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Enabling DOE Regional Energy-Water Technology Pilots

Katharine Jacobs, Committee Chair
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Sheila Olmstead, Committee Member

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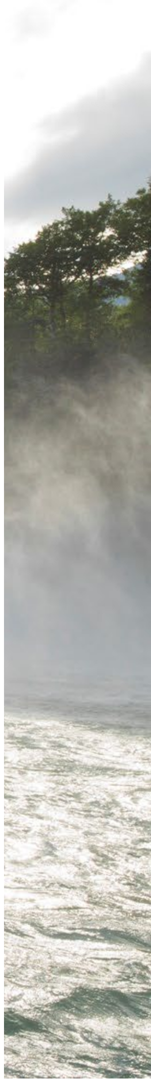
1
Context and Committee Introductions

Committee on Enabling DOE Regional Energy-Water Technology Pilots

(Jan 2025-May 2026)

“An expert committee will outline possible visions and programmatic elements that could bolster the design and success of a regional energy-water technology pilot program…”



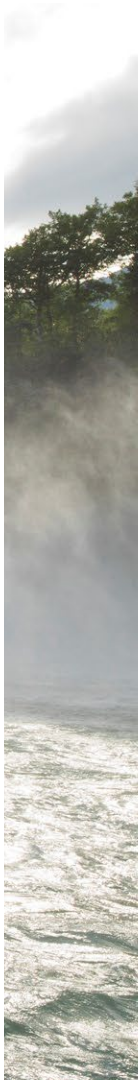
Study Scope:

- What should be the **criteria for selection** of regional technology pilots?

- What existing activities can be **leveraged?**

- How can pilot projects best **engage with stakeholders and communities** to develop and deploy integrated solutions for energy-water management?

- What are the **near- and long-term impacts** of regional energy-water pilots? How should these initiatives be evaluated? What **metrics** should be used?



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Study Committee

Katharine L. Jacobs, (chair) *The University of Arizona*

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Heather Cooley, *Pacific Institute for Studies in Development, Environment, and Security*

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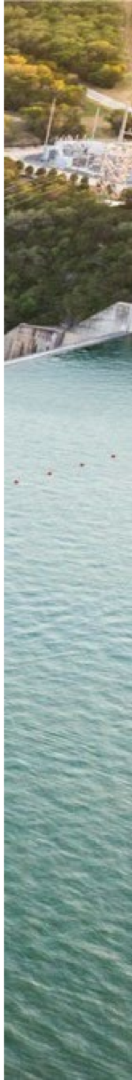
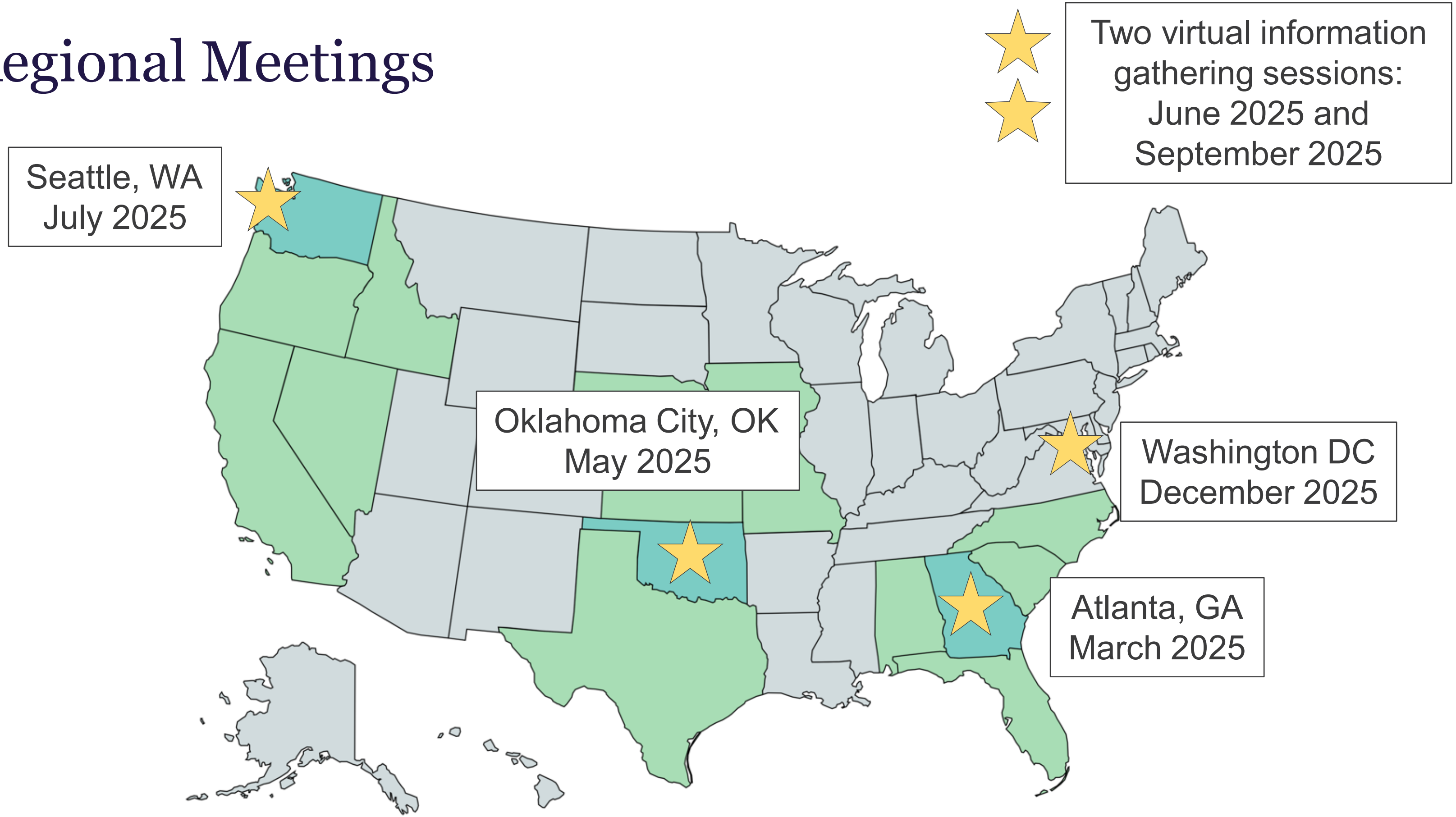
Nick Tew, Jr. , *Geological Survey of Alabama/State Oil and Gas Board*

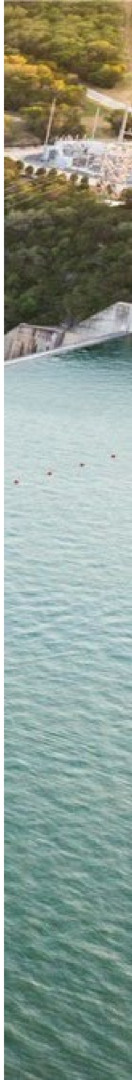
Pei Xu, *New Mexico State University*

Julie Zimmerman, *Yale University*



Regional Meetings

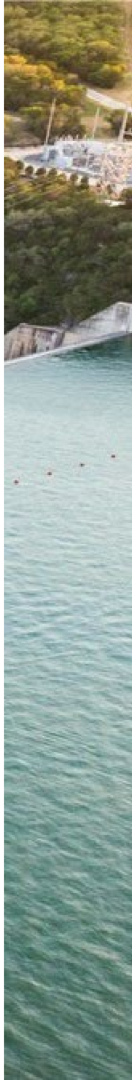




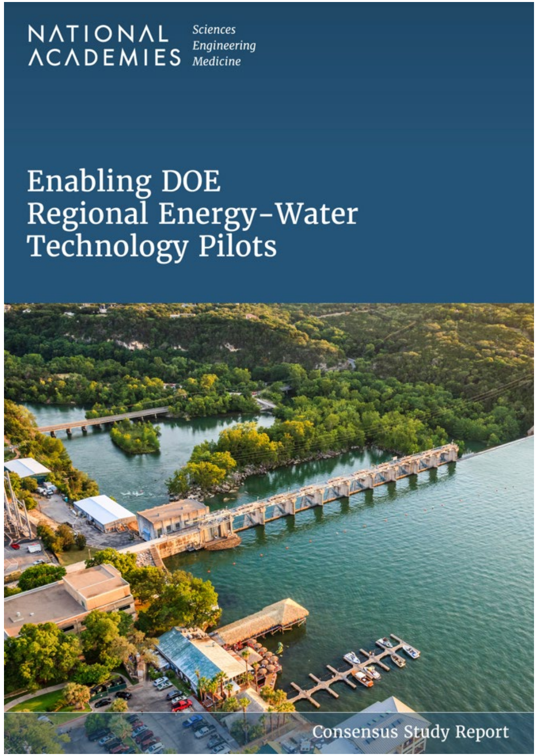
Recent DOE Energy-Water Nexus Activities

- 2005–2006 — DOE Energy–Water S&T roadmapping workshops and analyses
- 2006 — “Energy Demands on Water Resources” Report to Congress (DOE)
- 2008–2011 — Thermoelectric cooling water and water-use technology studies (DOE and national laboratories)
- 2012 — Office of Science integrated water-cycle modeling workshop
- Late 2012 — Formation of DOE’s Water–Energy coordination team
- 2012 — Federal interdependency and coordination assessment (GAO)
- 2014 — “The Water–Energy Nexus: Challenges and Opportunities” (DOE)
- 2016–2019 — Expanded systems and resilience framing (energy infrastructure + water stress)
- 2019 — DOE Water Security Grand Challenge
- 2020 — Launch of the National Alliance for Water Innovation (NAWI)
- 2020–present — Energy-efficient desalination and water treatment R&D (NAWI core program)
- 2021–present — Climate, Earth-system, and water-cycle modeling for energy applications (Office of Science)
- 2022–present — Infrastructure and community-scale energy–water systems integration

2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026



Report Snapshot



Chapters

1 Introduction

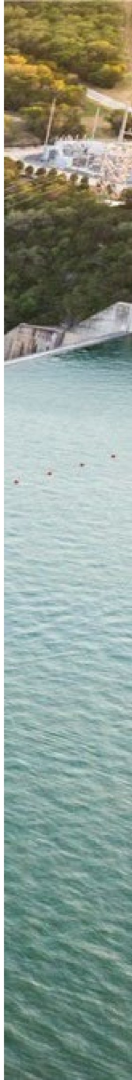
2 Emerging Energy-Water Issues in the United States

3 Leveraging Existing National Efforts

4 A Process for Program Design, Project Selection, and Management

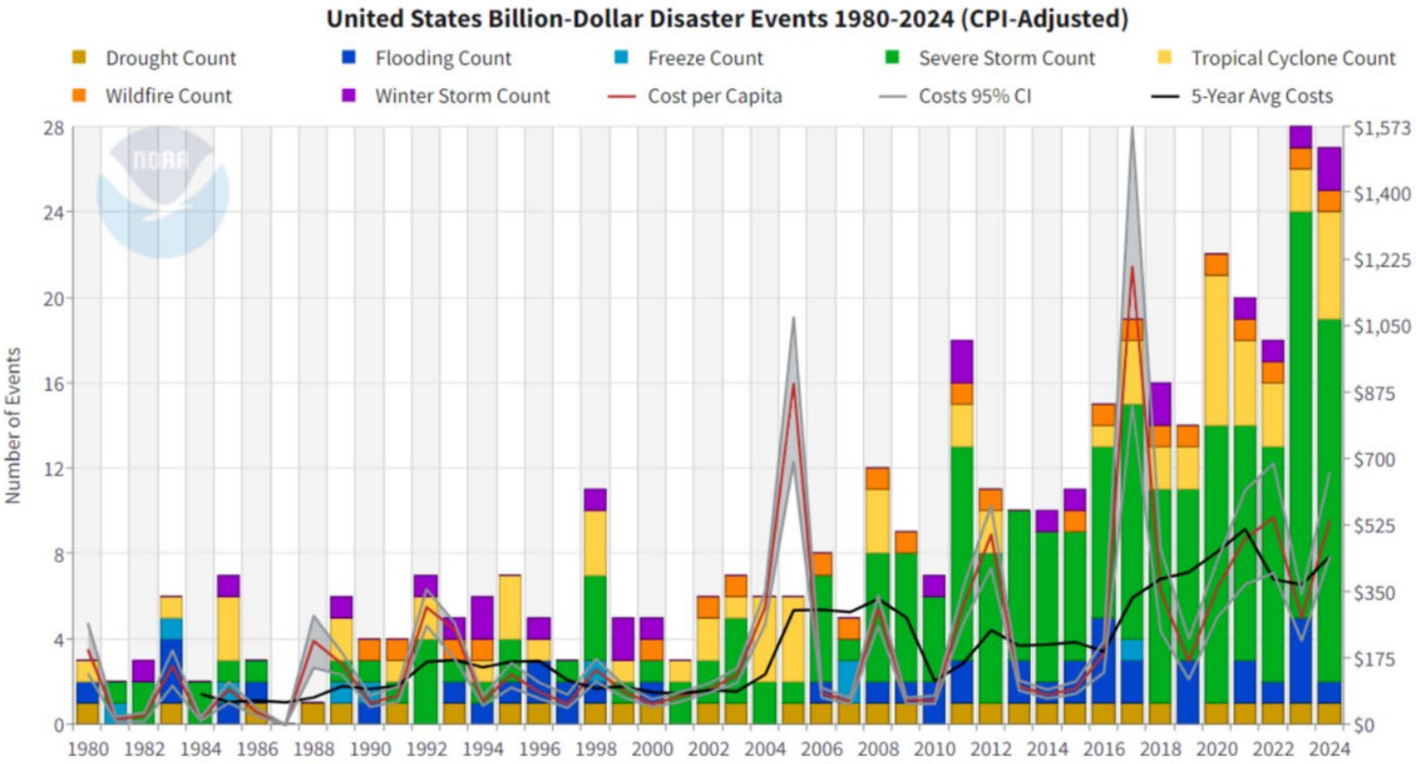
5 Evaluating Near-Term and Long-Term Impacts

27 Conclusions | 21 Recommendations

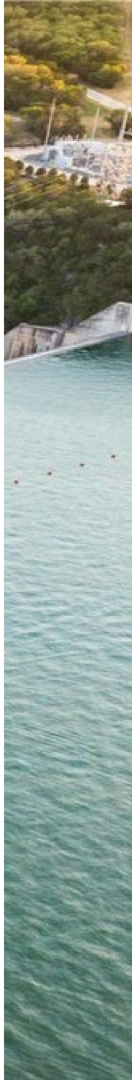


2
Framing the Challenge

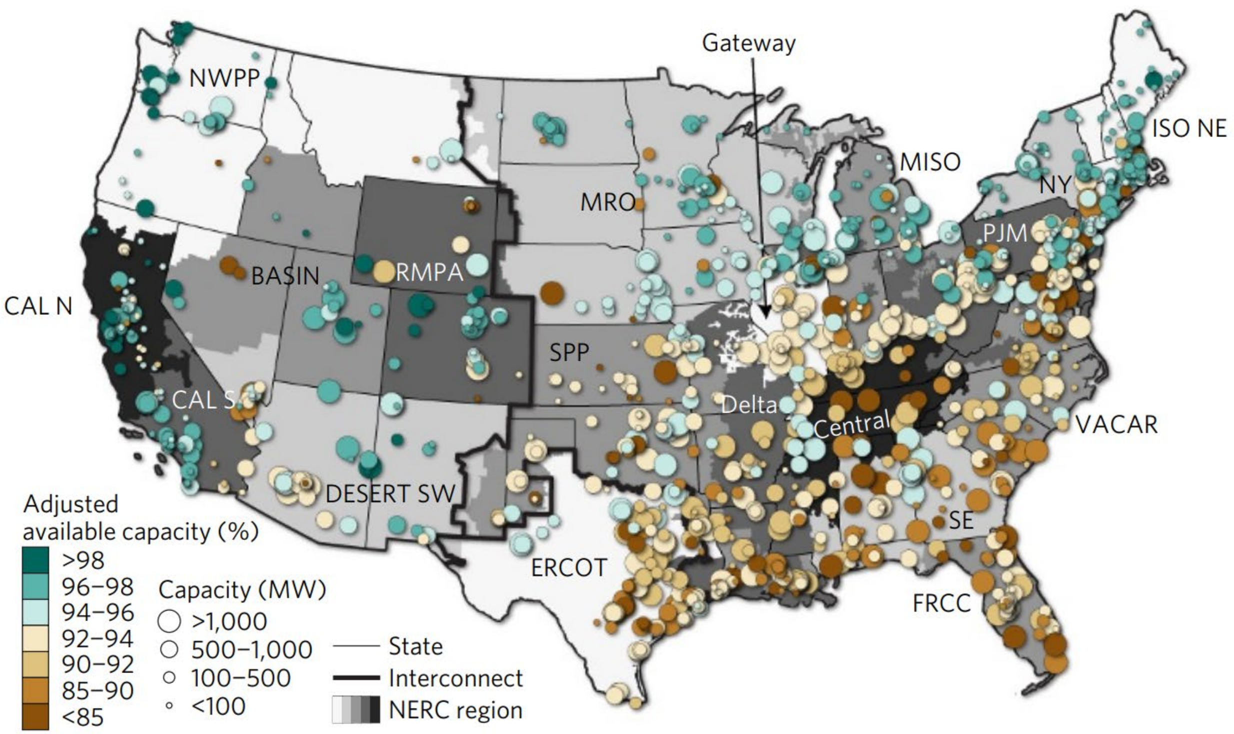
Framing the Challenge: Why This Matters Now



Source: Smith 2025 “An Active Year of U.S. Billion-Dollar Weather and Climate Disasters”



Interconnected Risks



Source: Miara et al. 2017 “Climate and Water Resource Change Impacts and Adaptation Potential for U.S. Power Supply”

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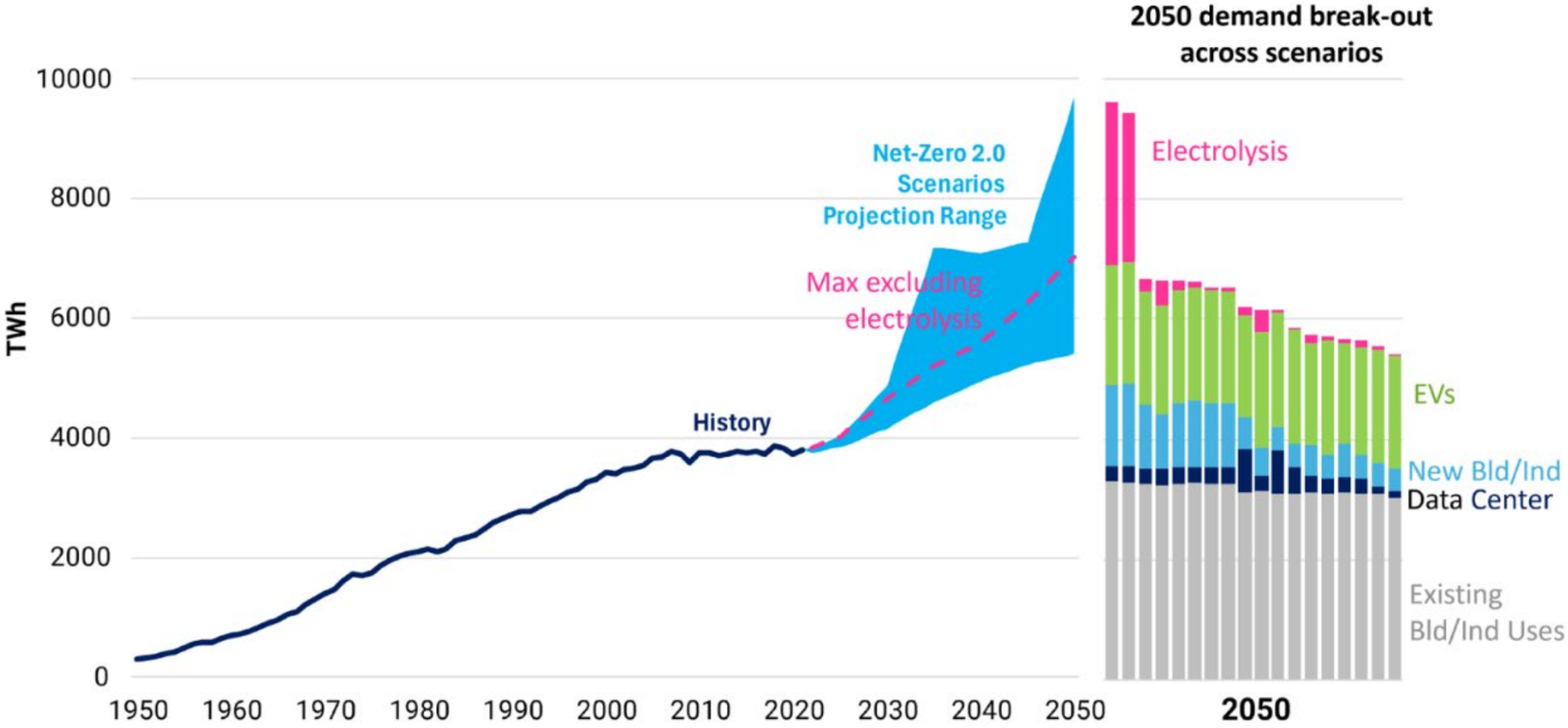
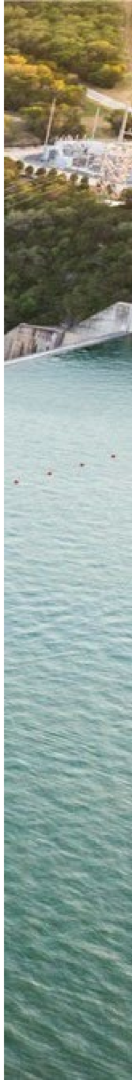
Evolving Supply and Demand Dynamics



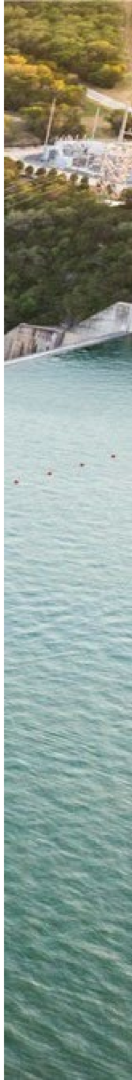
Source: EPRI 2025 “Net-Zero Scenarios 2.0: Sensitivity Analysis and Updated Scenarios for LCRI Net-Zero 2050”



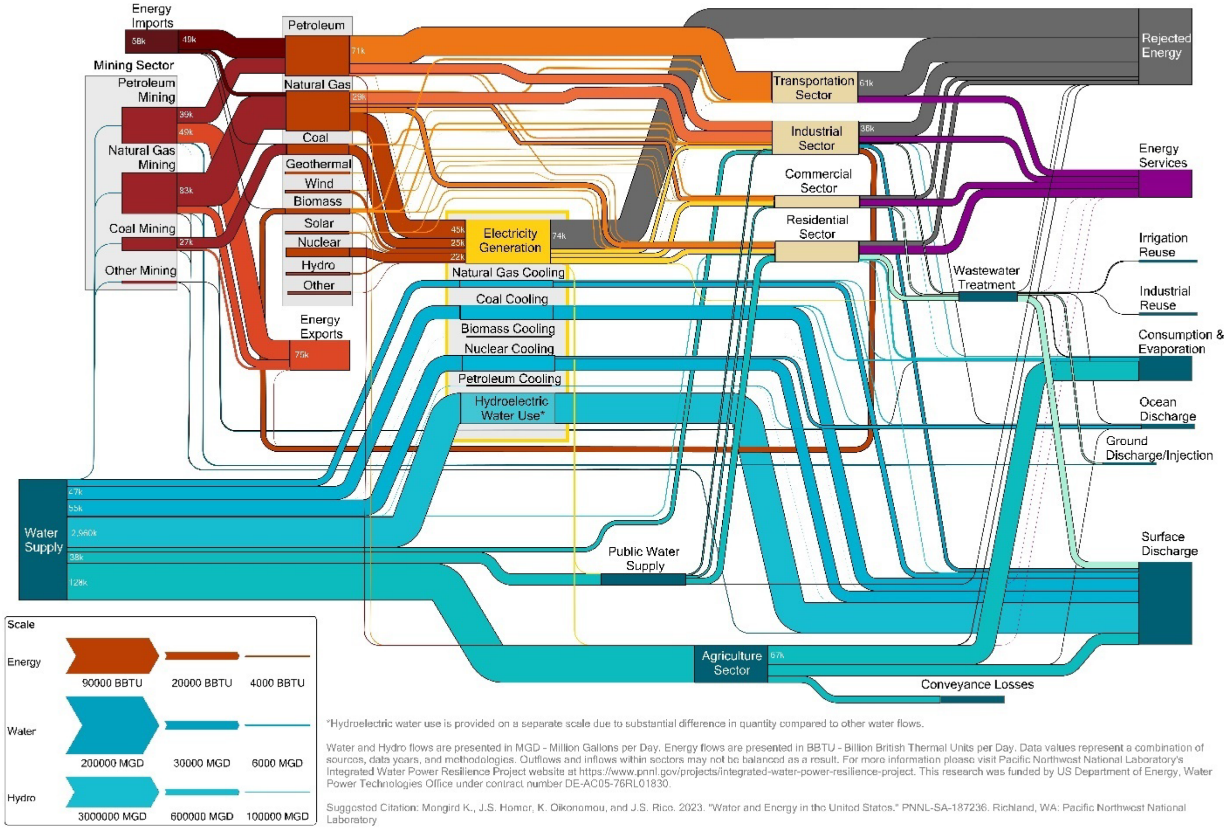
Framing the Challenge: Why This Matters Now

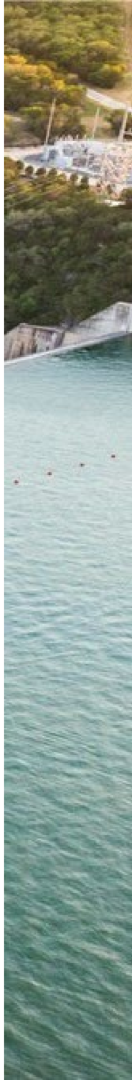
Recommendation 2-5: The Department of Energy's technology pilot program should **prioritize the proactive management of risks at the intersection of energy and water systems as a key strategic objective.**

Potential projects could include, for example, development of tools for anticipatory risk assessment, scenario planning, and early warning to identify vulnerabilities; enhanced cross-sector coordination; improved monitoring and data integration; and investments in resilient systems and infrastructure. A proactive risk management approach can enhance the reliability of critical energy and water services under increasing stress.



Intersecting systems, sectors, institutions and geographies





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Source: Mongird 2023 “Water and energy interdependencies across economic sectors of the U.S.”

Defining Key Terms

“Energy-Water Nexus”

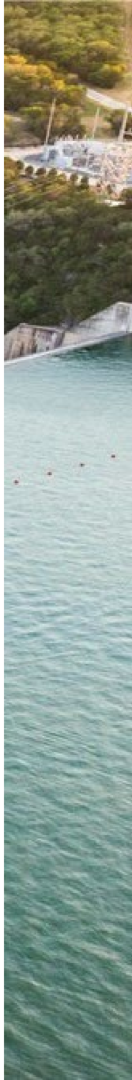
The intersection of energy and water systems broadly construed, encompassing infrastructure and end uses, and crossing sectors, not solely limited to electric and water utilities

“Region”

A geographic boundary, shared resources such as in a watershed or energy-shed, or a specific issue (e.g. groundwater depletion, wildfire risk, industrial development)

“Pilot Program”

A portfolio of transdisciplinary collaborative projects to develop, test, validate, or scale energy–water nexus solutions. It can encompass any aspect of research, development, and demonstration (RD&D)



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Strategic Objectives, Theory of Change

Inputs

Conditions that enable action:
- Resources
- Program Structure

Activities

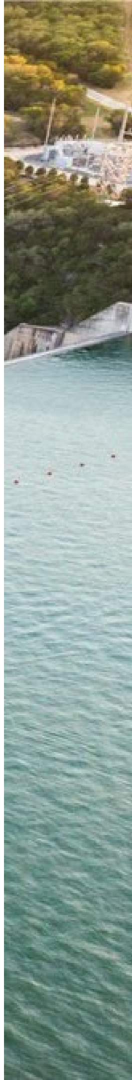
- Projects
- Research
- Partnerships
- Management

Outputs

- Knowledge gained
- Systems adjusted
- Technologies developed/adopted

Impact

Contribution to strategic objectives and long-term change



3
Emerging Issues

Major Emerging Trends

Water Resource Dynamics and Quality

- Total water withdrawals for electricity are declining, but proportion consumed through evaporative cooling is increasing
- Use of alternative water supplies is increasing
- Emerging water contaminants can increase energy demand for water treatment
- Produced water volumes are increasing while disposal sites are decreasing

Climate and Environmental Pressures

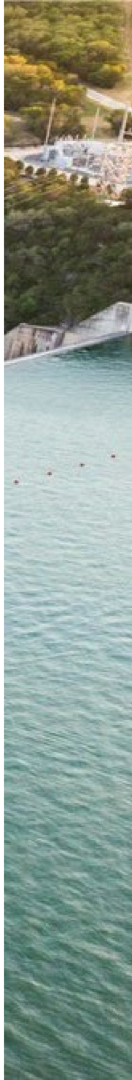
- Thermal and hydroelectric power generation are increasingly constrained by water availability and quality
- Extreme events (wildfires, floods, droughts, hurricanes) are increasing in frequency and intensity
- High and low temperature extremes are increasing pressure on water and energy systems
- Electricity generation from hydropower is decreasing

Energy Demand Growth and System Transition

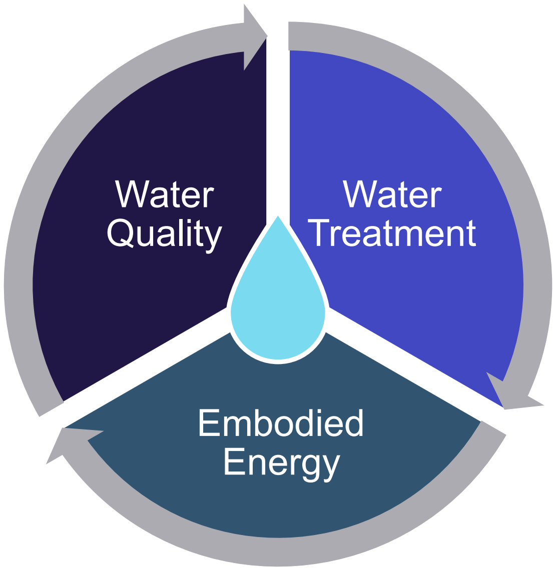
- Expansion of data centers and other industries are increasing electricity and water demand
- Electrification of transportation and heating/cooling can increase localized peak demand
- Conventional renewable fuels production is unchanged while alternative renewable fuels production, particularly sustainable aviation fuel, is increasing

Infrastructure and System Constraints

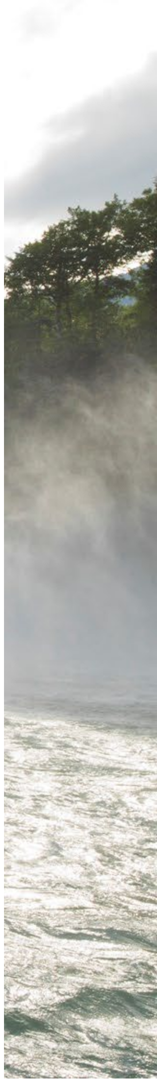
- Energy and water infrastructure across the U.S. is aging



Unintended Consequences: Energy-Water Quality



- Use of alternative water supplies is increasing, often increasing energy use
  - Emerging water contaminants, (e.g. PFAS, microplastics) and changing regional water quality have energy implications
  - Increasing water efficiency generally means increasing concentrations of contaminants



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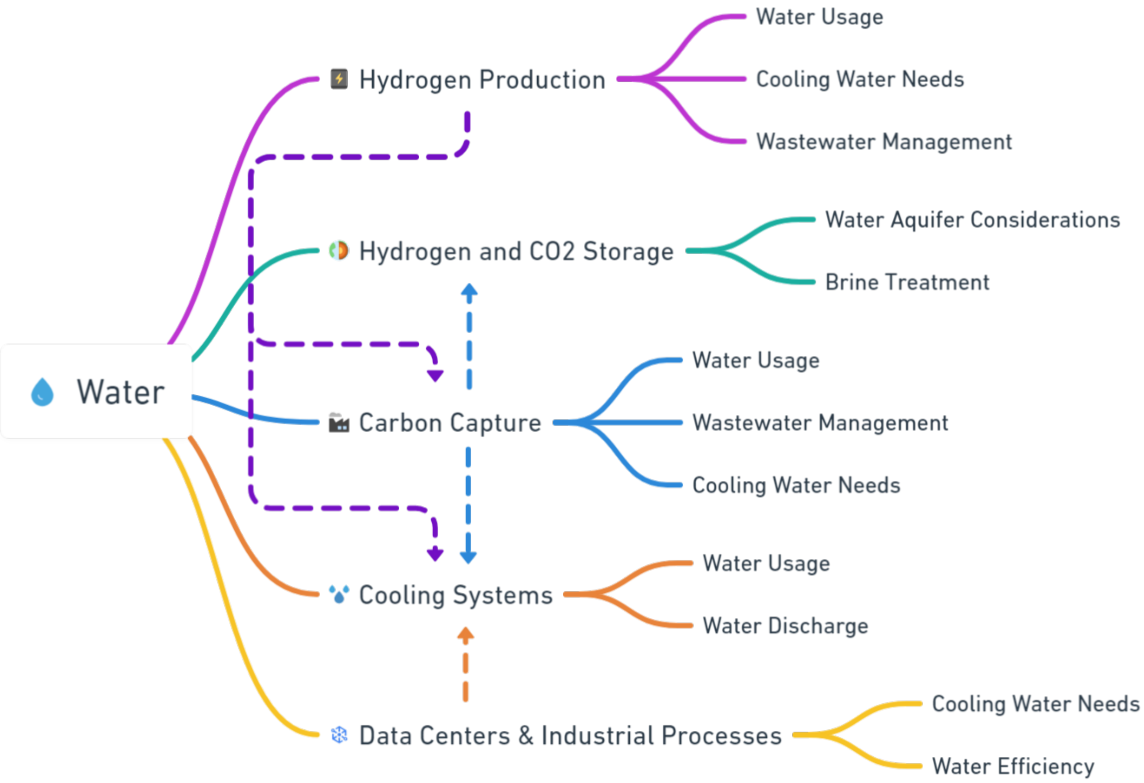
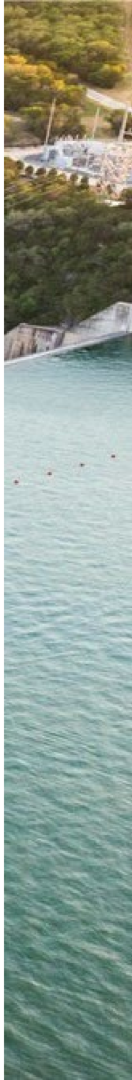
Emerging Technologies Need Both Energy and Water



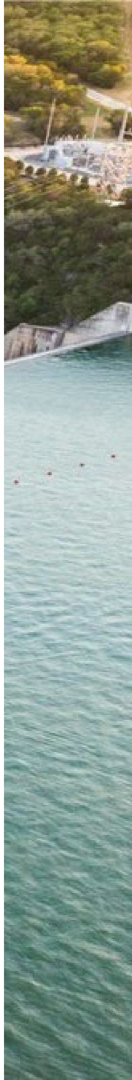


Major Emerging Trends and Opportunities

Recommendation 2-3: Within the program portfolio, energy–water projects should include consideration of

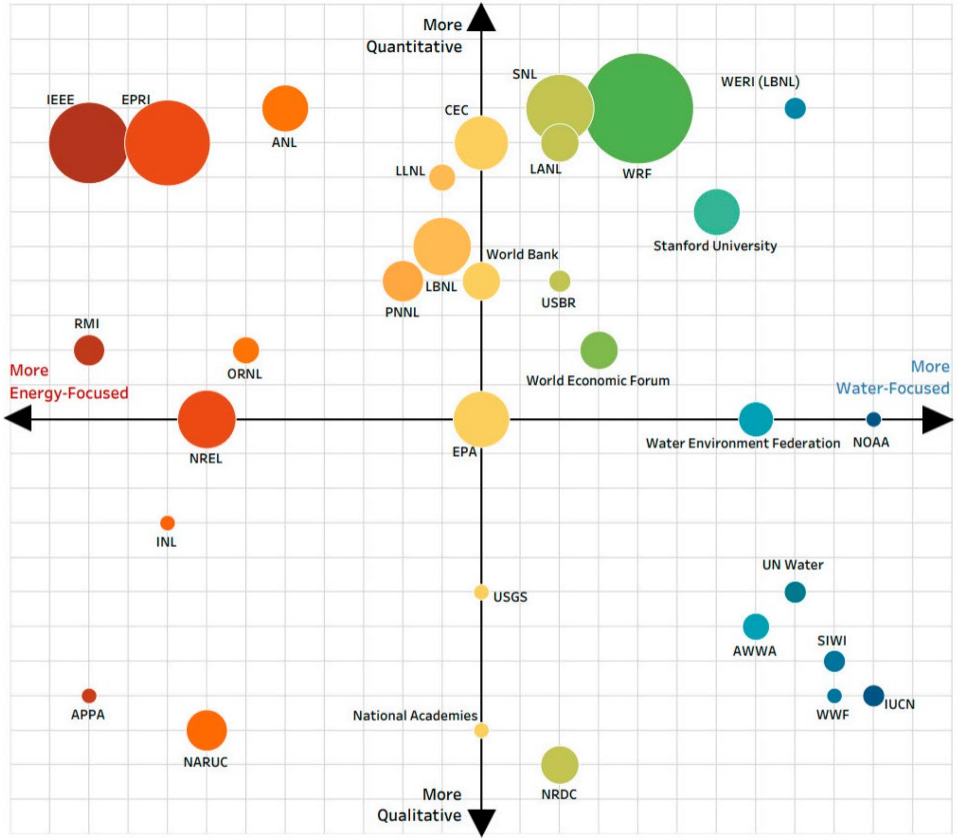
(1) **regional supply and demand for both energy and water**;
(2) **spatial and temporal challenges**; and
(3) the effects of potential **extreme events** (to the extent feasible).

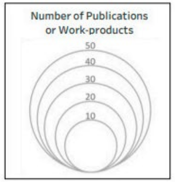
...Effective planning for periods of acute scarcity or stress requires understanding region-specific challenges and their implications for investment priorities and affordability.

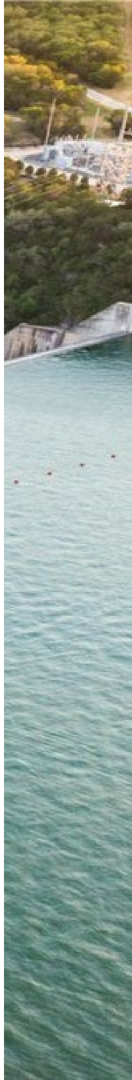


Data Gaps as a Critical Barrier

- Lack of coordinated, high-quality, georeferenced data
- Need for real-time decision-relevant data
- Need to understand energy-water system interactions
- Better data are available for energy demand/supply than for water





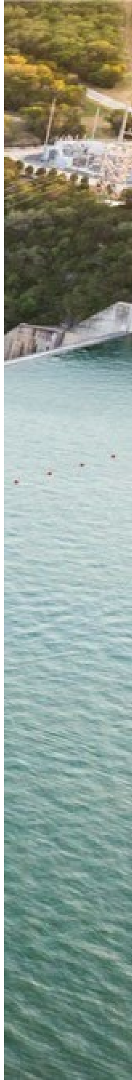


Source: Oikonomou et al. 2021 “Resilience of Interdependent Water and Power Systems”

Addressing Institutional and Social Challenges

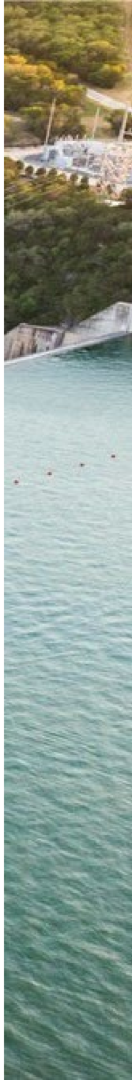
Recommendation 3-4: The Department of Energy (DOE) could promote the use of innovative technologies at scale by establishing a broad scope for the program and dedicating a portion of its portfolio of projects to addressing institutional and social challenges related to the deployment of solutions.

DOE might also consider requiring applicants and/or projects to include a structural barrier analysis that identifies regulatory, institutional, financial, and social constraints to the implementation of innovations and embeds strategies for addressing them in project planning, as well as including a stakeholder engagement plan.



Co-Benefits

Recommendation 3-5: The Department of Energy should **consider projects that provide benefits beyond energy or water utilities**, particularly partnerships with agricultural, industrial, and commercial operations that lead to co-benefits. Such projects (for example, use of waste heat from manufacturing, food processing, or data centers to support energy needs of partners), can generate synergies, conserve energy and water, and develop transferable best practices



4
Why Pilots?

Why Pilots?

Reduce uncertainty

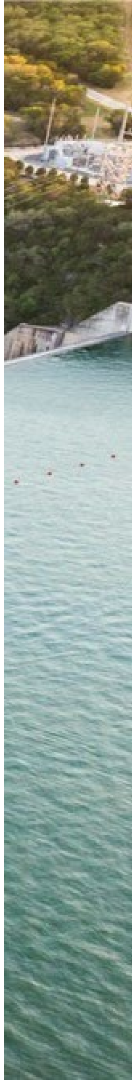
Generate real-world data

Build shared systems of knowledge

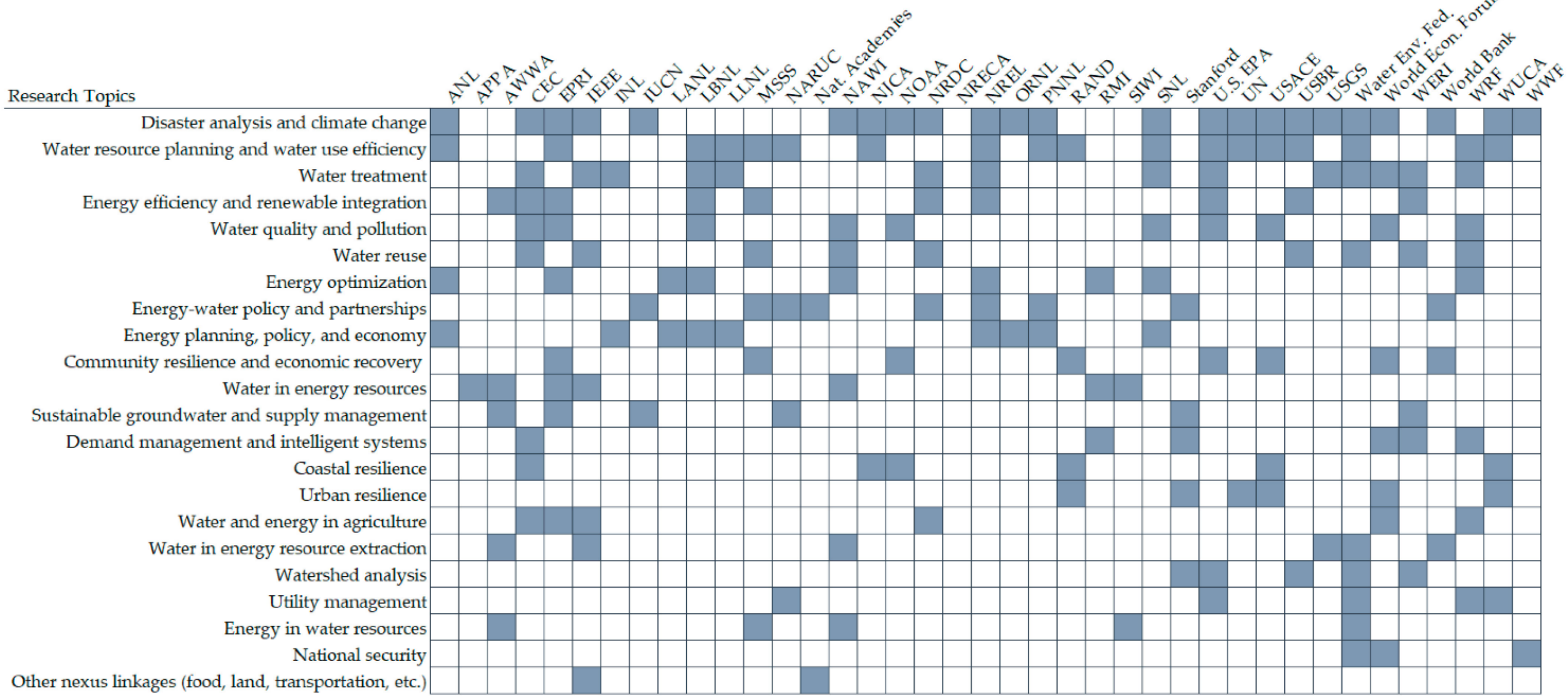
Build institutional and technical capacity

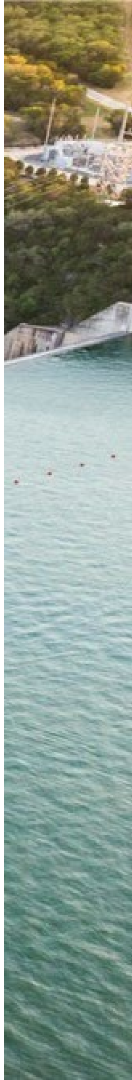
Test alternative approaches

Integrate relevant social and behavioral components

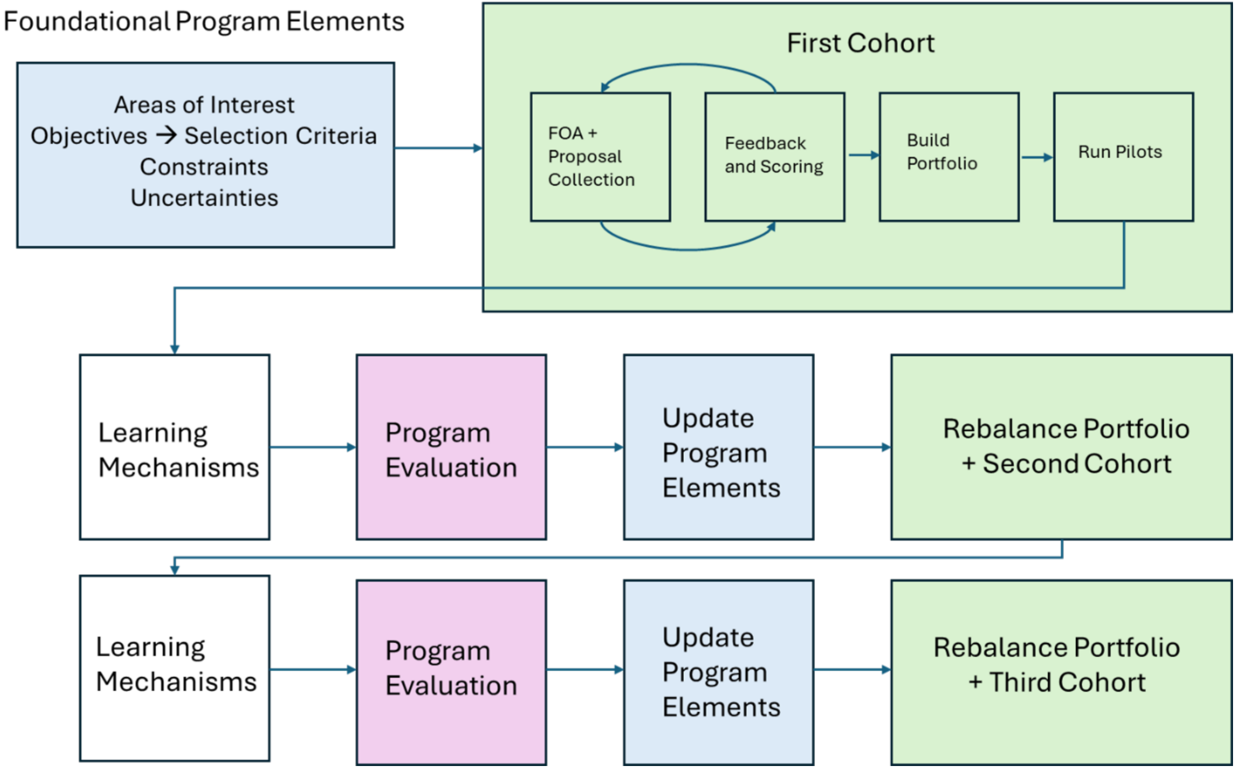


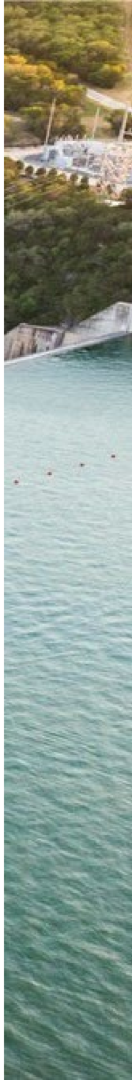
Leveraging Existing Efforts (within the federal government and beyond)





Pilots as Learning Systems





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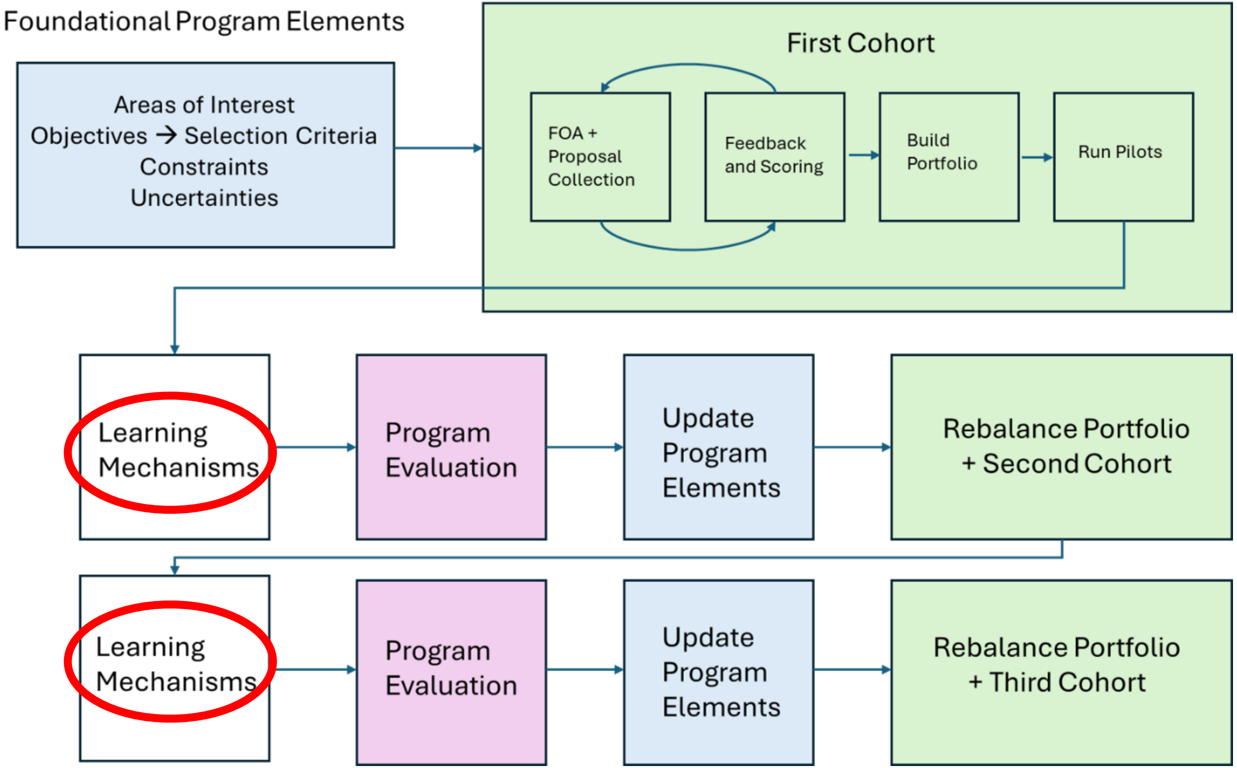
Pilots as Learning Systems



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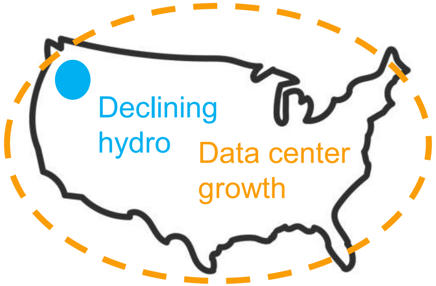
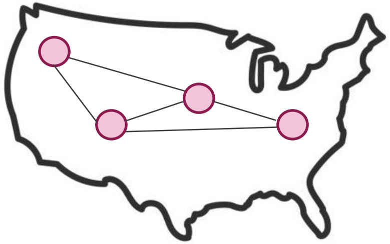
5
How to Design Effective Pilots

Why a portfolio approach?

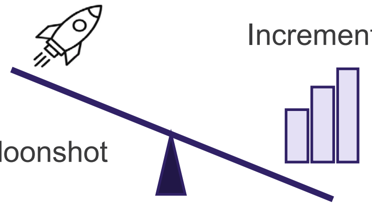
Strategic Coverage



Learning and Synergies

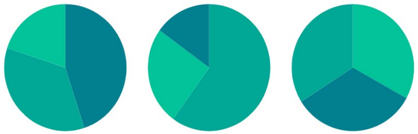


Risk Management



Resource Optimization

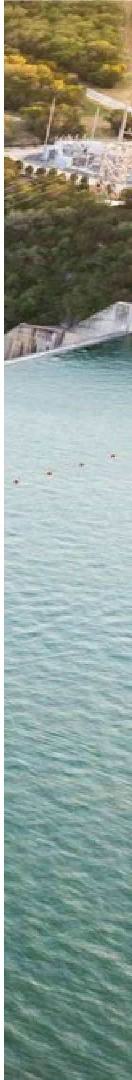
Cohorts or Portfolios



Why a portfolio approach?

Recommendation 4-1: The Department of Energy should implement a portfolio approach that allows for the testing of many potential solutions. Approaching technology challenges at multiple scales and readiness levels can reduce risk, accelerate progress, promote synergies across projects, and balance short- and long-term needs while navigating trade-offs among competing objectives.

This approach is well suited to tackle **regional**, **context-specific problems** where **learning** across a broader cohort can yield more impactful outcomes

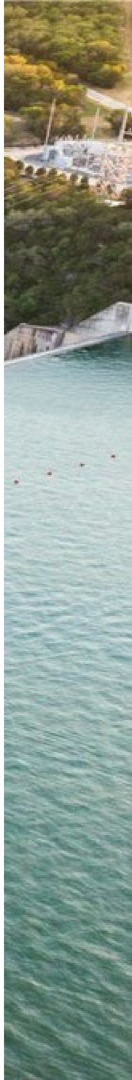


Stakeholder Engagement

Effective stakeholder engagement begins with **clear articulation of the scope**; this aligns expectations and supports meaningful participation. A clearly defined scope provides stakeholder with a shared understanding of purpose, expected outcomes, and long-term vision.

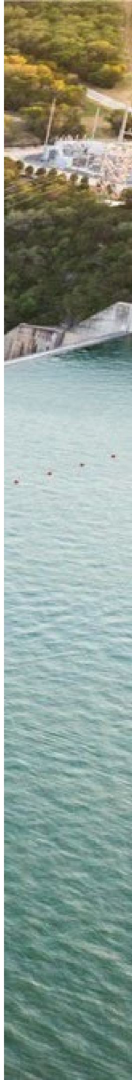
Successful partnerships are defined by:

- Clear roles and well-articulated expectations
- Shared goals
- Transparent and frequent communication
- Space for bidirectional feedback, and shared learning
- Adequate time and resources to support engagement processes



Managing Complexity and Uncertainty

Recommendation 4-4: Criteria for selecting pilot projects should explicitly assess applicants’ ability to articulate a clear project vision, define roles and responsibilities of collaborators, implement nimble project management structures, and cultivate effective partnerships and stakeholder engagement. These attributes will increase the likelihood that applicants can respond effectively to unforeseen changes and achieve useful outcomes.



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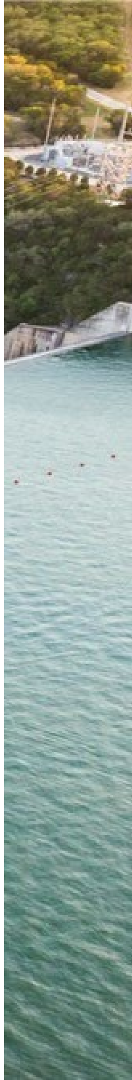
Adaptive Project Management

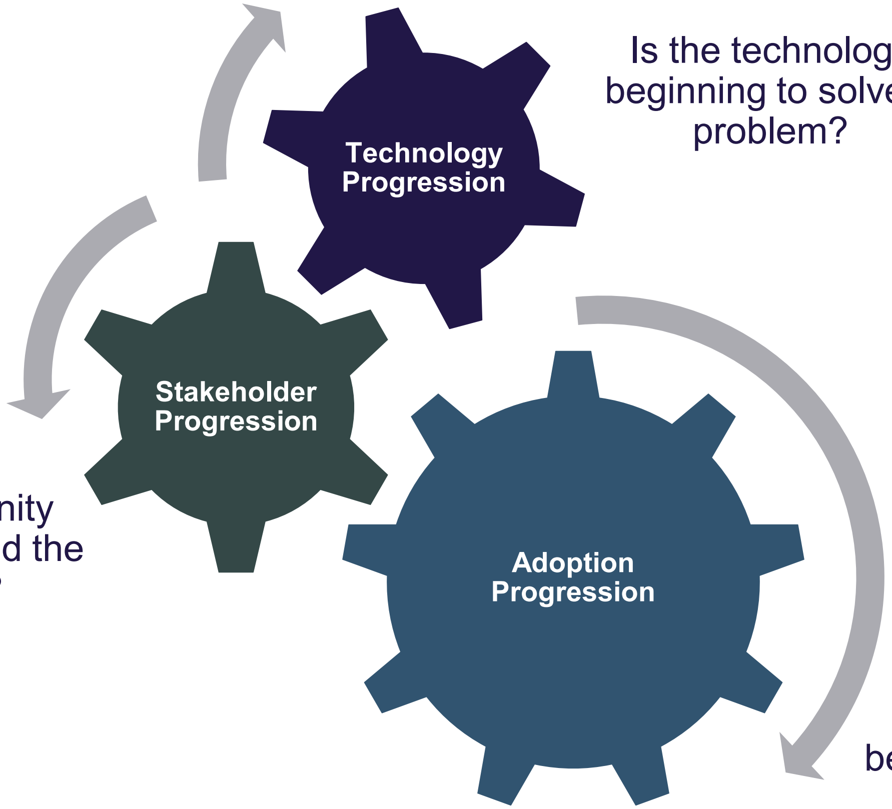
Recommendation 4-7: The Department of Energy should consider iterative proposal reviews, site visits, staged funding (seed and full awards), and other risk-mitigation measures. **Adaptive portfolio management**, including the reallocation of resources away from underperforming projects, and agile project management methods should be built into program design and informed by regular performance reviews.

Efficient elimination of unproductive directions should be balanced with learning from "good failures"…



6
Measuring Impact

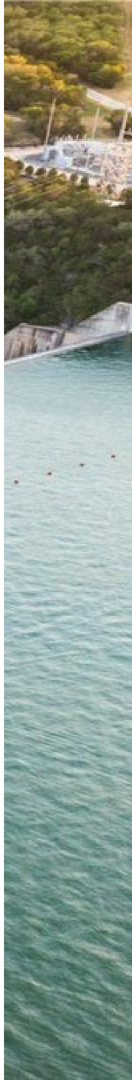
Measuring What Matters, Broadly



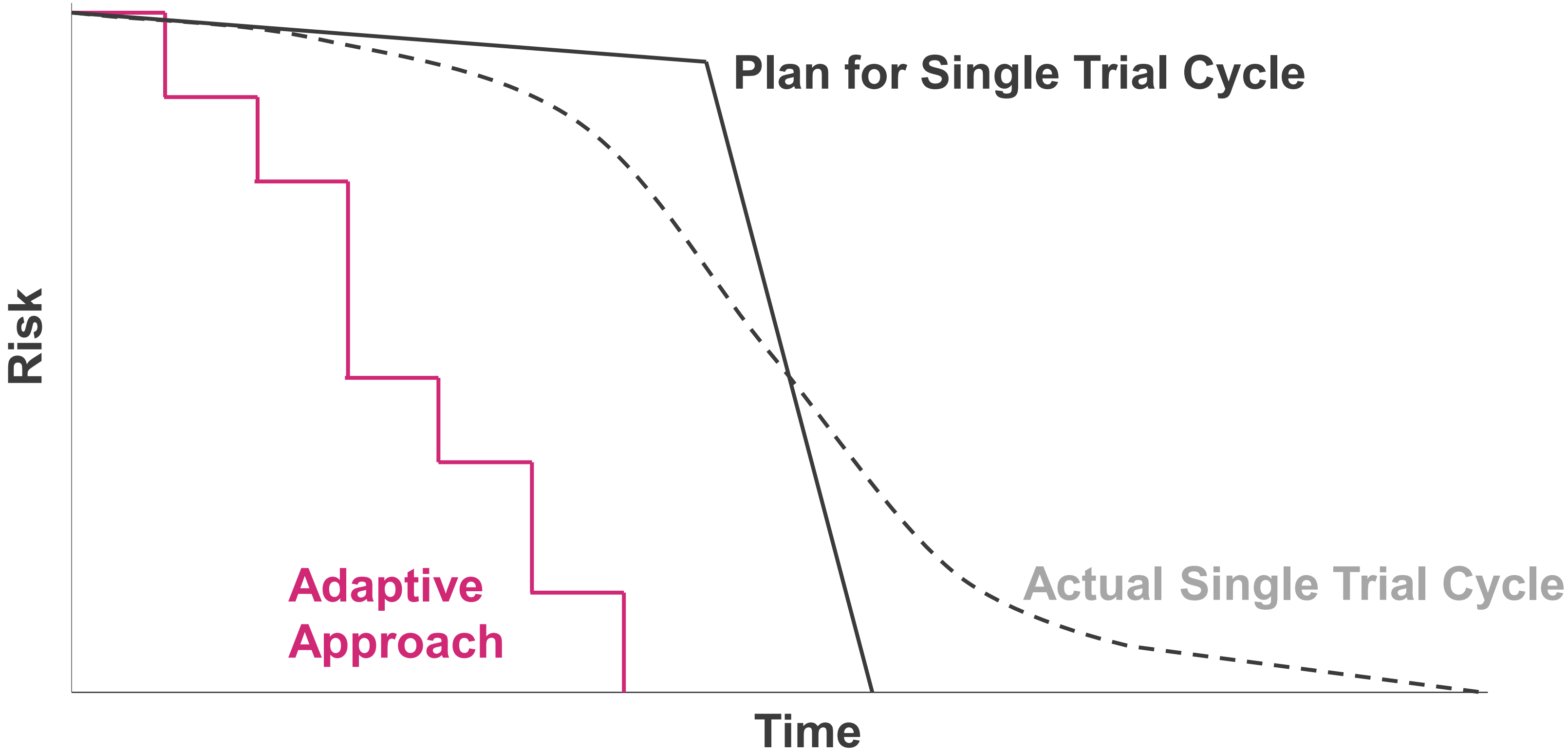
Is the technology beginning to solve a problem?

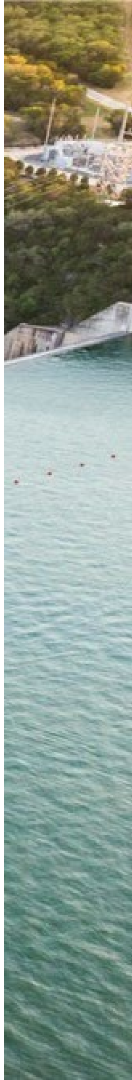
Is a community forming around the solution?

Is the system becoming easier to deploy?



Measuring Often & Adapting Quickly

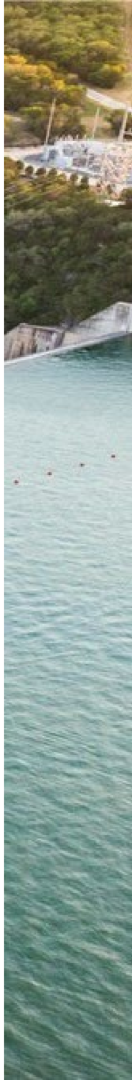




Evaluation is not just ROI

Decades of experience in federal demonstration programs show that **ROI-centric evaluation can systematically undervalue outcomes that matter most for public missions**, including increasing resilience, risk reduction, environmental sustainability, and regional economic vitality.

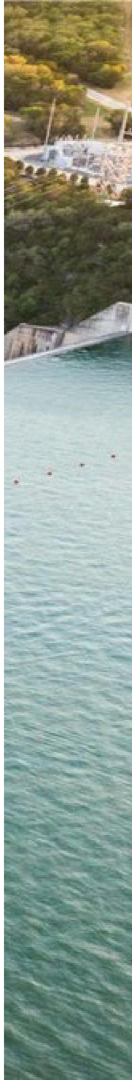
Demonstration projects frequently generate public goods that accrue to society rather than to any single firm. Because private actors cannot capture the full value of these benefits, **market forces alone tend to underinvest in such innovations**, even when they generate substantial long-term public value (Arrow 1962; Stiglitz and Weiss 1981).



Keeping Pilot Programs Focused

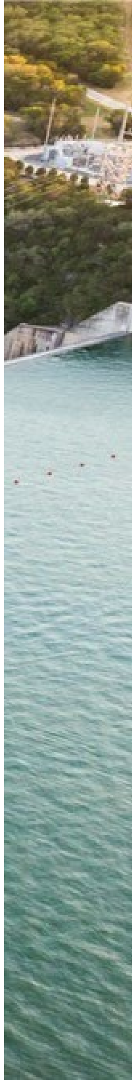
Good metrics should:

- Measure the factors with the most impact on objectives
- Align well with the criteria used to select the projects
- Provide feedback that is actionable
- Be easily measurable
- Document progress or adaptation to changing conditions
- Engage partners and stakeholders in a fruitful collaboration
- Avoid unnecessary administrative burden



Maximizing Societal Benefits

Recommendation 5-1: The Department of Energy should design **evaluation metrics that explicitly account for considerations such as short- and long-term societal benefits**, including economic growth, job opportunities, environmental sustainability, public health outcomes, access to water and energy services, and community resilience….



7
Conclusion

Key Takeaways

A successful pilot program needs:

- A broader definition of Energy-Water Nexus
- Clear program objectives directly related to program design
- Collaborative and adaptive management; frequent and focused feedback
- A portfolio approach with a learning focus
- Metrics based on progress in technology development, stakeholder engagement, and adoption progress
- Integration of social science to amplify impact and increase adoption potential