Committee on Science, Space and Technology
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Testimony of Dr. Vincent Tidwell, Sandia National Laboratories[1]

Chairman Lamb, Ranking Member Weber, and distinguished members of the Committee, I thank you for the opportunity to testify today on this critical issue of the energy-water nexus. Last week while on vacation, I had the opportunity to travel from Albuquerque, New Mexico to Park City, Utah. On this trip I crossed the San Juan, Colorado and Green Rivers along with the Rio Grande. I also passed numerous power plants, hydropower dams, oil and gas plays and coal mines. The relation between these important resources was evident. Equally evident was the critical role these resources play in the economy, livelihood, culture and environment of the communities they serve. These resources are our heritage. Thank you for your concern and interest in securing these resources for generations to come.

It is no secret that energy production is the largest user of water in the United States, and in turn a significant fraction of energy in the U.S. is used to treat and move water. This energy-water nexus is a complex system that my colleagues and I in the research community have sought to understand. We in turn use this knowledge to develop advanced technologies and tools to support water and energy policymakers and planners. While our focus today is on the nexus of energy and water we must not lose sight that the connections go far beyond. Energy and water are tightly coupled to land, food and agriculture. In fact, most all of our nation's critical infrastructures are dependent in one way or another on these key resources.

There are three major points I'd like to make with my testimony this morning:

1. Challenges and opportunities related to the energy-water nexus are expressed differently in different regions.
2. Integrated planning improves coordination between water, energy and environmental managers jointly addressing issues of resource sustainability, waste management and supply chain security.
3. Harnessing the research and development capabilities of our National Laboratories, academia, private industry and federal agencies, we can develop advanced water treatment technologies that make new sources of water cost competitive, reducing our reliance on freshwater.

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Place Matters

It is often said that all water issues are local. Much the same can be said of the energy-water nexus where challenges and opportunities are expressed differently in different regions. Consider that difficulty in permitting new thermoelectric power plants due to limited freshwater availability is largely an issue of the Western U.S. In contrast, disruption of thermoelectric power generation by drought is limited to the East. Here, the issue is not with sufficient water but cooling water discharge that exceeds permitted thermal loads. Although drought impacts hydropower production nationwide, effects are most acute in the Northwest where hydropower accounts for 60% of all electric generation capacity. Management of oil and gas produced water is an issue where there is a lack of deep well injection or where such injection threatens seismic activity. Penetration of wind in the Plains States and solar in the Southwest has significantly reduced the water burden associated with electric power generation in these regions. Natural hazards display a geographic preference with threat of wildfire in the West, hurricane along the Gulf and Atlantic Coast, while the threat of drought and flooding are relatively ubiquitous. Energy use for agricultural irrigation and transbasin conveyance is largely limited to the Western U.S. These regional expressions of the nexus reflect the geographic character of the underlying energy-water systems; specifically, regional differences in water availability, water use, natural occurrence of energy resources, technology deployment, water/energy policy, culture and other. This complexity calls for a deep understanding of the linkages and dynamics relating these critical resources and their associated infrastructure. Broad participation across the U.S. is required to fully appreciate the full geographic context.

Integrated Planning

The expressions of the energy-water nexus, as previously noted, have started people talking. Talking in ways that historically has not happened. I am speaking of integrated planning where energy, water and environmental managers work together to manage these interacting resources. Sandia, aided by other National Laboratories and Dr. Webber, have helped bring the nation's three large electric interconnections (Western Electricity Coordinating Council, Eastern Interconnection Planning Cooperative, and the Electric Reliability Council of Texas) together with state water managers to integrate water into long-term transmission planning. Specifically, we have provided data, modeling and analysis to determine where the availability of fresh water or the cost of a non-fresh sources of water might limit the siting of new thermoelectric generation. We have also helped identify potential changes in water supply, electricity demand, and hydropower scheduling due to a changing and variable climate. Beyond integrated resource planning, management of produced waste streams must be considered. Significant quantities of water and energy are required in the management of generated wastes. Examples include emission scrubbers, carbon capture and sequestration systems, produced water disposal, and concentrate management from desalination systems. Regulation and technology largely drive waste management decisions; however, new technologies are emerging to extract value from these waste streams such as utilizing waste heat from a power plant to drive water desalination, extracting biogas from wastewater/landfills, and production of building materials from scrubber blowdown and/or coal ash. DOE and the National Labs are going even deeper to

integrate supply chain security into resource planning. Water and energy are embedded throughout the supply chain in fuels extraction, fuel processing, fuel/water transportation and water treatment. Not only are these uses important considerations to the overall water budget, but these supply chain elements are often geographically separated, thus experiencing unique risks throughout the chain.

Advanced Water Treatment Technology

There is significant opportunity for technology to radically change the way we view the energy-water nexus. While there are numerous potential roles for technology, I will focus my comments on water treatment. In 1961 President Kennedy said, "if we could ever competitively, at a cheap rate, get fresh water from salt water, that it would be in the long-range interests of humanity which would really dwarf any other scientific accomplishment." President Kennedy's better-known ambition from that same year, "that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth" proved in the end the easier of the two. Nevertheless, there are over 18,000 desalination plants in operations around the world; however, I don't believe anyone would characterize desalinated water as cheap. Part of the reason for this lingering challenge is the sheer breadth of the problem. We are dealing with heterogeneous source waters with salinities that differ across several orders of magnitude (e.g., brackish to seawater). There are other contaminants beyond salt found in municipal/industrial wastewaters, produced water from oil and gas production, and agricultural return flows. Each requires a treatment system tuned to the unique characteristics of the source water as well as the particular demands of the use case. There is also the confounding issue of concentrate management, that is what do we do with the separated salts and other contaminants? Sandia has helped provide technical leadership by developing of two desalination roadmaps that prioritized needed research. Subsequently, the National Laboratories, academia, industry and other federal agencies have invested in R&D across the technology development spectrum. What has been missing is a coordinated effort across these individual and disparate projects. Toward this need, the DOE released a plan for an Energy-Water Desalination Hub (DE-FOA-0001905) with the goal to "to advance technologies that will enable pipe parity water for a range of non-traditional water sources using energy-efficient, water-efficient, cost-competitive, and manufacturable technologies." More importantly the Hub will provide a platform for coordinated federal, academic and industrial research. This effort will focus on early stage R&D in four distinct thrusts:

- New materials such as membranes and corrosion resistant materials;
- New processes including desalination, pre/post treatment, and concentrate management systems;
- Modeling and simulation supporting technology development and evaluating competitiveness of emerging technologies; and
- Integrated data and analysis to establish metrics and track progress.

Close integration with industry will be key in selecting and nurturing new technologies to a point where industry can carry the innovation to the point of commercialization. Alternative waters at competitive prices will help secure our nation's water and energy future.

Conclusion

Thank you again for the opportunity to share my testimony about this important topic. The energy-water nexus is a complex and nuanced issue with implications for two resources that underpin our national security. We are making progress in areas of integrated planning and advanced technology development, but more work is needed. I want to stress that this work is more than simply avoiding unintended consequences of a complexly coupled system; rather, we have the opportunity to completely reimagine our energy and water future. We are striving for an energy system that is not dependent on freshwater in our water limited regions. Likewise, we envision a future where non-traditional water sources like brackish water, seawater, produced water and wastewater can be treated at cost competitive levels. Such changes will have impact well beyond the energy and water sectors, influencing our economy and national security.

Thank you for convening this hearing, and I look forward to your questions.