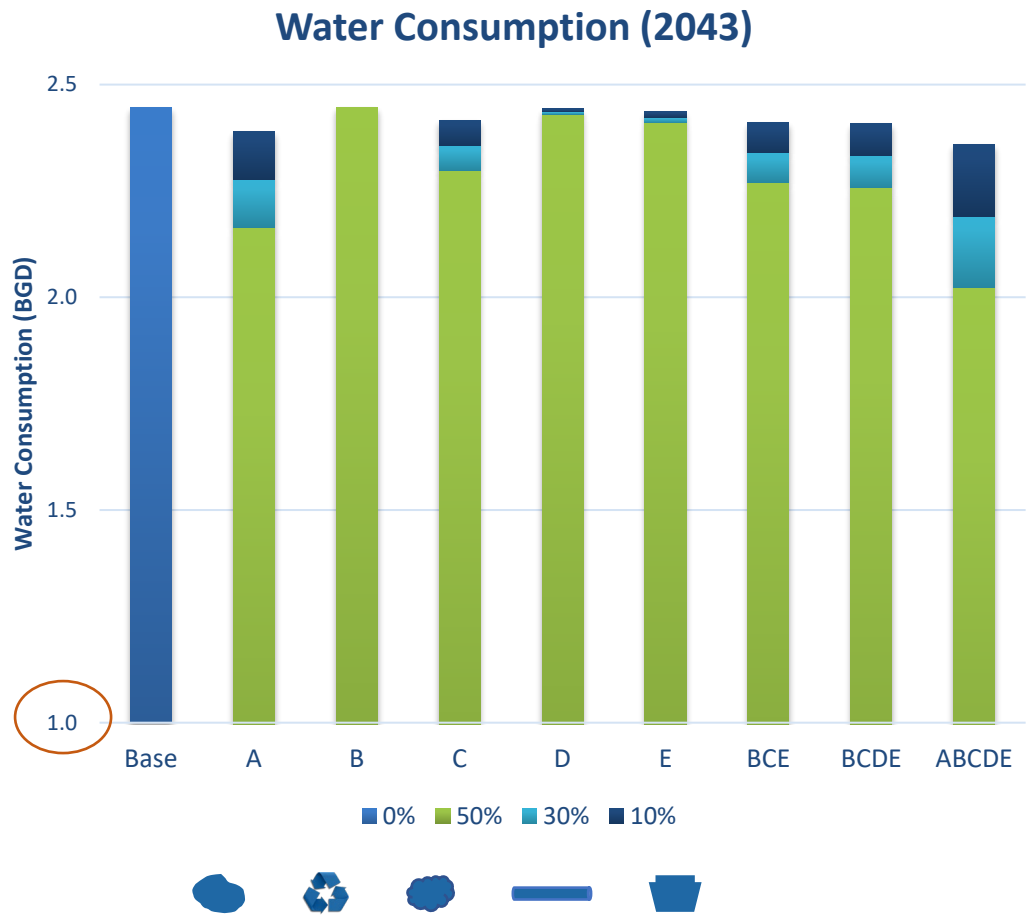
Freshwater Reduction Technologies

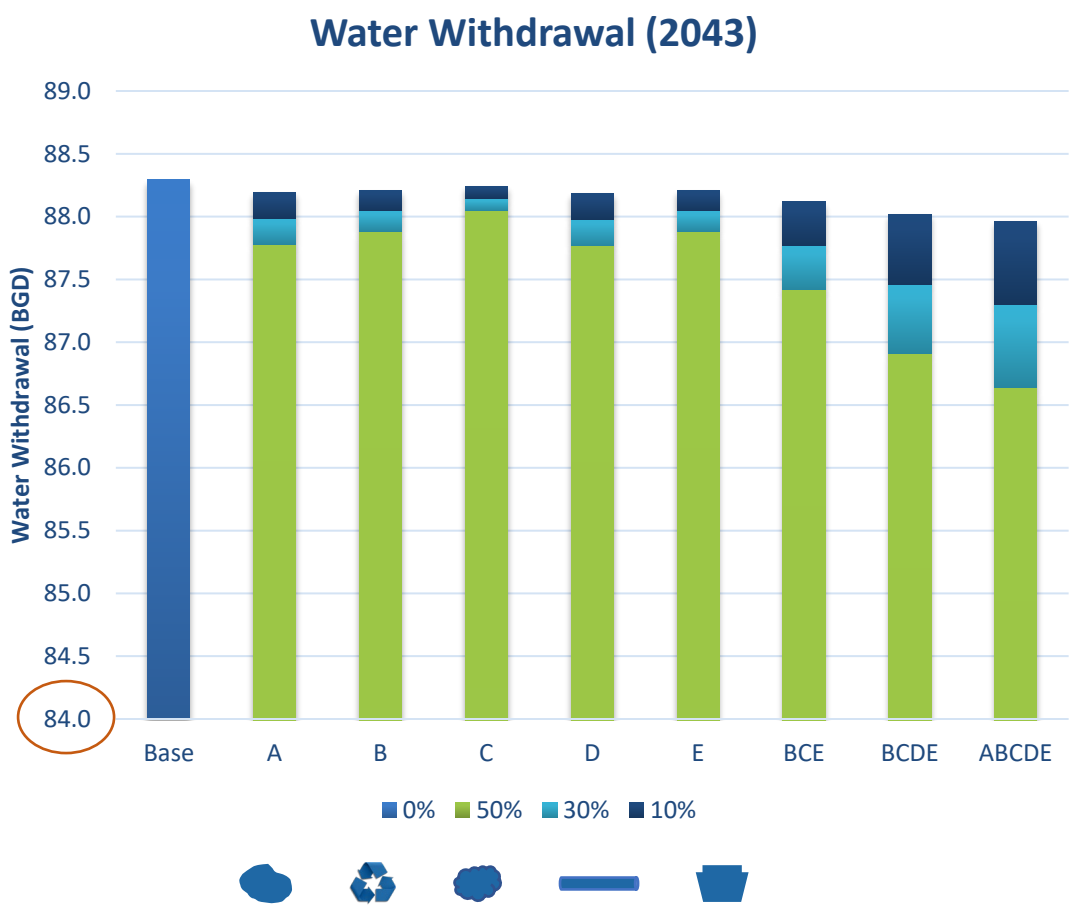
Applied to all thermoelectric power plants



Water Saving Technology Benefits

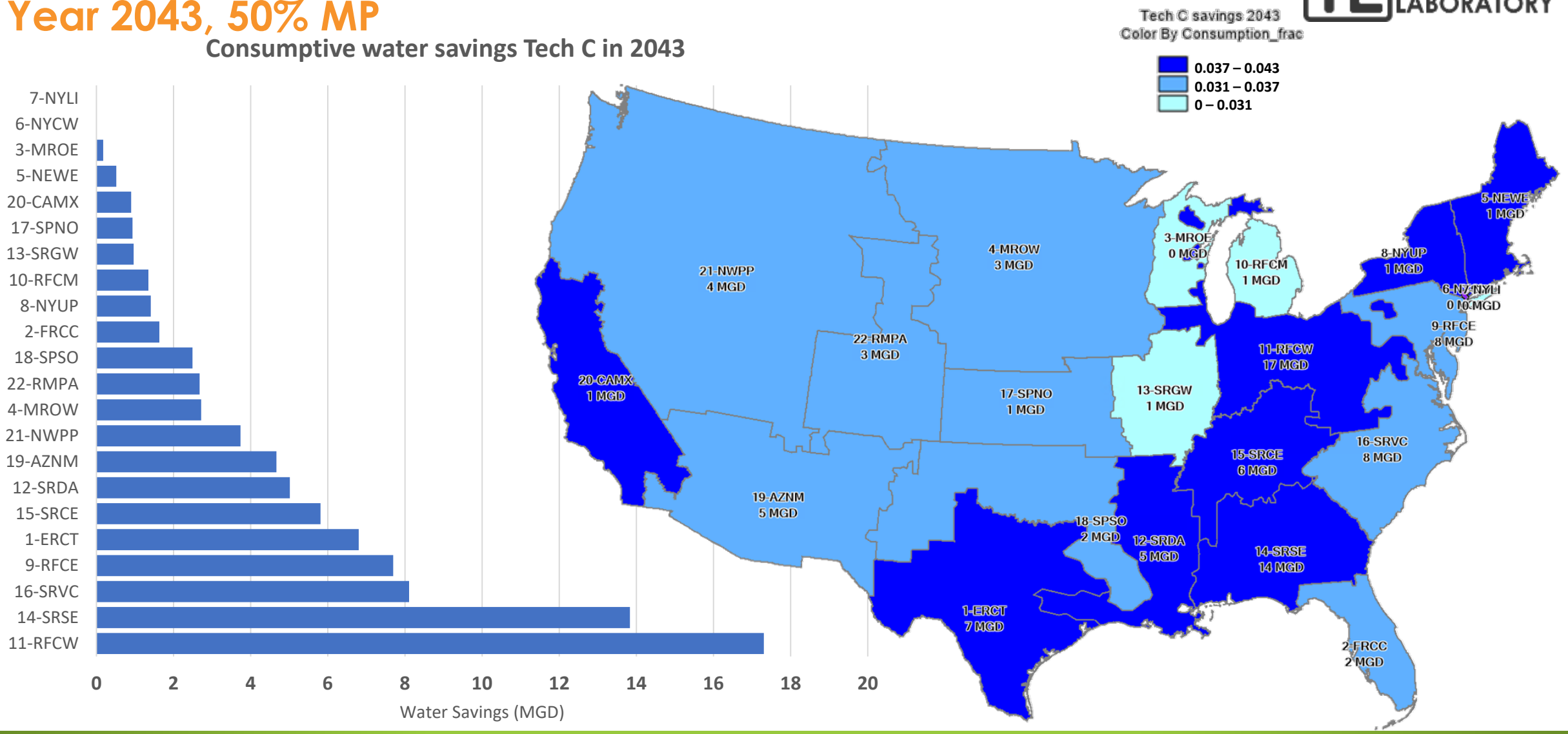
A – External Water Sources B – Internal Water Sources C – Advanced Cooling D – Condenser E – Cooling Tower





Regional Results: Technology C (Plume Abatement)

Year 2043, 50% MP



Concluding Remarks

AWARE and Benefits Modelling

- **Thermoelectric consumption does not drive Water Stress Factors (WSF)**
  - Mostly driven by resource availability rather than use
- **Greater water consumption during summer months contributes to WSF**
- **AWARE-US can be used to value potential water saving technologies for new or existing thermoelectric power plants**
- **Combined technologies could reduce thermoelectric water**
  - Withdrawal by 603 BGY
  - Consumption by 154 BGY
- **Current EY21 Work**
  - Plant-level Hydrogen Water Integration Needs for Thermoelectric Facilities
  - Updating Water Use and Benefits Model
  - Investigate National and Regional CCS Water Use

Thank You!

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Thank you to the Water Management Crosscutting Program and to Briggs White and Nick Siefert for their guidance and support.

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