S. HRG. 109–314

# DESALINATION WATER SUPPLY SHORTAGE PREVENTION ACT AND WATER SUPPLY TECHNOLOGY PROGRAM ACT

## HEARING

BEFORE THE

## COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED NINTH CONGRESS

FIRST SESSION

ON

## S. 1016

A BILL TO DIRECT THE SECRETARY OF ENERGY TO MAKE INCENTIVE PAYMENTS TO THE OWNERS OR OPERATORS OF QUALIFIED DESALINATION FACILITIES TO PARTIALLY OFFSET THE COST OF ELECTRICAL ENERGY REQUIRED TO OPERATE THE FACILITIES, AND FOR OTHER PURPOSES

## S. 1860

A BILL TO AMEND THE ENERGY POLICY ACT OF 2005 TO IMPROVE ENERGY PRODUCTION AND REDUCE ENERGY DEMAND THROUGH IMPROVED USE OF RECLAIMED WATERS, AND FOR OTHER PURPOSES

OCTOBER 20, 2005

Printed for the use of the
Committee on Energy and Natural Resources

U.S. GOVERNMENT PRINTING OFFICE

26–509 PDF WASHINGTON : 2006

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
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# DESALINATION WATER SUPPLY SHORTAGE PREVENTION ACT AND WATER SUPPLY TECHNOLOGY PROGRAM ACT

**THURSDAY, OCTOBER 20, 2005**

U.S. SENATE,
COMMITTEE ON ENERGY & NATURAL RESOURCES,
*Washington D.C.*

The committee met, pursuant to notice, at 2:25 p.m. in room SD–366, Dirksen Senate Office Building, Hon. Pete V. Domenici, chairman, presiding.

## OPENING STATEMENT OF HON. PETE V. DOMENICI, U.S. SENATOR FROM NEW MEXICO

The CHAIRMAN. Senator Bingaman is en route and we've kind of got a little confusion going, because they've been telling us we're going to have a vote, and we're trying to figure out how we'll get the most time in here. So as soon as he arrives, he will give his opening statement, wherever we are.

But I'm going to open the meeting, I don't think he will mind. First let's start with panel No. 1. Mr. Faulkner, Acting Assistant Secretary, Principal Deputy Assistant, Office of Energy Efficiency, Renewable Energy, U.S. Department of Energy; Dr. Jane Long, Associate Director, Environment and Energy, Lawrence Livermore; Dr. Les Shephard, Vice President of Energy and Infrastructure Assurance at Sandia National Laboratory, Albuquerque; and Dr. James Roberto, Deputy Lab Director, Science and Technology, National Laboratory of Oak Ridge. Thank you all for being here.

I have some brief opening remarks, and like I said, wherever we are when the Senator arrives, we'll interrupt and let him make his opening statement. Once again, as usual on these matters relating to water issues, it's a pleasure to welcome experts that help us in this regard, and help us think through this process. We're going to be talking about S. 1016, the Desalination Water Supply Shortage Prevention Act, introduced by Senator Martinez, and S. 1860, the Energy and Water Technology Research, Development and Transfer Program Act of 2005, a bill I introduced and co-sponsored by Senator Bingaman, Majority Leader Frist, Senator Alexander, and Senator Feinstein.

Water scarcity and declining water quality are obviously critical in our country and throughout the world. As the world's population grows and stores of fresh water are depleted, finding additional sources of fresh water is critical not only to meeting our national

needs and ensuring that for our people, but also to move in the direction of peace and domestic tranquility abroad.

Widespread water shortages are expected here at home. A GAO report, which we had recently, states that thirty-six States anticipate some kind of shortage in the next 10 years. While we've had long periods of time where we've dealt with these issues of shortages, that is, at least in our Western States, the available supplies on the east coast have also been stretched thin, and many don't even know in many parts of the country that there is a pending water problem.

That's probably why we don't do more about it, because it's not quite to the surface yet. In any event, without significant technological advancement that allows us to better utilize, conserve, and produce additional water in a cost-efficient manner, it is unclear how we're going to meet the needs.

Ensuring that the supply is also available to the United States, which we know is critical, we have this bill before us, which we believe that if we could pass it and implement it, it would do a lot of positive things toward America's future energy problems.

I have some additional remarks explaining the bill itself, but we'll get those throughout the afternoon with the debate, discussions and questions. So I'd like to welcome our witnesses again, I've introduced you, and now Senator Bingaman has arrived, and we'll leave it up to him, if he wants to open now, or let them start, or whatever. Would you like to make your remarks?

[The prepared statement of Senator Alexander follows:]

PREPARED STATEMENT OF HON. LAMAR ALEXANDER, U.S. SENATOR FROM TENNESSEE

First, I want to thank Chairman Domenici for identifying and addressing this important issue. I'm honored to join him in co-sponsoring the Energy-Water Efficiency Technology Research, Development and Transfer Program Act of 2005 along with Majority Leader Frist and others.

I also want to thank the witnesses for coming today and in particular, Dr. Jim Roberto, the Deputy Director for Science and Technology at the Oak Ridge National Laboratory in my home state of Tennessee. Dr. Roberto has been instrumental in bringing to fruition a number of multi-lab initiatives not unlike the one being discussed here today. The DOE National Laboratory system has demonstrated its ability to address national challenges like this, but is underutilized to this point on water-related R&D. The most recent successes at ORNL are successful construction of the Spallation Neutron Source (SNS) and the Center for Nanophase Materials Science, where ORNL has demonstrated its ability to use federal investments effectively to accomplish national priorities, and it has done this by teamwork with other Labs, universities, and other federal agencies. It is time to put these same skills to work on energy and water problems.

Providing reliable energy and clean water are absolutely critical to the economic stability and health of our country. And they are increasingly linked to one another. There will be important positive interactions between the Energy-Water advancements discussed here and progress on other important fronts such as clean air. The low-emission power sources of the future, including nuclear and Clean Coal, do have high water demands for cooling and emission control. Technologies that reduce water demand in the energy sector will therefore make development of clean energy easier.

New technologies to improve water-use in the energy sector, reduce energy demand in the water sector, and provide new, cost-effective sources of clean water will benefit both U.S. and other countries. The needs are clear and the stakes are high; the only question is whether we will step up to fill them. This legislation will provide the investment and commitment to ensure success. Thank you again, Mr. Chairman for shining a light on this topic today. I look forward to working with you to bring this program to fruition.

**STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO**

Senator BINGAMAN. I'll make about 30 seconds worth of remarks, Mr. Chairman. Thank you very much for having the hearing. Dr. Les Shephard is here, I believe from New Mexico. Thank you very much. From Sandia, Ed Archuleta is here from El Paso, I understand. He's in the back, he's in the second panel, I gather.

I do think this issue that you've identified for the hearing is extremely important. Just as in the case of oil and gas, and the other issues we deal with in this committee, water is a commodity where demand exceeds the renewable supplies, at least in our part of the country. And water quality is also a very major issue that we have very major challenges on in a lot of our communities.

I think trying to figure out what can be done to meet those challenges to help local communities meet those challenges is very valuable. I'm cosponsoring the legislation that you've introduced, Mr. Chairman, and I hope this hearing gives us a good record with which to move ahead with that legislation. Thank you.

The CHAIRMAN. Thank you, Senator. I might indicate for the Senator and for the record that the chairman of the counterpart committee in the House has introduced a similar bill, so that gives us a little bit of an opportunity to see a little bit of sunlight that might otherwise be overshadowed and take a much longer time to get itself up and get some visibility. With that, we're going to start with Mr. Faulkner and go to Dr. Shephard, and go right along. So would you proceed please, Mr. Faulkner.

**STATEMENT OF DOUGLAS L. FAULKNER, ACTING ASSISTANT SECRETARY FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY, DEPARTMENT OF ENERGY**

Mr. FAULKNER. Mr. Chairman and members of the committee, I appreciate the opportunity to testify today on S. 1016. Although supplying and distributing water is largely a local responsibility, we believe there is a Federal role in providing appropriate scientific and technological support for these efforts.

S. 1016, however, poses a narrower question: Should the Department of Energy subsidize electricity costs at desalination facilities? We believe the answer is no. While well intended, S. 1016 is not a comprehensive approach to the challenge we face. It would subsidize a narrow group of electricity users engaged in water desalination efforts, and could divert limited Federal funding from efforts to engage in a more comprehensive approach.

It is our view that incentive payments are not the best means to remove the energy cost barriers to desalinating water. Instead, we feel continued targeted Federal support for desalination research and development, as well as the implementation of comprehensive energy legislation, will have a longer impact in the long-run on reducing desalination costs. The Department of Energy finds S. 1860 to be well intentioned, as it shares our view that we must develop innovative new approaches to dealing with the regional, national, and global challenges related to water availability and quality.

However, we have several concerns regarding the specific language of this bill. First, the bill appears to shift substantial statu-

tory authority from the Secretary of Energy to the designated national laboratories and places the lead labs in inappropriate roles for assessing Federal funding and activities across agencies.

We are also concerned that the bill appears to leave out the private sector and its key role in research and commercialization. The bill places as much as two-thirds of the funding at the lead labs, largely outside of any merit-based competitive process and it does so with little flexibility, not recognizing that the allocation of funding will vary with the status of technology and commercialization, and private sector roles. We believe that the funding levels, roles and responsibilities of our labs, universities, and private sector should be determined by the Secretary of Energy.

The many and complex challenges related to water availability and quality are commanding significant attention at the highest levels of the administration. For example, a year ago, the White House Office of Science and Technology Policy and Office of Management and Budget identified water as a top administration R&D priority. This led to the formation of a new interagency group, which is now developing a comprehensive research plan.

The Water Desalination Act of 1996 gave lead responsibility to the Department of the Interior to conduct, encourage, and assist in the financing of research to develop cost-effective and efficient means for converting saline water into potable water. We are looking at ways to better coordinate our efforts with Interior through the interagency process.

The Department has been in serious discussions with some of our labs about the energy-water nexus. The relationship between energy and water is not well understood by the public, surprising many, for example, that the amount of fresh water withdrawn nationally for electricity production is more than twice as much as the water used for residential, commercial, and industrial purposes combined.

Price and regulatory signals can create market incentives to reduce water use and remove some of the demand pressure from regional water supplies. Innovative technologies and processes can help to accomplish that, too.

One area of consideration is the water-intensive process of thermoelectric generation from fossil fuels such as coal. My own Office of Energy Efficiency and Renewable Energy is supporting R&D for innovative wind and solar electricity supply technologies, that may prove beneficial to the desalination industry and place no further demand on water supplies for their operation.

These and other technological advances can also help hone the competitive edge for U.S. exporters in overseas markets thirsty for fresh water.

Mr. Chairman, this completes my prepared statement, and I am happy to answer any questions the Committee may have.

[The prepared statement of Mr. Faulkner follows:]

PREPARED STATEMENT OF DOUGLAS L. FAULKNER, ACTING ASSISTANT SECRETARY FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY, DEPARTMENT OF ENERGY

Mr. Chairman and Members of the Committee, I appreciate the opportunity to testify today on S. 1016, requiring the Secretary of Energy to make incentive payments to the owners of qualified desalination facilities to partially offset the cost of electrical energy required to operate facilities, and S. 1860, which would amend the

Energy Policy Act of 2005 to improve energy production and reduce energy demand through improved use of reclaimed waters and other purposes.

Although supplying and distributing water is largely a local responsibility, we believe there is a Federal role in providing appropriate scientific and technological support for these efforts. S. 1016, however, poses a narrower question: Should the Department of Energy subsidize electricity costs at desalination facilities? We believe the answer is no.

While well intended, S. 1016 is not a comprehensive approach to the challenge we face. It would subsidize a narrow group of electricity users engaged in water desalination efforts, and could divert limited Federal funding from efforts to engage in a more comprehensive approach.

It is our view that incentive payments are not the best means to remove the energy cost barriers to desalinating water. Instead, we feel continued targeted Federal support for desalination research and development consistent with the Administration's Research and Development Investment Criteria, as well as our ongoing efforts to reduce energy demand and increase supply through the adoption of comprehensive energy legislation, will have a larger impact in the long-run on reducing desalination costs than will making incentive payments to the owners or operators of individual facilities.

The Department of Energy finds S. 1860 to be well intentioned as it shares our view that we must develop innovative new approaches to dealing with the regional, national, and global challenges related to water availability and quality. However, we have several concerns regarding the specific language of this bill.

First, the bill appears to shift substantial statutory authority from the Secretary to the designated National Labs and places the lead National Labs in inappropriate roles for assessing Federal funding and activities across agencies. We are also concerned that the bill appears to leave out the private sector and its key role in RD&D and commercialization.

The bill places as much as two-thirds of the funding at the lead National Labs, largely outside of any merit-based competitive process and it does so with little flexibility, not recognizing that the allocation of funding will vary with the status of technology RD&D and commercialization, and private sector roles. We believe that the funding levels, roles and responsibilities for the Labs, Universities, and private sector should be determined by the Secretary in order to meet the national needs identified by the legislation.

We share the view that we must develop innovative new approaches to dealing with the regional, national, and global challenges related to water availability and quality, and this is an issue that is commanding significant attention at the highest levels of the Administration.

For example, in August 2004 the White House Office of Science and Technology Policy (OSTP) and Office of Management and Budget (OMB) identified water as a top Administration research and development priority and called upon the National Science and Technology Council (NSTC) to "develop a coordinated, multi-year plan to improve research to understand the processes that control water availability and quality, and to collect and make available the data needed to ensure an adequate water supply for the Nation's future." The NSTC Committee on Environment and Natural Resources has formed a Subcommittee on Water Availability and Quality (SWAM) comprised of more than 15 Federal Departments and Agencies who are now in the process of developing a comprehensive research plan. Their first report, "Science and Technology to Support Fresh Water Availability in the United States," was released in November, 2004. Among the points highlighted by this report are the following:

- We do not have an adequate understanding of water availability at national, regional, or local levels.
- Water, once considered a ubiquitous resource, is now scarce in some parts of the country—and not just in the West as one might assume.
- The amounts of water needed to maintain our natural environmental resources are not well known.
- We need to evaluate alternatives to use water more efficiently, including technologies for conservation and supply enhancement such as water reuse and recycling as a way to make more water available.
- We need improved tools to predict the future of our water resources to enable us to better plan for the more efficient operation of our water infrastructure.

The Water Desalination Act of 1996 (Public Law 104-298) gave lead responsibility to the Department of the Interior to conduct, encourage, and assist in the financing of research to develop cost-effective and efficient means for converting saline water into potable water suitable for beneficial uses. We are looking at ways to better co-

ordinate our efforts with those of the Department of the Interior and other agencies through the process underway in the NTSC's Subcommittee on Water Availability and Quality.

At the Department of Energy, we have been in serious discussions with some of our labs on what we call the "energy-water nexus." The relationship between energy and water is not well understood by the public, and it is surprising to many, for instance, that the amount of fresh water withdrawn nationally for electricity production is more than twice as much as the water used for residential, commercial, and industrial purposes, and is comparable to the amount of water used for agricultural irrigation. Meanwhile, pumping, storing, and treating water consumes huge amounts of electricity—an estimated 7 percent of California's electricity consumption is used just to pump water.

We understand that our energy and water supplies are interconnected. In fact, as much energy is used for water and wastewater purposes as for other major industrial sectors of the U.S. economy such as paper and pulp and petroleum refining.

Price and regulatory signals can create market incentives to reduce water use. One area for consideration is the water intensive process of thermoelectric generation from fossil fuels such as coal. For these systems, an average of 25 gallons of water is withdrawn to produce a kilowatt hour (kWh) of electricity of which nearly one-half gallon is consumed by evaporation. Overall, fossil-fuel-fired power plants require withdrawals of more than 97 billion gallons of fresh water each day.

The Department's Office of Fossil Energy is supporting several research projects aimed at reducing the amount of fresh water needed by power plants and to minimize potential impacts of plant operations on water quality. One project at West Virginia University is assessing the feasibility of using underground coal mine water as a source of cooling water for power plants. A North Dakota project is attempting to reduce the water consumption of power plants by recovering a large fraction of the water present in the plant flue gas. A project in New Mexico is exploring whether produced waters, the by-product of natural gas and oil extraction which often present a disposal issue, can be used to meet up to 25 percent of the cooling water needed at the San Juan Generating Station, as well as investigating an advanced wet-dry hybrid cooling system. In addition, the Department currently has a competitive solicitation on the street seeking additional innovative technologies and concepts for reducing the amount of fresh water needed to operate fossil-based thermoelectric power stations, including advanced cooling and water recovery technologies. The Department is also investigating whether a suite of specially selected, salt-tolerant agricultural crops or other plants can be used to remove sodium and other salts from coalbed methane produced water so that it can be safely discharged or used in agriculture.

One promising new approach to electricity generation, Integrated Gasification Combined Cycle (IGCC) technology that converts coal and other hydrocarbons into synthetic gas, offers significant environmental and water benefits compared to traditional pulverized coal power plants. Because the steam cycle of IGCC plants typically produces less than 50 percent of the power output, IGCC plants require 30 to 60 percent less water than conventional coal-fired power plants. The Department is supporting research, development, and demonstration on a number of advancements that will significantly drive down the costs of IGCC plants.

The Fossil Energy office is also supporting work at the University of Florida investigating an innovative diffusion-driven desalination process that would allow a power plant that uses saline water for cooling to become a net producer of fresh water. Hot water from the condenser provides the thermal energy to drive the desalination process. Using a diffusion tower, saline water cools and condenses the low pressure steam and fresh water is then stripped from the humidified air exiting the tower. This process is more advantageous than conventional desalination technology in that it may be driven by waste heat with very low thermodynamic availability. In addition, cool air, a by-product of this process, can be used to cool nearby buildings.

The Department's Office of Energy Efficiency and Renewable Energy (EERE) is supporting R&D for innovative wind and solar electricity supply technologies that have attributes that may prove to be very beneficial to the desalination industry.

For example, wind power is now becoming a competitive, clean, bulk electric power supply option in many areas of the Nation, and places no further demand on water supplies for its operation. In addition, excellent offshore wind resources are available near many coastal areas facing water supply challenges. The role that wind could play in powering desalination could take a range of forms, from standalone systems exclusively powered by wind, to desalination plants that receive the majority of their energy requirements from wind power delivered via electricity grid systems. In either case, the relative ease and low cost of storing desalinated water,

in comparison with storing electricity, will allow operating flexibilities that will facilitate using inherently variable wind power as a primary energy source for desalination.

We are currently funding a concept design study which will set up engineering and economic models to examine viability of wind-powered reverse osmosis systems, looking at applications for coastal seawater, inland brackish water, and water produced during oil or gas recovery. A second project will model solar and wind resources for a desalination unit to determine the effects of variable loads on desalination, and perform pilot-scale testing to determine how renewable energy could reduce desalination costs.

We are also undertaking a mapping project to overlay data such as fresh and brackish water resources, wind resources, water consumption, estimated growth, and electricity supply. Two maps will be developed, one of the United States, and one for the four-state region of Colorado, Utah, Arizona, and New Mexico, identifying locations that have the best economic and technical potential for using wind to power desalination.

Even as we proceed with these activities, we are mindful that the energy intensive technique of reverse osmosis we use for desalination today may not be the membrane technology of tomorrow. But whether that breakthrough comes from a lab working specifically on desalination, or through an area of broader scientific research remains to be seen. The Department's Office of Science, for example, is studying microbes and smart membranes that may ultimately have relevance to desalination in the future.

Having said that, it seems certain that desalination will play an important role in maintaining and expanding our Nation's and indeed, the world's water supply. Where fresh water aquifers are under pressure in many regions, over-drafted and subject to salt-water intrusion, brackish aquifers can be found throughout the country and the world, a ready source of new water. More than 120 countries are now using desalination technologies to provide potable water, most commonly in the Persian Gulf where energy costs are low. The desalination plants of the future must come in a range of sizes so that they can be installed where demand exists—smaller footprint facilities which can make use of smaller deposits of impaired water, at a price the community can afford. For American companies, the growing need for desalination will open new global markets.

Mr. Chairman, this completes my prepared statement, and I am happy to answer any questions the Committee may have.

## STATEMENT OF DR. LES SHEPHARD, VICE PRESIDENT FOR ENERGY, RESOURCES AND NONPROLIFERATION, SANDIA NATIONAL LABORATORIES, ALBUQUERQUE, NM

Dr. SHEPHARD. Mr. Chairman and distinguished members of the committee, thank you for the opportunity to comment on the Energy-Water Technology Act of 2005. I am Les Shephard, Vice President for Energy, Resources and Nonproliferation at Sandia National Laboratories, a multi-program national security laboratory, with locations in New Mexico and California.

Today, approximately 40 percent of the fresh water withdrawn from our country's lakes, rivers and aquifers goes to electric power generation. In return, a significant portion of this electric power is then used to move and treat dwindling water supplies. On a national scale, water supply and reclamation consumes 4 percent of all electric power generation, roughly equivalent to all the electricity used in the State of New Jersey last year.

On a typical day in the United States, coal, gas, and nuclear plants across our country use about 136 billion gallons of fresh water to generate electricity. This water is essential for power generation: No water, no electricity.

Fortunately, only 3 percent of this water is actually consumed. The remainder can be reused after cooling. Unfortunately, this demand competes with other major water needs: agriculture, indus-

try, municipalities and the environment. In short, energy depends on water, and water depends on energy.

And the impact of interdependency will grow as we increase our electric power production by nearly 30 percent over the next 20 years. The significant impact of increased energy costs for creating new water is recognized in the Desalination Water Supply Shortage Act of 2005, which proposes incentives to partially offset the cost of electricity required to operate desalination facilities.

While these subsidy incentives may be appropriate in the short term, a longer term strategy must invoke development and implementation of cost-effective, innovative technology to significantly reduce the energy cost of creating new water supplies. The Energy Water Technology Act enables this longer term strategy. This act will forge the energy/water link needed to accelerate development of revolutionary technologies of tomorrow, new power plant designs that use less water. New membranes and separation processes that require less energy to produce drinking water. New ways to harvest heat, to purify water, and new ways to cheaply treat non-traditional waters for consumption and power generation.

The act includes many of the critical elements we believe are required for success. Long-range vision and technical direction will be developed through technology road mapping. Systems solutions, continuity of technical focus and technology transfer will be provided by lead laboratories and their university partners in conjunction with the Department of Energy. Cutting-edge research and development on specific problems will be implemented through the competitive grants program.

Throughout this process, a strong connection with industry and end users must be maintained. As the agency responsible for this program, the Department of Energy must have flexibility in developing the overall approach for strategic implementation.

Scientific research and technical innovation are critical elements in addressing water and energy. This act provides the basis to enable a national effort to focus and integrate research that leads to the development of energy/water efficiency and supply technologies which are critical for meeting our future energy and water security needs.

Thank you, Mr. Chairman, and members of the committee, for your sustained leadership in this important area, for your sustained leadership on the Energy Policy Act of 2005. And I also will be delighted to answer any questions you may have.

[The prepared statement of Dr. Shephard follows:]

PREPARED STATEMENT OF DR. LES SHEPHARD, VICE PRESIDENT FOR ENERGY, RESOURCES AND NONPROLIFERATION, SANDIA NATIONAL LABORATORIES

SUMMARY POINTS

- Today approximately 40 percent of the freshwater withdrawn from our country's lakes, rivers and aquifers goes to electric power generation. In return, a substantial portion of this electric power is then used to move and treat dwindling supplies of water. In short, energy depends on water and water depends on energy—and the cost of both are rising as our population grows and as competing demands for water outstrip supplies.
- Our country must aggressively develop the technological advances required to solve these important emerging issues or face spiraling costs for energy and water, which are both fundamental to economic security.

- The Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005 establishes a program in the U.S. Department of Energy that directly addresses these important issues.
- The Act contains multiple elements that are important to a successful program. Long-range vision and technical direction will be developed through technology road mapping. Cutting edge-research and development on high priority scientific and technology challenges will be implemented through competitive grants. Systems solutions, integration of research into technology, and technology transfer will be coordinated by lead laboratories and their university partners.
- Strong engagement of industry and end users is very important to the success of the proposed program. This engagement must include active participation in the technical advisory panel, extensive participation in technology road mapping, and direct partnering in pilot testing and technology transfer.
- As the agency responsible for this program, the Department of Energy must have flexibility in developing the ultimate strategic implementation of this program.
- Sandia National Laboratories strongly supports establishment of the Energy-Water Efficiency Technology Research, Development, and Transfer Program.

## INTRODUCTION

Mr. Chairman and distinguished members of the committee, thank you for the opportunity to comment on the Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005. I am Les Shephard, Vice President for Energy, Resources and Nonproliferation at Sandia National Laboratories.

Sandia National Laboratories is managed and operated for the U.S. Department of Energy (DOE) by Sandia Corporation, a subsidiary of the Lockheed Martin Corporation. Sandia is a multi-program laboratory with mission responsibilities in national security, homeland security, energy, and science.

I will make three principal points in this statement.

The first one is crucial: The "water cost" of energy and the "energy cost" of water are inextricably linked. In the absence of technological advance, the cost of both will rise rapidly in the future.

Second, accomplishing the needed technological advance will require integration across the full spectrum of research, development, and commercialization, drawing on the best science and engineering capabilities in our national laboratories, universities, and innovative industry.

Third, the Act contains the critical elements for a successful program: technical direction of the program driven by technology road mapping and an independent technical advisory board with strong industry and end user focus for the program; research and development drawing on the full spectrum of the universities, national laboratories, and other research institutions through a competitive grants program; and integration from research and development to commercialization through lead laboratories and industry partnerships.

## ENERGY-WATER INTERDEPENDENCY LEADS TO RAPIDLY RISING COST

Today, approximately 40 percent of the freshwater withdrawn from our country's lakes, rivers and aquifers goes to electric power generation. In return, a substantial portion of this electric power is then used to move and treat dwindling supplies of water. In short, energy depends on water and water depends on energy—and the costs of both are rising as our population grows and as competing demands for water outstrip supplies.

### *The "Water-Cost" for Energy*

On a typical day in the United States, coal, gas, and nuclear plants across our country use about 136 billion gallons of fresh water to generate electricity. This water is essential for power generation: no water, no electricity. Underlying these statistics, there is good news and there are two major challenges.

The good news is that only three percent of the water withdrawn for electric power generation is actually consumed. The first challenge is that once used for power generation, water contains waste heat that must be dissipated before it can be used again. The second, more important, challenge is that the water required for power generation competes with other major water needs: agriculture, industry, people and the environment. In a growing number of regions of our country, freshwater supplies are fully allocated. There simply is not enough water to meet all of these competing needs.

This critical energy-water interdependency is not theoretical. In the summer of 2004, after several years of drought, coal-fired power generation in the Four Corners region of New Mexico, Arizona, Colorado and Utah came very close to being severely curtailed due to lack of water. In the southwest, power generation will need to nearly double over the next twenty years, exacerbating competition over already limited water supplies.

This critical energy-water interdependency is not unique to the arid southwest. Over the past three years, power plant applications have been turned down in Idaho, Wisconsin, Michigan, North Carolina and New Jersey because there is not enough water. In the Southeast, surface waters are completely allocated and new power plants are increasingly forced to consider using non-traditional waters—mine waters, subsurface brines, and wastewater—which often must be treated before the plants use them for cooling. There is a clear need for more "water-efficient" power plant designs and designs that reduce water quality impacts, particularly as new power plants are constructed to meet growing demands.

The spiraling cost impact of this critical energy-water interdependency will grow in the future. Our country must increase electric power production by nearly 30 percent in the next twenty years—or approximately 1000 new power plants. While moving to dry cooling is an option, the capital cost is typically three times the cost of water-based cooling, and efficiencies are typically 5 to 15 percent lower. Therefore, to keep energy costs from rising *because of water-scarcity alone* we need to lower the "water cost" of energy and the "energy cost" of water.

*"Energy-Cost " for Water*

Pumping, distribution and treating water requires large amounts of energy. Approximately 20 percent of electricity consumed in the state of California is used for the state's water infrastructure. On a national scale, water supply and reclamation consumes 4 percent of U.S. electric power generation, and 75 percent of the cost of municipal water processing and distribution is for electric power. These numbers will grow significantly as our country moves to greater utilization of saline and other impaired waters to meet growing demand.

Because freshwater supplies are fully allocated across many regions of our country, competition for water for people, energy, industry, agriculture, and the environment is increasingly intense. To meet the needs of projected 20 percent population growth, we must create "new water" through desalination, treatment of waste-water for reuse, and treatment of other impaired waters. Creating new water is expensive and will consume significantly more energy than is used today. Almost half (44 percent) of the cost of desalinating sea water using today's technology is for energy.

The utilization of advanced technologies for creating new water is growing across the country. In Tampa Bay, Florida, a seawater desalination plant producing 25 million gallons of freshwater per day recently began operations. In El Paso, Texas, ground was recently broken for an inland brackish-water desalination plant that will produce 25 million gallons per day. California, Texas, Florida, North and South Carolina, and Massachusetts are in the planning stages for additional major seawater desalination plants, and new inland desalination plants are planned in New Mexico, Arizona, California and Texas.

The significant impact of increased energy cost for water is not theoretical. The purpose of Senate Bill 1016, the Desalination Water Supply Shortage Act of 2005 is to partially offset the major cost of electrical energy required to operate desalination facilities. This Act calls for incentive payments of $200 million dollars to offset the "energy-cost" of creating potable water. While these subsidy incentives may be required in the short term, a longer term strategy must be invoked that will drive development of cost-effective, innovative technology that will significantly reduce the energy cost of creating new water.

COST AND ENERGY REDUCTION REQUIRE TECHNOLOGICAL ADVANCE THROUGH INNOVATIVE RESEARCH AND DEVELOPMENT, AND AGGRESSIVE INTEGRATION FROM ADVANCED R&D THROUGH COMMERCIALIZATION

There are major opportunities of technological advance resulting in major reductions in the water-cost for energy, and the energy-cost for water. Opportunities for reducing the water cost for energy includes improving the water efficiency of power-generating technologies, utilization of brackish or other impaired waters for cooling, and reducing severe competition among water-use sectors by increasing water efficiency and developing new sources of water for other water sectors that compete with energy. Major reductions in the energy-cost of water will come from breakthroughs in membranes and separation processes, development of new technologies for reuse of impaired water, as well as enabling management optimization through

system-level modeling and real-time monitoring of chemical and biological parameters.

*Innovation requires competitive access to R&D capabilities*

Accomplishing these needed technological advances for specific high priority needs will require drawing on the best science and engineering capabilities in our national laboratories and universities. Research at universities across the country is a major source of innovative concepts with significant potential to address energy and water issues. University research adds the substantial benefit of educating the undergraduate and graduate students who will work to solve these challenges well into the future.

Solutions for many of these technological challenges will build on the foundation work in multiple DOE Office of Science programs, including such areas as science at the nanoscale, molecular-level material design, engineering the convergence of chemical and biological processes. Through the national laboratories, the Energy-Water Nexus team has been at the forefront of defining technical challenges related to energy-water interdependency. These laboratories have extensive water and energy expertise.

*Success in bringing innovation to application requires continuity across R&D, through pilot testing to commercialization*

While focusing R&D on specific problem components is important to achieving research breakthroughs, these breakthroughs must be incorporated into technologies and products. Research solutions will require technology integration, systems assessment, and continuity in moving research through technology development, systems engineering, pilot-scale testing, and product commercialization. Technology testing, transfer, and commercialization must be an integral component of the program.

The ultimate merit for success of this program will be widespread commercialization and adoption of new technologies by industry and local communities. Therefore, partnership with industry and end users is imperative. The program must include mechanisms for industry and end-users to engage early in the definition of research needs and priorities.

THE ENERGY-WATER ACT OF 2005 SETS FORTH CRITICAL ELEMENTS NECESSARY FOR A SUCCESSFUL PROGRAM

Success of the Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005 will require long-range vision, systems solutions, continuity of technical focus, cutting-edge research and development on specific problems, and a very strong connection to industry and end users. The Act includes many of the critical elements required for this success. Long-range vision and technical direction will be developed through technology road mapping. Systems solutions, continuity of technical focus and technology transfer will be provided by lead laboratories and their university partners. Cutting-edge research and development on specific problems will be implemented through the competitive grants program. Throughout this process, a strong connection with industry and end users will be maintained through the technical advisory panel, direct participation in road mapping, and direct partnering in pilot testing and technology transfer. As the agency responsible for this program, the Department of Energy must have flexibility in developing the ultimate strategic implementation of the program.

*Department of Energy Engagement in Solution of Energy-Water Issues*

The Department of Energy has broad responsibilities for ensuring future energy production, foundational scientific research, and broad program expertise engaged in both energy and water. Therefore, the Department of Energy is the right federal agency for this program. Because of the diversity of water use sectors, other federal agencies also have significant water responsibilities. The Act appropriately calls on DOE to coordinate with these other pertinent agencies.

The proposed Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005 maps the proposed program into the Title I Energy Efficiency program area of the recently signed Energy Policy Act of 2005. The Energy Policy Act of 2005 also includes Section 979 that addressed similar energy and water issues within the Title IX Science area.

As noted previously, the Office of Science has multiple foundational research programs with strong potential to contribute. In addition, core Office of Science research facilities, such as the Nanoscale Science Research Centers, provide state-of-the-art facilities that enable breakthrough research. Solution of the critical energy-water challenges faced in the U.S. will require both scientific research and tech-

nology development. DOE should have the flexibility to define an integrated program strategy, enabling integrated execution of appropriate research in the Office of Science (through Section 979 of the Energy Policy Act of 2005), with a complementary program in an applied program area of DOE such as Energy Efficiency (through the proposed Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005). Energy-water issues cut across multiple applied program areas within DOE (e.g. Fossil Energy), and DOE must have the flexibility to address how best to meet the energy-water challenges across program areas.

*Technical Direction and Program Feedback*

The proposed Act specifies that technical direction for the program be driven by a combination of technology road mapping and a Technical Advisory Panel. Technology road mapping is a critical element, as it provides a rigorous framework for engaging industry and end users, along with university and national laboratory scientists and engineers, in defining research and technology priorities. The results of technology road mapping should be used to define the framework for critical technologies that will be developed through the competitive grants and lead laboratory programs.

The Technical Advisory Panel will play an important role in providing both guidance and feedback. This panel will provide a source of ongoing information from which to build a broad understanding, not only of research technology challenges, but also of industry, end user and regulatory issues. Therefore, it is important that the Technical Advisory Panel include not only industry and research expertise in energy and water technologies, but also representatives of federal, state and local agencies with management and regulatory responsibilities, as well as water and energy focused nongovernmental organizations.

The proposed Act also calls for National Academy of Sciences (NAS) periodic reviews of the program. NAS reviews have the potential to provide valuable insight to the research dimensions of the program. However, some form of program review that directly engages industry and end users is also important. One possibility is that the Advisory Panel provide, or oversee, this review. Other possibilities should be considered as well.

*Program Grants*

As noted in a previous section, achieving the needed technological advances for specific high priority needs will require drawing on the best science and engineering capabilities across the U.S. The competitive Program Grants element of the proposed Act is an effective mechanism for accomplishing this requirement.

As noted above, technical framework and direction for the Program Grants should be driven by the technology road mapping. Technical framework for the Grants Program and Lead Laboratory Program must be coordinated, especially in activities involving technology transfer that enables widespread commercialization of newly developed technologies.

Finally, an important component of any competitive grants program is a rigorous, transparent selection process. The Technical Advisory Panel will be in a position to assure that this requirement is met.

*Lead Laboratory Program*

As noted previously, solution of major energy-water challenges requires continuity and integration in technology development. The proposed Act provides the institutional mechanism necessary to accomplish this by specifying lead laboratories. Important roles that must be carried out by these laboratories and their partner universities include integration of research into technology and systems assessment. Another important role of the lead laboratories will be to provide continuity in moving research through technology development, systems engineering, pilot-scale testing, and product commercialization. In addition to moving individual technologies, lead laboratories must also work across multiple technologies to identify and develop integrated, systems solutions.

An important element of the Program Lead Laboratory program element is partnerships. As noted previously, university partnerships will be important for research and development. The proposed Act calls for each Lead Laboratory to partner with at least one university in carrying out the program. Multiple university partnerships will likely play an important role in carrying out this portion of the program, as well as in facilitating technology integration and transfer from the Grants Program.

Strong partnerships among Lead Laboratories and across DOE labs will also be important. Building on DOE foundational science research at multiple labs and collaboration with labs involved in the Grants Program R&D will be important.

Success in pilot testing, technology transfer, and commercialization will require strong partnerships with industry, end users, and industry research associations. These partnerships must be built through broad end-user and industry engagement with technology road mapping, the Technical Advisory Board, and specific industry commercialization partners.

SANDIA NATIONAL LABORATORIES IS COMMITTED TO MAKING THE PROPOSED PROGRAMSUCCESSFUL THROUGH TECHNICAL EXCELLENCE AND PARTNERING

Sandia National Laboratories is committed to making the proposed Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005 successful. Essential ingredients of our engagement are technical excellence and commitment to partnering.

Sandia National Laboratories is actively engaged in a broad range of water research and technology development. In partnership with the Bureau of Reclamation, Sandia jointly developed the 20-year "Desalination and Water Purification Technology Roadmap." The Joint Water Reuse and Desalination Task Force (a partnership of the American Water Works Association Research Foundation, WateReuse Foundation, Bureau of Reclamation, and Sandia National Laboratories) is currently updating the 2003 road map to define a more detailed framework of national research needs for desalination and water reuse. Sandia is currently conducting research in areas such as biomimetic membranes and nano-engineered water treatment technologies. Working with the Department of Energy and the Energy-Water Nexus team, Sandia is currently coordinating the development of a roadmap focusing on energy-water technology challenges.

In the areas of water monitoring and water security, Sandia worked with the American Water Works Association Research Foundation and the Environmental Protection Agency to develop a security risk assessment methodology for water infrastructure that has been used to conduct vulnerability assessments of over 90 percent of large U.S. cities, covering the water supply systems of over 130 million people. Sandia is creating new generation sensor technologies enabling real-time monitoring of water quality, and recently entered a major Cooperative Research and Development Agreement (CRADA) for commercialization of micro-chem-lab-on-a-chip technology for water applications. Future sensor development will benefit greatly from the major microsystems, microelectronics, and engineering design investments at the Microsystems and Engineering Sciences Applications (MESA) facility at Sandia.

Sandia's management philosophy has always stressed the linkage of research through development to application. Systems integration is a distinguishing strength of Sandia's technical management. We have a long history of partnerships at both ends of the development cycle, both with research universities and with industrial firms and consortia. Sandia's approach to research and development derives from a heritage of fifty years under industrial management, and it yields tangible results. It is not science for its own sake, but science and engineering working together with the mission in mind.

CLOSING COMMENTS

In closing, Sandia strongly supports the establishment of the Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005 as a vital component to U.S. energy and economic security. We are committed to working with the Department of Energy to make the proposed Act successful.

Thank you for the opportunity to comment on this program.

## STATEMENT OF DR. JANE C.S. LONG, ASSOCIATE DIRECTOR, ENERGY AND ENVIRONMENT DIRECTORATE, LAWRENCE LIVERMORE NATIONAL LABORATORY, LIVERMORE, CA

Dr. LONG. Mr. Chairman and members of the committee, I am Jane Long, Associate Director for Energy and Environment at Lawrence Livermore National Laboratory. My job is to oversee the laboratory's research and earth system science, atmospheric releases, and nuclear power and fuel cycles.

Livermore is administered by the University of California for the Department of Energy's National Nuclear Security administration and is a multi-program laboratory with special responsibilities in

national security, homeland security, energy and environment, and state-of-the-art capabilities that are also applied to other pressing national needs. I will summarize my written testimony here, and submit my written statement for the record.

I am pleased to be here for the opportunity to discuss S. 1860, the Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005. I would like to make three points today: First, that water and energy security are growing issues; second, that S. 1860 is an important bill that addresses these issues and we fully support it; and third, Lawrence Livermore is committed to making this program successful in solving this real world problem.

Energy and water are constrained resources, as our chairman just mentioned, subject to high and growing demand. Increasingly, each of these resources are associated with the Nation's security. The linkages between energy and water are important and compelling areas for research and development and require both fundamental science and applied technology.

Our population is growing and along with it, the demand for energy is growing. And as we've seen lately, matching this demand with supply is not guaranteed. As well, the demand for water is growing while supplies are dwindling in the West, especially in the West but throughout the country as well.

Water pumping, treatment and conveyance currently accounts for 3 percent of national energy consumption and as much as 10 percent in California. So water uses energy. This water sector energy use is likely to grow, and is likely to be an important component of our energy sector in the future. Efficiency in this area for both the water use and water purification, therefore, is an issue. Technologies are needed to increase this efficiency.

Energy uses water, as well. As Les mentioned, 39 percent of all freshwater withdrawals are for energy production. A single kilowatt hour of electricity uses 25 gallons of water, on average, to produce. And we use three times as much water for lights and appliances in our homes as we do for domestic water direct use.

Water availability poses constraints for existing power generation and future expansion. For example, Lake Powell is half full after a 5-year drought. So what effect will that have on power generation?

My second point is that this is an act that addresses the problem. The first part of the act called for an assessment of the current R&D and the state of programmatic support of the Government. This is very appropriate, as it will include perspectives from many agencies responsible for water and energy and a roadmap to the R&D that is important for addressing these issues.

The proposed legislation taps into the national labs, university partners, research community, industry and a multi-year commitment to address these energy/water efficiency and supply issues. Grants are 40 percent of the funding and these will draw the best of ideas from the greater research community. Commercialization effort will ensure that the research reaches fruitful application and an advisory board will review the progress and keep the program on track. Livermore is committed to making this program effective and we're lucky to have many capabilities to add. At Livermore,

water treatment, and monitoring technologies are at all stages of development, from new materials at the design state to commercial units.

We, for example, look at selective treatment. Can we use design material to create membranes that only remove contaminants of interest and leave the others that aren't harmful behind, thus saving energy? We have been working in desalinization for 20 years and have won R&D awards in that area, and recent research is essentially looking at desalinization as if it was an artificial kidney.

As well, we have sensor programs that detect biological and chemical agents to determine if contaminants are accidentally or intentionally entering the water supplies. These sensors utilize molecular biology and material science at a very advanced rate. We have experience as well in managing water problems and partnerships throughout the State of California in particular with water districts, universities and industry.

Livermore is completely supportive of S. 1860 and we look forward to contributing to the program's success. We appreciate the committee's leadership in putting this legislation forward and we think it's an important element in planning for our Nation's water and energy future. This concludes my remarks, and I'd be happy to answer any questions.

[The prepared statement of Dr. Long follows:]

PREPARED STATEMENT OF JANE C. S. LONG, ASSOCIATE DIRECTOR, ENERGY AND ENVIRONMENT DIRECTORATE, LAWRENCE LIVERMORE NATIONAL LABORATORY, UNIVERSITY OF CALIFORNIA

OPENING REMARKS

Mr. Chairman and members of the committee, thank you for the opportunity to appear before you today. I am Jane Long, Associate Director of the Energy and Environment Directorate at Lawrence Livermore National Laboratory (LLNL). Our Laboratory is administered by the University of California for the Department of Energy's National Nuclear Security Administration. Lawrence Livermore is a multiprogram laboratory with special responsibilities in national security and state-of the-art experimental and computational capabilities that are also applied to meet other pressing national needs. In particular, LLNL pursues a broad portfolio of innovative research and development programs in energy and environmental sciences, many of which deal with water issues.

Water issues and their close ties to energy issues are the important subjects of today's hearings. Both energy and water are constrained resources subject to high and growing demand. They are inexorably linked and understanding these linkages is vital to effective future management of America's energy and water supplies. Water supply and management uses large amounts of energy; thus, the availability of freshwater resources may be curtailed by insufficient or too costly energy. Conversely, the energy sector uses considerable amounts of water. Insufficient water resources can reduce the supply of energy or drive up costs.

Clearly, thoroughly understanding the linkages between energy and water is prerequisite to increasing the supply and efficient use of both resources. Congress recently took action to meet this need with the passage of the Energy Policy Act of 2005 and today's hearing is about two relevant bills, S. 1016 and S. 1860. My comments focus on S. 1860, the "Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005." It is a vitally important bill and we fully support it. The program defined by S. 1860 builds on Section 979 of the Energy Policy Act, which specifically calls for a DOE assessment and research program to address energy and water related issues.

S. 1860 establishes a well-designed program to assess the current situation, build a roadmap for future activities, pursue energy-water efficiency and supply technology research, development, and transfer to end-users. It calls upon DOE's national laboratories, working in partnership with universities, other research institutions, industry, and governmental agencies, to develop and deploy the needed tech-

nologies. It also defines appropriate mechanisms to steer the activities and advise the Secretary and Congressional committees of program progress.

Most importantly, S. 1860 fully recognizes the need to apply the nation's best science and technology to ensure abundant energy and water to meet our country's future demands. As one of the lead national laboratories identified in the bill, Lawrence Livermore is committed to vigorously pursuing research and development of new technologies, working with U.S. industry to turn them into effective products for the user community, and to teaming with Sandia, Oak Ridge and the other national laboratories to meet this challenge. My testimony will include pertinent examples of LLNL's capabilities in fundamental and applied science, current research projects, and ongoing partnerships.

## THE ENERGY-WATER LINKAGE

Passed by Congress and signed into law by the President, the Energy Policy Act of 2005 provides the United States with its first national energy plan in more than a decade. The Act promotes investments in energy efficiency and conservation as part of a comprehensive plan to reduce the nation's dependence on foreign energy. Affordable and reliable energy is vital to the continuing economic growth of the United States and the well-being of its citizens. Greater energy security is a challenge that calls for a sustained effort in energy technology research, development of more energy-efficient products and new resources, and conservation. The Energy Policy Act is an important first step.

The subject of this hearing is a proposed amendment to the Energy Policy Act of 2005. The bill (S. 1860) builds on Section 979 of the Act, which specifies that the Secretary of Energy shall carry out a program of research, development, demonstration, and commercialization to address energy-related issues associated with water and water-related issues associated with energy. It also directs the Secretary to assess the effectiveness of existing Federal programs to address energy and water related issues.

*The energy-water nexus*. Because the energy and water sectors are interdependent, water supplies may be curtailed by insufficient or too costly energy, and conversely, insufficient water can reduce the supply of and increase the cost of energy. This critical energy-water nexus is the subject of the proposed bill: "to improve energy production and reduce energy demand through improved use of reclaimed waters, and for other purposes." The linkages between energy and water provide compelling areas for research and development that would substantially benefit both sectors and will require substantial and timely investments in both fundamental science and applied technology.

*Water-related issues associated with energy supply and management.* Water is an increasingly strained resource, particularly in the West, where population is growing most rapidly and water is least available. More generally, freshwater supplies are dwindling in many parts of the U.S. due to extended droughts, and future supplies will be affected by long-term trends in regional and global temperatures. It is much more than a national issue; water has been and will continue to be a potent source of international conflict. Modernization of urban centers in the developing world, including expanding energy infrastructures, will demand tremendous amounts of water, making it vital to international security that we develop and share technologies with other nations to enhance and better manage their water supplies.

U.S. Geological Survey data show that electricity production from fossil and nuclear energy requires 190,000 million gallons of water per day, or 39% of all freshwater withdrawals nationally. While only a portion of these withdrawals are consumed, the returned water is thermally and chemically affected by its use. Moreover, enough water must be available to sustain energy production and meet other needs. Much of the nation's energy fuel production is also dependent on adequate water supplies. Energy resource recovery and processing create large volumes of wastewater that require treatment for reuse or disposal. Future shifts to energy sources such as coal liquefaction or gasification, biomass, and hydrogen will place additional demands on water resources.

*Energy-related issues associated with water supply and management.* Water pumping, treatment and conveyance use large amounts of energy—equivalent to the energy used by the paper or refining industries (about 3% of national energy consumption and as high as 10% in California). Water sector use of energy will likely substantially outpace growth in other high-energy use sectors. There will be greater demand for water reuse and recycling as well as energy-intensive treatment of impaired or saline water sources, a greater need to tap deep groundwater sources, and

higher requirements for water storage and transport—all significantly increase energy usage.

The water sector's demand for energy will also grow due to a deteriorating infrastructure for treatment and conveyance of freshwater supplies, an increased need to treat for harmful natural constituents, such as arsenic and other contaminants introduced into the environment, and concerns over soil salinization and depletion of groundwater. Significant improvements in energy efficiency will require investments in research, development, demonstration and deployment of water treatment technologies for treating an ever-growing number of contaminants.

THE ENERGY-WATER EFFICIENCY AND SUPPLY TECHNOLOGY RESEARCH, DEVELOPMENT, AND TRANSFER PROGRAM

The proposed amendment to the Energy Policy Act of 2005 establishes the Energy-Water Efficiency and Supply Technology Research, Development, and Transfer Program. The bill (S. 1860) defines a program that provides a means for the Secretary of Energy to carry out responsibilities established in Section 979 of the Energy Policy Act, and it authorizes appropriations to execute the program.

The Energy-Water Efficiency and Supply Technology Research, Development, and Transfer Program is designed to clarify issues at the energy-water nexus and to pursue the development and deployment of innovative technologies at this critical junction. The focus of the program will be more efficient or decreased use of water and energy, and creation of new water supplies through advances in treatment or management.

Four features of the Energy-Water Efficiency and Supply Technology Research, Development, and Transfer Program—specifically called out in S. 1860—are important to long-term success. The program includes:

- Initial development of a water-supply technology assessment to guide the investment strategy.
- A commitment to invest in research and development of needed technologies together with their deployment for real-world applications.
- Effective use of the Department of Energy national laboratories in partnership with universities, other research institutions, industry, and governmental agencies to develop and deploy technologies.
- Appropriate mechanisms to steer the activities and advise the Secretary and Congressional committees of program progress.

*Water-supply technology assessment*. The proposed program fittingly begins with an assessment of the current state of energy-water efficiency and supply technology research and the development of a roadmap. Rapid completion of the assessment and roadmap development is challenging, but necessary and appropriate, given the urgency of the problem. Wide-ranging capabilities are needed to carry out the assessment, including knowledge about water supply and energy systems, expertise in state-of-the-art science and technology, access to systems analysis tools, experience working with technology end users, and an understanding of existing policy and sociological constraints.

There are areas of significant synergy between the energy-water nexus program goals and those of existing programs within various federal, state, regional, and local agencies—and likely large gaps where new research and development investments will be required. Roadmap development needs to consider the perspective, needs, and equity of these agencies and other organizations that are responsible for water and energy issues. There are also important efforts in water research and development at regional, state and local levels, led by government agencies, universities, and other organizations. These contributions need to be integrated with the DOE efforts at the energy-water nexus.

*Research and development and real-world technology deployment.* A strength of the national laboratories is their ability to tackle a problem—from fundamental science to engineering development—and seek breakthroughs that offer dramatic improvements over current capabilities. Coupled with a multi-year commitment to work energy-water efficiency and supply issues, this attribute is important to long-term program success.

Successful research and development projects alone are not the answer. The proposed program includes investments to ensure that the technologies created through energy-water research and development are deployed successfully by end-users. In addition to technology innovation, the program will support pilot testing and assessment, technology transfer and commercialization, and an assessment of the economic and policy constraints for regulatory and public acceptance. To be successful, a new technology must be economically viable, environmentally acceptable, easy to

integrate into existing infrastructure or processes, and compliant with all applicable laws and regulations.

*National laboratories leading a broad partnership.* The bill proposes that three national laboratories-Lawrence Livermore, Oak Ridge, and Sandia—be designated as "program lead laboratories" and shoulder principal responsibility for carrying out the Energy-Water Efficiency and Supply Technology Research, Development, and Transfer Program. Each lead laboratory will select one or more university partners to assist in program efforts. Based on the technology assessment and the developed roadmap, the program in future years will include appropriated funds for activities at the lead laboratories and program grants for research, development, and demonstration projects. Since at least 40 percent of the funding in FY2007 and beyond are earmarked for grants, the program will be inclusive—drawing on the best of ideas from universities, other research institutions and agencies, and industry.

Concentration of program responsibilities in three DOE national laboratories makes eminent sense. Three is a number large enough to provide diverse viewpoints and a very wide range of expertise and technical capabilities; yet it is small enough to keep the program manageable and provide the laboratories funding on scale commensurate with the need to pursue large-scale multidisciplinary research and development activities. Each of the three selected lead laboratories brings to bear important attributes that will contribute to program success:

- *Broad ranging capabilities.* As premier research facilities, the DOE national laboratories are large repositories of multidisciplinary expertise and home to many of the world's largest computers and state-of-the-art experimental facilities. They define the forefront of science and engineering in materials and nanotechnology development, advanced computations, numerical simulation, and detection and analysis of hazardous chemical and biological compounds. These cross-cutting capabilities are essential to solving water challenges.
- *Relevant ongoing research and development activities.* The lead laboratories have been engaged in both energy and water projects for many years. One particular source of special expertise in water issues at Lawrence Livermore stems from long standing efforts to characterize and cleanup groundwater at the Laboratory (and other superfund sites). These activities in the 1990s led to the development and transfer to U.S. industry of novel technologies for water treatment, including dynamic underground stripping for rapid groundwater remediation, and capacitive deionization (CDI) for removal of a variety of contaminants. Lawrence Livermore's capabilities in materials science, molecular modeling and separations science continue to fuel develop and transfer of a wide variety of water-and energy-related technologies, as discussed in the next section.
- *Interactions with a wide range of partners.* The lead laboratories routinely work with sister research institutions including major universities, and transfer the technologies they develop to U.S. industry for commercialization. In addition, water technology programs at the laboratories entail many partnerships with federal, state, regional, and/or local water agencies.

*Advisory and review processes.* The proposed legislation very appropriately establishes an Advisory Panel to review program progress, help the lead laboratories identify legal and other barriers to implementing technology options, advise the Secretary of Energy on energy-water issues, and recommend program grant awards. Composed of members with diverse expertise, background, and interests, the Advisory Panel will be most helpful to the lead laboratories responsible for carrying out the Energy-Water Efficiency and Supply Technology Research, Development, and Transfer Program. The laboratories will depend on their guidance, and they will support the panel as appropriate to help shape the grant program. The program peer reviews conducted by a National Academy of Sciences (NAS) group also will be important. In recent years, the NAS has completed a wide range of very insightful studies examining water quality and management issues.

## LAWRENCE LIVERMORE'S CONTRIBUTING CAPABILITIES

Lawrence Livermore National Laboratory (LLNL) has a proven track record in applying its capabilities to the complex water issues facing its nearby communities, California, the West, and the nation. The Laboratory emphasizes bringing expertise from many scientific disciplines to its water technology projects. LLNL scientists and engineers have at their disposal unique facilities for analyzing trace amounts of hazardous compounds, some of the world's fastest computers, nanoscale characterization and fabrication capabilities, and special software and analytical tools developed for water and/or energy management.

At the Laboratory, water treatment and monitoring technologies are at all stages of development, from new materials at design-stage, based on breakthroughs in separations science, to laboratory and field-scale pilots, to commercial units. These research and development activities are sponsored externally and internally and pursued in partnership with a variety of government agencies, water organizations, and corporations.

Four areas of LLNL's technology research and development activities are briefly highlighted here: selective water treatment, desalination, advanced sensors, and monitoring/management tools. I also will discuss our partnerships that support and inform these efforts.

*Selective Water Treatment Technologies.* Present water treatment technologies, such as membrane filtration or reverse osmosis, are energy-intensive and expensive, in part because they remove many compounds in addition to contaminants. Technologies that selectively remove only undesired contaminants can improve water treatment operating costs and energy efficiencies enough to allow many small communities and rural households to use local freshwater supplies that currently do not meet potable standards because of a single contaminant (e.g., arsenic, selenium, perchlorate, uranium, or nitrate).

With the Laboratory's world-class computing facilities, which include three of the world's top 13 supercomputers, LLNL has made breakthroughs in the fundamental science of separations technology, developing complex molecular-level simulation models to understand the chemical transport of contaminants through different types of materials. The objective is to design materials that are "tuned" to selectively attach to and remove compounds of choice. Laboratory experts in advanced materials science then test these concepts using a diversity of media, including membranes, ion-exchange resins, aerogels, and aerogel composites. (An area of special expertise at LLNL, aerogels are high-surface area, low-density materials that can adsorb large amounts of contaminants per unit weight and volume.) To date, Livermore scientists have been able to identify, fabricate and test designer materials (e.g., chemical functional groups on membranes) to selectively remove arsenic, metals, radioactive compounds, and hydrocarbons from water. LLNL also has developed a spectrum of energy-efficient portable treatment units. These units, designed to have low capital and operating costs and to operate at remote sites, can be configured to run on renewable energy sources such as solar power.

The Laboratory is also helping municipalities in California's Central Valley that need to treat nitrate-or arsenic-contaminated groundwater. The water is naturally hard and prone to precipitating minerals, creating plugging problems in the low-cost filter media needed to eliminate the nitrate and arsenic. LLNL is using its geochemical modeling expertise to determine ways to prevent the minerals from forming, allowing these communities to efficiently use these low-cost media rather than higher cost alternatives to meet arsenic and/or nitrate standards.

*Desalination*. LLNL has been developing technologies to improve the energy efficiency of desalination processes for over twenty years. In the 1990s, the Laboratory licensed an innovative approach to capacitive deionization (CDI) using aerogels to desalt water. In 1995, this technology received an R&D 100 Award as one of the top 100 technology innovations of the year. Next-generation and spin-offs from this original technology are under development, including a concept based on the electrodialysis (ED) process. ED is more energy efficient than reverse osmosis at removing salt from brackish water, but it is still not cost effective enough to treat large volumes of marginally impaired waters. Laboratory scientists are working on developing "smart" membranes for ED. They would be designed to selectively remove only the contaminant of interest. Accordingly, the process would be far more efficient and lower energy costs by 50 percent or more. California state agencies are actively supporting this research and development.

*Sensor Technologies*. LLNL is applying its expertise in sensor technologies and its national and homeland security capabilities to help water utilities and agencies. In support of the U.S. Department of Homeland Security, LLNL has recently performed an assessment of sensors and systems currently available to utilities for detection of biological and chemical contamination in water distribution systems. More generally, unique facilities at Livermore are available for real-time detection and response to hazardous releases. They include the National Atmospheric Release Advisory Center (NARAC), the Biosecurity and Nanosciences Laboratory, the Biodefense Knowledge Center, and the Forensic Science Center.

In addition, Livermore is at the forefront of developing new sensors for chemical and biological hazards, including detectors for single molecules of deadly pathogens, and rapid biohazards detection by polymerase chain reaction (PCR). Over the past three years, three LLNL-developed biological agent detection systems have earned R&D 100 Awards. Coupling its expertise in electronics miniaturization and mate-

rials science, the Laboratory is also developing high-resolution portable chemical sensors, including a sensor for arsenic, based on selective membrane technology.

*Water Monitoring and Management Tools.* LLNL is applying innovative analytical and modeling tools to monitor and manage water resources. For example, the Laboratory has state-of-the-art facilities for age-dating tritium (helium-3) and methods for low-level detection of tracers and contaminants. Integrated with high-resolution hydrologic models, these capabilities are aiding California in assessing groundwater vulnerability to MTBE and other contaminants in the State's Groundwater Ambient Monitoring Assessment (GAMA) program. LLNL has and continues to assist the state of California in multimedia analysis for new transportation fuels. In support of the Orange County Water District, LLNL scientists used these methods to determine how long reclaimed water, which was injected to prevent seawater intrusion, would remain underground before withdrawal for potable use. LLNL has also helped stakeholders understand water management alternatives to meet Total Maximum Daily Loads limits in the Dominguez Channel, Long Beach, California. LLNL is supporting the U.S. Bureau of Reclamation by using these techniques to determine if an aquifer in California's Imperial Valley, fed by leakage from agricultural canals, is a sustainable water supply or could be used for water banking.

LLNL also develops database management tools for water agencies to use to assess and manage contaminated water resources. GeoTracker, a GIS tool developed by the Laboratory and managed by the state of California, provides a public online database of groundwater compositions for all leaking underground fuel tank (LUFT) sites and public wells. Scientists are currently working with a California water agency and the National Water Research Institute on a tool to balance contributions from multiple water sources and manage arsenic loading to a municipal water supply. Another software tool allows water managers to visualize sources, uses, and disposal of water in systems from watershed to national scales, as demonstrated by use of U.S. Geological Survey data to diagram water flows in the U.S. and in some states. LLNL staff participated in the recent water energy relationship study conducted by the California Energy Commission as part of its 2005 Integrated Energy Policy Report.

*Partnerships.* Livermore researchers collaborate with a wide variety of partners including many universities across the nation and industry, ranging from large multinational to small companies that serve niche markets. Sponsors and federal, state and local agency partners include: U.S. Bureau of Reclamation, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Geological Survey, California Environmental Protection Agency, California Energy Commission, California Department of Water Resources, and California State Water Resources Control Board.

For example, LLNL researchers will investigate innovative brine disposal options in a joint project with two California water districts interested in pursuing brackish water desalination as a new water source. Also involving university researchers for membrane testing and an engineering firm, this project will receive state funding as well as contributions from the lead partners. Our many university/research institution partners include: Arizona State University, Hunter College, Santa Clara University, Stanford University, University of Arizona, University of California (UC) Berkeley, UC Davis, UC Los Angeles, UC Merced, UC San Diego Scripps Institute of Oceanography, UC Santa Cruz, UC Cooperative Extension, University of Texas, Austin, and Lawrence Berkeley National Laboratory.

A significant fraction of public drinking water supply wells in the State of California are contaminated by nitrate, the single most reported contaminant in public wells. Using internal funding, LLNL researchers have been investigating nitrate transport and assimilative capacity in groundwater basins. Working with water agencies, academic institutions, an agricultural outreach organization, and supporting students, LLNL conducted studies in both urbanized groundwater basins and at dairy farms. The significance of the work has been recognized by follow-on funding from the State Water Resources Control Board. Our many water utility partners include: City of Modesto, Santa Clara Valley Water District, Zone 7, Dublin San Ramon Water District, East Bay Municipal Utilities District, Los Angeles Department of Water and Power, Alameda County Water District, City of Ripon, Grayson, San Benito County Water District, and Orange County Water District.

A licensee of LLNL's capacitive deionization technology has just announced an agreement for development and manufacturing of the key aerogel material that is the heart of the company's product. Given the commercial viability of the technology, LLNL researchers are working on next-generation innovations to improve performance and efficiency. Private industry/consortia partners include: CDT Systems, Balance Hydrologic, Perlorica, Tetra Tech, Boyle Engineering, Malcolm Pirnie, Crystal Clear Technologies, RMC Water and Environment, and the National Water Research Institute.

CLOSING REMARKS

Our Laboratory is fully supportive of S. 1860, the "Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005." It is an important bill; America's current and future needs for abundant energy and water will only be met by pursuing innovative science and technology to address energy and water issues.

S. 1860 establishes a well-designed program to assess the current situation, build a roadmap for future activities, and pursue energy-water efficiency and supply technology research, development, and transfer to end-users. The program makes effective use of DOE national laboratories working in partnership with others to develop and deploy technologies. It also defines appropriate mechanisms to steer the activities and advise the Secretary and Congressional committees of program progress. S. 1860 is an important element in planning for our nation's water and energy future.

Senator BINGAMAN. Thank you very much. Unfortunately, they're about to finish off this vote so I think I better put this hearing in recess until Senator Domenici returns. Then we'll hear from you, Dr. Roberto.

[Recess.]

**STATEMENT OF DR. JAMES B. ROBERTO, DEPUTY DIRECTOR FOR SCIENCE AND TECHNOLOGY, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TN**

Dr. ROBERTO. My name is James Roberto, and I am the Deputy Laboratory Director for Science and Technology at Oak Ridge National Laboratory, which is a Department of Energy multi-program laboratory managed by UT-Battelle, a partnership of the University of Tennessee and Battelle Memorial Institute.

The Water Technology Act would open an important area of research for our laboratory and for the Nation. Reliable energy and clean water are essential elements to the quality of life. When we lack one or the other, our standard of living suffers. We have a responsibility to safeguard these resources for the American people.

In my testimony today, I will concentrate on two subjects. One, how energy/water issues are becoming acute in the Southeastern States. And two, how new science can make a difference. Population increases throughout the United States will drive demand for both energy and water into the foreseeable future. As energy production accounts for the largest withdrawal of freshwater in the United States, the growing demand for energy and the need to provide water for cities and industry will inevitably collide.

Water Technology notes that Nevada will have a population of four million people by 2030, which is twice what it had in 2000. The same trends are occurring in Southeastern States such as Georgia, and Florida where the growth rate is about the same. Most of Georgia's new water demand will be located in the Atlanta metropolitan area that is already struggling with water supply shortfalls.

To meet future demand, many eastern coastal cities are turning to seawater desalination projects. For example, Tampa has been operating a seawater desalination plant since 2003 to augment its groundwater supplies. Tampa's experience is an important, leading example of how to provide new water sources for our cities, but desalination remains expensive, energy-intensive, and environmentally challenging.

In central Virginia, the expansion of a nuclear power plant is being delayed because of limited water resources. Lake Anna was created in 1971 to provide cooling water for the power station. Over the years, the lake has become home to marinas, subdivisions, and a State park. As is happening elsewhere in the United States, changing water-use values are putting pressure on water for energy uses.

Expansion of the power station would lead to water loss through increased evaporation, putting fisheries in the reservoir-based recreation at risk. This and many other examples make it clear that water and energy are major resource development issues throughout the country, both in the West and the East.

One example of a broad class of technologies that can have a transforming impact in the last two of these areas is the use of inorganic membranes. Depending on the materials used, inorganic membranes are resistant to corrosive liquids and gases, even at high temperatures over 1000 °C.

In seawater desalination applications, the increased durability and other properties would result in less costly operation and maintenance and less energy-intensive performance could be achieved.

At ORNL, we have been exploring ways to build inorganic membranes for many years. The proposed Water Technology Act would enable us to develop this technology. DOE's laboratories have a wide range of capabilities that are well suited to tackle the most difficult challenges at the intersection of energy and water. These include new information systems, computational models, and monitoring technology to better understand demands for both energy and water. New materials, separation methods, and sensors/controls can be developed to create clean water and to increase water-use efficiencies. The biotechnologies and nanotechnologies that are being developed within the national laboratories will have many applications to cleaning water.

DOE's national laboratory system is an excellent place to center a new water technology program, because of our multi-disciplinary nature and our ability to carry out complex integrated projects. We need to draw on a broad range of skills, not only from the labs, but also from other agencies, academia and industry.

We also must ensure that the new technology that is developed is transferred expeditiously to commercial end-users. A base technology program in labs and universities, combined with competitive grants, will produce effective directed research and the opportunity to incorporate the best new ideas from all sources.

Thank you, Mr. Chairman, for your commitment to providing reliable energy and clean water to our Nation and the world. The scientific community appreciates the committee's leadership in this area and firmly believes that the future of our Nation depends on continued progress in science and technology, including the energy/water nexus.

[The prepared statement of Dr. Roberto follows:]

PREPARED STATEMENT OF JAMES B. ROBERTO, DEPUTY DIRECTOR FOR SCIENCE AND TECHNOLOGY, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TN

Mr. Chairman and Members of the Committee: My name is James Roberto, and I am the Deputy Laboratory Director for Science and Technology at Oak Ridge Na-

tional Laboratory (ORNL). My role at ORNL is to oversee the Laboratory's science and technology programs, including physical and materials sciences, neutron sciences, biological and environmental sciences, advanced computing, energy and engineering, and national security. ORNL is a Department of Energy multiprogram laboratory managed by UT-Battelle, LLC, a partnership of the University of Tennessee and Battelle Memorial Institute. It is an honor to appear before the Committee in support of The Energy-Water Efficiency and Supply Technology Research, Development, and Transfer Program Act of 2005 (referred to here as the Water Technology Act).

The Water Technology Act would open an important area of research for our Laboratory and other parts of the federal and nonfederal research community in the U.S. As Senator Domenici has stated, reliable energy and clean water are essential elements in the quality of life of our citizens and those elsewhere in the world. When we lack one or the other, our standard of living suffers greatly. We have a responsibility to safeguard these resources for the American people.

With your leadership and others, we are all getting better educated on the issues associated with unsafe water and unreliable energy—this is a hopeful sign. I will not repeat more water facts here, but I have attached a statement from the National Laboratory Energy-Water Nexus Team, a multi-laboratory team that has been working for more than two years to highlight these issues. This attachment is a concise statement of the relation between energy production and water resources and of how science and technology can contribute to new solutions to resource limitations. The Energy-Water Nexus Team is a broad collaboration among DOE's Laboratories that I hope will continue to function within the new Program you are proposing.

In my testimony today, I will concentrate on two subjects: 1) how energy-water issues are becoming acute in the southeastern states, and 2) how new science can make a difference. The first point shows that water problems are not restricted to the western U.S. The second shows some of the benefits that will come from the Water Technology Act.

## ENERGY-WATER ISSUES IN THE SOUTHEAST

Population increases throughout the U.S. will drive demand for both energy and water into the foreseeable future. As energy production accounts for the largest withdrawal of freshwater in the U.S., the growing demand for energy and the need to provide water for cities and industry will inevitably collide over limited freshwater. The competition for water between energy, municipalities, and industry is often compounded by the need to reallocate available water to environmental conservation. We are seeing these types of competitive problems in the eastern U.S. today.

In the introduction of the Water Technology Act, Senator Domenici explains how Nevada will have a population of four million people by 2030, twice as many as in 2000. The same trends are occurring in southeastern states such as Georgia, where the growth rate is about the same. Most of Georgia's new water demand will be located in the Atlanta metropolitan area that is already struggling with water supply shortfalls. Population growth rates similar to those in Nevada and Georgia are occurring all along the east coast of the U.S., in states from Florida to Virginia. It is clear that there are water technology needs throughout the country and that the R&D investments in this proposed legislation are needed as soon as possible.

To meet future water demand, many eastern coastal cities are turning to seawater desalination projects. For example, Tampa has been operating a seawater desalination plant since 2003 to augment its groundwater supplies. Tampa's reverse osmosis plant is located next to a 2,000-MW, coal-fired power plant, where they share a water intake. Tampa's experience is an important, leading example of how to provide new water sources for our cities, but desalination remains expensive, energy-intensive, and environmentally challenging. Biofouling of water intakes and membranes; unexpectedly high costs for construction, operation, and maintenance; and environmental impact of disposal of concentrated brines are continuing problems. These unresolved technical problems are delaying water solutions at other cities in the East and the West.

In central Virginia, the expansion of a nuclear power plant is being delayed because of limited water resources. The North Anna Nuclear Power Station near Mineral (north of Richmond) is located on Lake Anna, a 9,600-acre impoundment of the relatively small North Anna River. Lake Anna was created in 1971 to provide cooling water for the power station. Over the years, the lake has become home to marinas, dozens of subdivisions, a state park and thousands of recreational users. As is happening elsewhere in the U.S., changing water-use values are putting pressure on water for energy uses. Expansion of the North Anna Power Station would lead

to water loss through increased evaporation of cooling water (either from the cooling reservoir or wet cooling towers), and that water loss would put plant safety, striped bass fisheries in the reservoir and downstream, and reservoir-based recreation at risk. This and many other examples make it clear that water and energy are major resource development issues throughout the country, both in the West and the East.

NEW SCIENCE AND TECHNOLOGY SOLUTIONS

Can new science, technology development, and technology transfer help solve these problems quicker, cheaper, or better than existing technologies? I am confident that the answer is "yes"—science and technology can make a real difference, and in a reasonable period of time. A combination of improvements to existing technologies and new technologies that we can expect from the dramatic advances occurring in, particularly, the materials sciences will help us use water more efficiently, produce water for human use from brackish or salt water, and reduce and often remove contaminants from water that we return to the environment. Let me illustrate the opportunities for progress through one example of a broad class of technologies that can have a transforming impact in the last two of these areas, the use of inorganic membranes.

Reverse osmosis membranes can be constructed out of inorganic materials: ceramics or metals. Inorganic membranes would be much more versatile than existing organic membranes. Depending on the materials used, inorganic membranes are resistant to corrosive liquids and gases, even at high temperatures (over 1000 °C). In seawater desalination applications, inorganic membranes would have distinct advantages. They could be selectively designed for use in the pre-treatment stage to remove biofouling organisms and other contaminants, or they could be designed for use in later treatment stages. The increased durability and other properties would be compatible with cheaper and more frequent and repetitive regeneration methods. Less costly operation and maintenance and less energy-intensive performance could be achieved. At ORNL, we have been exploring ways to build inorganic membranes for many years. The new Program that would be established by the Water Technology Act would enable us to develop new applications that could make a real difference, such as portable, low-power water treatment packages to supply clean water to disaster victims.

DOE's Laboratories have a wide range of capabilities that are well suited to tackle the most difficult challenges at the intersection of energy and water. These include new information systems, computational models, and monitoring technology to better understand future supplies and demands for both energy and water. New materials, separation methods, and sensors/controls can be developed to create clean water and to increase water-use efficiencies in the energy sector. Increasing water-use efficiencies in energy, as well as in other industrial sectors, is an important priority, because it will delay the onset and the severity of unproductive competition between energy and water resources. As others have mentioned, the biotechnologies and nanotechnologies that are being developed within the national laboratories will have many applications to cleaning water that we hope will be more energy-efficient than current technologies.

The proposed Water Technology Program would have many important benefits beyond providing for domestic water and energy needs. These additional benefits include homeland security, increased resilience against climate change and variability, and contributions to international stability in regions of the world that suffer from lack of clean water. New technology to improve energy and water efficiency will contribute directly to improvements in the use of resources and protecting quality of life domestically and internationally.

THE BEST PATH FORWARD ON ENERGY-WATER TECHNOLOGY DEVELOPMENT

DOE's National Laboratory system is an excellent place to center a new water technology program, because of our multi-disciplinary nature and our ability to focus on challenging missions, such as this. However, we know that we cannot do this alone. The full spectrum of basic to applied research, demonstration, and deployment will be needed. The new water technology program should be implemented in a way that is needs-based and merit-based, so that funding is allocated to the most pressing problems and work is done by the best researchers. We need to ensure that we draw on a broad range of skills from Labs, other agencies, academia, and industry. We also must ensure that the new technology that is developed is transferred expeditiously to commercial end-users, so that we impact energy and water resources as quickly and cost-effectively as possible. As the Water Technology Act implies, a base technology program in Labs and universities, combined with competitive grants, will produce effective directed research and the opportunity to incor-

porate the best new ideas from all sources. This is a strategy that has proved successful in delivering high-impact outcomes in a variety of arenas.

Thank you, Mr. Chairman, for your commitment to providing reliable energy and clean water to our nation and the world. The scientific community appreciates the Committee's leadership in this area and firmly believes that the future of our nation depends on continued progress in science and technology, including the energy-water nexus.

## ATTACHMENT

The National Laboratory Energy-Water Nexus Team's answer to Question 4 of the Senate Committee on Energy and Natural Resources' Water Conference on April 5, 2005: What potential exists and what should be the federal government's role in enhancing the available water supply through the development of new technologies, conservation, metering, more efficient storage, water banking and other water transfers?

### ENHANCING WATER SUPPLIES WHILE ADDRESSING ENERGY NEEDS THROUGH RESEARCH AND TECHNOLOGY DEVELOPMENT

As highlighted in recent National Academy of Science reports, scientific research and technical innovation will be critical elements in resolving the impending water crises we face nationally and internationally. Achieving this will require increased investment, coordination among many federal agencies and collaboration among entities at federal, regional, state and local levels. There are a number of different areas where research and development could enhance water supplies.

Water plays many essential roles in our lives and in our economies: maintaining public health and sanitation, producing food, protecting sensitive ecosystems, enhancing recreation and aesthetics, and playing a critical role in industry, energy production, and economic productivity. All of these are potentially at risk should water supplies fail. The challenges of maintaining water sustainability also are fundamentally important both to national security and global stability. In observance of the 2002 World Day for Water, U.N. Secretary General Kofi Annan noted that "By 2025, two-thirds of the world's population is likely to live in countries with moderate or severe water shortages. Fierce national competition over water resources has prompted fears that water issues contain the seeds of violent conflict." In the U.S., competition also is growing for limited supplies of water of sufficient quality for use by municipalities, industries, agriculture, water and energy utilities, and others, including meeting ecosystem and recreational needs. Insecurity over water as a powerful source for conflict is evidenced by 37 incidents globally since 1948; but, over the same time period, water has been a greater force for international cooperation, including 295 negotiated water agreements (Shiffries and Brewster, 2004). Making sufficient alternatives available to negotiators depends in part on increased scientific understanding and new technological options that can increase the number of alternatives for enhancing water supplies to balance demands from competing water users.

A particularly important place for science and technology investment is at the energy-water nexus. The needs for both energy and water are expected to grow substantially over the next 25 years, and while the separate challenges arising from these projections are recognized, little attention is given to the fact that the future of one of these resources may be compromised by a failure of the other: insufficient or too costly supplies of water can cripple energy production; insufficient or too costly energy can cripple water supplies. A stable U.S. energy portfolio requires adequate and dependable water. According to the USGS, electricity production from fossil and nuclear energy requires 190,000 million gallons of water per day, or 39% or all freshwater withdrawals nationally. In other words, U.S. households indirectly use as much or more water turning on the lights and running their appliances as they use directly for bathing and watering their gardens. Conversely, water pumping, treatment and conveyance use large amounts of energy, equivalent to energy used by the paper or refining industries, about 75 billion kWh/yr or 3% of national energy consumption. In the west, energy use for water is even higher: about 7% of California's electricity is used for water pumping and as much as 25% of electricity use is water-related (Gleick et al., 2004).

### TARGETING RESEARCH AND DEVELOPMENT AT THE ENERGY-WATER NEXUS

Energy-water linkages result in synergies for research and technology efforts at the energy-water nexus. Increasing efficient use of energy effectively extends both water supply and energy supply; more efficient use of water effectively likewise en-

hances supplies of water and energy. There is a clear need for research and technology to develop a better understanding of the energy-water nexus and to find the innovative technological solutions needed to address the challenges at this critical junction. Such efforts should include energy-efficient technologies for treating and using impaired water sources, scientific and technologic advances to reduce water usage in power generation, reuse of waters used or produced in energy resource recovery, and improving energy efficiency in water pumping and conveyance, as well as a long list of other areas that will result in more efficient or decreased use of water and energy.

Water acquisition, management, movement, distribution, purification and post-use treatment are large users of energy (Anderson, 1999). Water sector energy demand also likely will substantially outpace growth in other high-energy use sectors. Increasing water demand, shifts to water reuse and recycling, more use of impaired water sources, tapping of deeper groundwater sources, and increased water storage and transport will significantly increase future energy demand. Energy demand for treatment and conveyance of freshwater supplies is increasing due to deteriorating infrastructure (American Water Resources Association, 2005), increased awareness of harmful natural constituents such as arsenic (Bitner, 2004), introduction of new contaminants into the environment (e.g., endocrine disruptors, disinfection byproducts), and concerns over soil salinization and depletion of groundwater (Lawford et al., 2003; McGuire et al., 2003). Addressing these factors will require long-term commitments of significant resources to research, develop, demonstrate and deploy water treatment technologies that can improve efficiencies for removing traditional compounds as well as treat an ever-growing number of new contaminants. Such research should include development of new energy-efficient and selective materials for membranes, ion exchange resins and filters, innovative processes for desalination, and improved processes for handling concentrate waste streams.

With inclusion of freshwater and saline water withdrawals for thermoelectric and hydropower, the energy sector is the largest water use sector. While these withdrawals are not completely consumptive, enough water still must be available to ensure sustainable energy production. With the exception of some renewable energy sources, and regardless of fuel sources, our electricity production is dependent on water supplies (Electric Power Research Institute, 2002; Brocksen et al., 1996). Additionally, much of our energy fuel production is dependent on adequate water supplies to obtain and process fuels (Wolff et al., 2004). Energy resource recovery and processing also create large volumes of wastewater that require treatment for reuse or disposal (Gleick et al., 2004). Future sources of energy such as coal liquefaction or gasification, biomass, and hydrogen will place new demands on water resources.

Many factors are driving the current condition of increasingly strained water resources toward a severe water crisis, translating to negative results for the energy sector. Nationally, population is growing most rapidly where water is least available. Internationally, in addition to the water needed for growing populations, tremendous amounts of water will be needed to modernize urban centers and industrialize the developing world. Freshwater supplies are dwindling due to extended droughts in parts of the U.S. and in other countries throughout the world (Hirsch, 2004). Water will be foremost among resources affected by long-term trends in regional and global temperatures or other manifestations of climate change.

All of these factors will contribute to increasing difficulties for the energy sector to obtain the water it needs for existing plants and for future expansion. Newspapers from throughout the country increasingly are reporting that drought, increasing competition among user groups for existing water supplies, and fears of negative impacts on ecosystems are causing denial of permits for new thermoelectric power generation or restrictions on existing electricity generation. For example, the Salt Lake Tribune reported that the drought now impacting the western U.S. has reduced hydropower production at Glen Canyon Dam by 25 percent, reducing output to just 124 megawatts out of 165 megawatts of power capacity. Drought has also reduced hydropower output from numerous smaller projects throughout the state, lowering revenues for hydropower producers and making electricity more expensive for many of Utah's households. In Lassen County in northern California, concerns over water are causing residents and conservationists to oppose construction of a 1400-megawatt coal-fired power plant planned across the state line in Nevada. The plant would produce cheap electricity at 2 cents per kilowatt-hour compared to 5 cents per kilowatt-hour for gas-fired plants, however, experts think that the 16,000-acre feet of water per year needed for the plant greatly exceeds sustainable withdrawals from the area's water resources. In both cases, water shortages result in increasing costs and decreasing supplies of electricity. In central Virginia, near Mineral, a siting permit to expand the North Anna Nuclear Power Station is being contested due to concerns over water. Lake Anna, a 9,600-acre river impoundment, was

created in 1971 to provide cooling water for the North Lake Anna Nuclear Power Station. Over the years, the lake has become home to marinas, dozens of subdivisions, a state park and thousands of recreational users. The siting permit has encountered significant resistance from other water users, residents and environmental groups over the impact of reducing lake levels, especially during droughts, and the resulting risk to plant safety, as well as the impacts on aquatic species and recreation from impingement, entrainment and thermal discharges from expanding the facility.

There are also energy implications resulting from choices in water resource utilization. For example, in California, where power shortages recently necessitated rolling blackouts and other extreme power conservation measures, water constraints are pushing industries and power plants to shift to wastewater reuse and recycling. Because energy as well as water may be limiting factors, the future availability and cost of the additional energy that will be required for wastewater treatment and conveyance should be considered in conjunction with the cost and availability of various water source alternatives, or switching to other options such as dry cooling or other low water-intensity power generation such as solar and wind power. The cascading blackout that temporarily devastated many parts of the economies of regions in the Northeast and Midwest several years ago also resulted in suspension of Cleveland's water supply because electricity was not available for pumping stations. Future city planning is likely to consider a mix of energy resource alternatives or back-up generators to increase the reliability and security of both energy and water systems. Decision analysis and systems tools that allow coupling the energy and water sectors are critical for such integrated planning.

Problems at the energy-water nexus are national in scope but there are profound regional differences in water issues and energy sources that dictate solutions be fit to regional and local needs. Water scarcity is most obvious in the arid West where surface water withdrawals are maximized and groundwater pumping rates exceed natural recharge rates, but even in the more humid Eastern states, limited storage, groundwater level declines, salt water intrusion and depletion of stream flow needed for aquatic ecosystems are common problems (NSTC, 2004). The benefits from new investments should be maximized by focusing on technologies that can be deployed nationwide by virtue of their adaptability to a variety of regional water resource scenarios.

Investment should also be made in a process to ensure that the technologies created through energy-water research and development are deployed successfully to end-users. Components of such a process should include technology innovation, research and development, pilot testing and assessment, technology transfer and commercialization, and concurrent studies of the economic and policy constraints that may impede regulatory and public acceptance. To be successful, a new technology must be economically viable, environmentally acceptable, should be easily integrated or substituted into existing infrastructure or processes, and comply with all applicable laws and regulations.

## SUMMARY

As highlighted in recent National Academy of Science reports, solving the national challenge of sustainable water and energy supply will require a coordinated and concerted investment in science and new technology development. There is an urgent need to increase research and development efforts to create science-based solutions to water-related constraints on future energy supplies and energy-related constraints on future water supplies. Over the last decades, there have been investments in some water related areas, such as groundwater cleanup and environmental restoration, fossil energy produced water management, thermoelectric power efficiency, and in-home water and energy efficiency. All of these efforts individually fall within the energy-water overlap, but more integration and coordination is needed to provide a foundation for broader research and technology development specifically targeted to cover the scope of the nexus between national energy and water supply needs. Science and engineering expertise to be tapped include high-performance, high-resolution computer simulation capabilities, advanced sensors and controls, separations science including advanced materials development, impaired water treatment and water reuse technologies, improved water and energy efficiency technologies and systems, technology testing and demonstration facilities, tools for integrated analysis of complex interdependent systems, and tools for decision-support analysis and visualization. Finally, a regional approach to water resources is needed, so that new technology development is matched to local and regional needs and priorities. Regionally based efforts should foster cooperation among national laboratories, universities, other federal agencies, private industry, state and local agencies

to target the most pressing national and regionally cross-cutting priorities. Creation of strong regional public/private partnerships that engage federal, state and local decision makers must be a key part of any solution.

The CHAIRMAN. Thank you very much. Senator Bingaman went to vote, as I indicated, and he will probably return. Senator Salazar is here now. And Senator, we're going to start questions. These are the four panelist that have just spoken. If you have any questions, I'll give you a turn shortly. If you would like to make an observation regarding the hearings, you are free now to do that, whichever you prefer.

Senator SALAZAR. I'm here just to support the committee and the chairman.

The CHAIRMAN. All right. Let me just make an observation for a moment. There's no doubt in my mind that our country has grown used to waiting until a crisis before we do anything and I'm very worried on many fronts as to what's going to happen because of that. This is one of those.

Second, I'm very concerned that we spend a lot of our money on things that are not going to take care of our future. And somehow we have to get out of that ethic some way, and spend some money on some things that apply to our future. I have many Senators on this committee and I'm so pleased they're here because they feel the same way.

The Senator on my right feels that we're spending far too little on things we chose to call hardware, tangible things like new technology for water and the like. And we try to find money someplace. My worry is that we'll pass this bill—because if we work at it, we will—and then where do we get the money to do it? And it just won't happen, just because we wrote it.

Having said that, Senator Craig, you will know these four are the first panel. We're finished with their testimony. I will start with questioning, followed by Senator Salazar, then you.

So let's start with the representative of the Federal Government. Mr. Faulkner, you stated in your testimony that the appropriate Federal role in water supply and distribution is providing appropriate scientific and technology support for these efforts.

Do you believe that S. 1860 generally promotes the Federal role articulated in your testimony as representative of the administration's position?

Mr. FAULKNER. Sir, I think there's widespread agreement, as you said, that the energy and water nexus is an important issue. We do believe there's an important Federal role to play in research and development on energy/water related technologies, as well as in the laboratories.

Our laboratory systems have unique capabilities to bring to bear on that, to accomplish that mission. We do think that there are some specific things about the legislation, as I said in my testimony, that we have some concern about, mostly about providing sufficient flexibility to the Secretary of Energy.

The CHAIRMAN. All right. You stated in the testimony that S. 1860 appears to leave out the private sector and its key role in the research and development, demonstration and commercialization.

S. 1860 provides that at least 30 percent of the funding be made available for non-Federal competitive grants and provides for the

private sector to be a full advisory panel member. Could you tell us, is this what you mean by excluding the private sector, or do you mean this is not enough for the private sector?

Mr. FAULKNER. I believe the latter, sir, would be my view. I think public/private partnerships in research and development are really the bedrock of what at least my office does, at the Department of Energy. Getting the private sector in early in research and development is critical to the development and the commercialization of those technologies.

The CHAIRMAN. As I understand it, much of the DOE's water resources research has been done within the Office of Science, which focuses on basic research. And it's my belief that we should promote more applied research. What other offices within DOE should be brought to bear, if any, in carrying out S. 1860?

Mr. FAULKNER. As much as $20 million in research and development across the Department is on water-related topics. That's in the nuclear energy area, the energy efficiency area, the fossil energy area. And then there's some work going in my office also in terms of Federal energy management. They've been looking at water issues, reducing water use in Federal facilities for many years.

And then we also have our Energy Star program, which looks at setting criteria for reducing water use. So there are a number of different parts of the Department engaged in this, and the technologies they pursue are important to this area.

The CHAIRMAN. I have some other questions, but I want to go to Dr. Shephard, and then yield to the other side.

Dr. Shephard, what unique research capabilities do you think Sandia Laboratories should or could bring to bear to carry out the purpose of S. 1860?

Dr. SHEPHARD. As you know, the Sandia National Laboratories has been, since its inception, a science-based engineering laboratory. We have a very strong industrial heritage that dates back to Bell Labs and AT&T and Western Electric. Those two attributes have continued through to this day.

I believe that an important and—a very important aspect of this particular legislation is to assure that we remain focused on a systems perspective that allows us to understand how the various elements associated with research, development, application and commercialization are tied together from basically fundamental research and the investments that this country is making in a facility like Sandia, relative to our Center for Integrated Nanotechnology and our Microsystems and Engineering Science Applications facility, all the way through to the other end of the spectrum, which really relies very highly on probabilistic risk assessment methodologies and capabilities.

When one couples that with our direct engagement with industry—and by all metrics, Sandia has traditionally led the Department of Energy complex in terms of technology transfer, in terms of patents, in terms of CRADA, in terms of moving technologies into the private sector—that sweep from systems engineering to basic research and development to a strong industrial heritage collectively contribute to provide Sandia the right set of capabilities for this.

The CHAIRMAN. I have additional questions, as I do of the other laboratories, but I'm going to now yield. If I don't get time, I'll submit five or six questions to each of you.

Senator Bingaman.

Senator BINGAMAN. Thank you very much, Mr. Chairman. Let me ask about an issue. I guess I'll start with Dr. Shephard, since I know that you folks at Sandia have been focused on this. Maybe some of the other witnesses also have.

The biggest problem that I hear about—and I'm sure Senator Domenici hears about it regularly, as we travel around New Mexico—is this problem of arsenic in the water. Of course, we've established a requirement that all of these municipal water systems meet a very, very high standard. I think it's 10 parts per billion of arsenic. It used to be 50 parts per billion, then it was determined that that still was unsafe, and now it's 10 parts per billion.

I know there's some research going on at Sandia about how to deal with this arsenic problem in a cost-effective way, and what kinds of technologies would assist in doing this. Could you give me an update on where that stands, whether there's any sort of comprehensive effort, or is this just sort of something that a few people are interested in, or——

The CHAIRMAN. Dr. Shephard, would you please hold. Senator Bingaman, would you yield to me for just one moment? Senator Bingaman, starting back about 3 years ago, we started funding, and through Sandia's special efforts, they're getting very close to having a special institute that would be directed at this.

But in the meantime, there are three laboratories, mobile, set up for arsenic research elimination. One is in Albuquerque, and I can't remember the other. And actually they are looking at three or four, five different technologies. They haven't got one that they can say is ready yet, and everybody here should know, I've talked with Senator Craig about it, you should know Senator, the deadline for meeting the standard is January of this coming year. And it's a very enormous problem, because most of them can't meet it. Albuquerque can, Senator, because they mix water with what they've minimized arsenic in the previous pool.

I think he's going to explain in your answer what they're doing, and I would tell you that if we can keep it going for a while, we're going to find some terrific answers, but we have to be very worried about what happens the next couple of months. I will share with you and the committee what I think are some ways to get some help, but I don't have a way right now.

Thank you. Excuse me for interrupting.

Senator BINGAMAN. Sure.

Dr. SHEPHARD. Yes, sir, Senator Bingaman, and Mr. Chairman, Sandia has been actively engaged, as Senator Domenici has indicated, for a number of years, and actually looking at various technologies that you're aware of as well for addressing this particular problem. It is a widespread, ubiquitous set of issues for the Southwestern part of the United States, but other areas as well around the country.

We have recently—in fact, as recently as the last 2 weeks—convened an outreach program where we have brought together leaders from the various communities around the State of New Mexico

explicitly to try to engage them and understand their specific needs and issues in terms of meeting the particular compliance requirements that, as the chairman has indicated, come into effect in January of next year.

We are looking at the development of a pilot plant. Rio Rancho, New Mexico actually is actively engaged in commercialization-related activities as an end user, again, to provide feedback to our researchers internal to the laboratory to see what actual processes are most effective and most cost-efficient overall in terms of treating locations and communities the size of Rio Rancho, to those much smaller locations which have similar problems in other parts of our State.

Senator BINGAMAN. Thank you very much.

Let me go to Mr. Faulkner with a question. You know, one of my pet peeves all along is it doesn't seem to me we have a very well structured system for monitoring developments in other countries that deal with some of these issues. I don't know what we have in the Department of Energy that focuses on this set of issues. You know, the need for ensuring water quality in particular, is much greater in many of the Third World countries than it is even in our own. And I know there's a lot of work going on in some of these other countries to try to deal with that problem, to try to solve that problem.

Do we have any systematic way in the Department of Energy of tracking what other countries are doing, what the level of progress is, and their technology development?

Mr. FAULKNER. I don't know for sure, Senator, but my guess would be no. But what I'd like to do is go back and check on that and insert that for the record if that's okay.

[The information follows:]

The Department of Energy does not have a systematic way of tracking what other countries are doing in the field of ensuring water quality, nor are we aware of other agencies conducting such work.

Senator BINGAMAN. I would appreciate that. It seems to me to make a lot of sense for us to do it. This is not just a United States problem. None of these are just United States problems. To the extent that we can come up with solutions, we need to share them with the rest of the world. To the extent that someone else comes up with solutions, we need to steal them, or borrow them, or whatever you want to call it. We need to take advantage of those solutions is the point I'm trying to make.

There is one other question I wanted to ask. My understanding is the White House Office of Science and Technology was working on a comprehensive research plan to support fresh water availability. Mr. Faulkner, do you know when that plan is due out? Is that something that you're familiar with?

Mr. FAULKNER. Yes, sir. They've issued one report already, which is outlining sort of the bigger broader issue. They are working on finishing up another report, the one you're referring to, I think. But they're looking at six challenges and I'm told that will be early in this coming year. And then there's a third one following that, that they've only started conceptualizing. But the one I think you're talking about will be early in 2006.

The CHAIRMAN. Senator Salazar.

Senator SALAZAR. If I can just make a quick comment about your legislation, S. 1860. First, I think that all of the labs that you've identified there are wonderful labs that add tremendously to the technology and research of our country—Sandia, Lawrence, and Oak Ridge Laboratory.

And I think the subject of the bill with respect to water efficiency and technology is something that we have not given enough attention to. And so I'm just delighted to be in support of your bill, and I offer to co-sponsor your legislation and to help you get it through.

The CHAIRMAN. Senator, would you mind, maybe we've already asked you, but check and have your staff communicate with us, if you have the arsenic problem in your State.

Senator SALAZAR. There is indeed an arsenic problem in many of the communities in the southern part of Colorado. The town of Alamosa has probably 5,000 to 6,000 people in its population and they know they have to deal with the standard and the deadline and have had to spend millions of dollars trying to figure out what the solution is to meeting the arsenic standard.

In fact, I think, from a water rights and water quality point of view, there are solutions available to the community that probably could be implemented at 1/100th of the cost, if it was only allowed to happen. But the arsenic issue is something that many of the communities in Colorado are very concerned about.

The CHAIRMAN. Well, Senator, I think the same thing you just said applies to a lot of places. They need a little more time to find these alternatives. They're not going to find them by January, from what the experts have told me. I think we have to work collectively to see how we can ask in a reasonable way for an extension, and we're working on it, and we'll invite you to join us. Senator Bingaman's staff is in on it, Senator Craig's, and we'll ask other members.

Senator SALAZAR. I'd be happy to help.

The CHAIRMAN. Now we're going to yield to Senator Craig.

## STATEMENT OF HON. LARRY E. CRAIG, U.S. SENATOR FROM IDAHO

Senator CRAIG. Mr. Chairman, first and foremost, thank you for your attention to this. I think the energy/water nexus is critically important. You talked about arsenic and you and I have had numerous conversations about that already. I don't know how many communities we have in Idaho, but the geology of Idaho, without question, says we've got arsenic, and we have it at much higher levels than even the scientists would agree is healthy and yet we have a very healthy population. In fact, it is interesting that Idaho—well, you know, the interesting thing, Senator Bingaman, is that Idaho—Idaho and Utah have some of the longest living people in the country. Maybe it's because of—instead of. I'm not sure.

But anyway, beyond the reality is the reality, and the reality is we've got a law that many of our communities are trying to comply with, and can't get there. It's obviously very important that we extend time, but in extending time, get the technologies to them. The Senator and I—the chairman and I have also had conversations about a new treatment facility that is a spin-off from an incubator at the University of Idaho, that is now a standup company that is

stripping additional phosphates out of the water and is doing very well, and is doing the heavy metals and arsenic very successfully.

So there are technologies coming and developing, but I will simply get my oar in the water and suggest there is another fine and leading laboratory that happens to be in the mountain west, and that is important. And a great deal of work is going on at INL, and they've worked collaboratively with Sandia and Lawrence Livermore and others, as we work on this issue from hydropower engineering, geothermal generation, and of course nuclear.

Idaho, and its laboratory, is unique in one respect. It sits on the world's largest active aquifer at the moment and is working cooperatively with all of the water interests of Idaho in that capacity.

One of the areas also, as we look at nuclear hydrogen, the nuclear/hydrogen nexus, is the ability to reduce the amount of water necessary to generate nuclear power and hydrogen as we begin to rely increasingly on a finite resource in the West, maybe to provide the next generation of surface transportation.

Obviously, that technology is part of what we're doing in—and moving forward. But we've led in a couple of other areas that I think very well—the biochemical science of water. A lot of work has gone on in Idaho on that issue.

And of course, the one that I think is working extremely well—when I was a freshman Senator, I was sitting on a tractor on a farm in Idaho, that was an INL tractor. I didn't know there was such a model. Actually, it was a John Deere tractor, but it had a national laboratory sign on it. And we had installed it with a GPS, and a program in which we were applying fertilizer to pieces of a field necessary to test the soil in the field, and the GPS was guiding us in doing that. The Idaho lab, along with these farmers, were pioneers in that which has now become a somewhat standard application in the area.

But it not only increased production, it reduced the overall amount of water used, the amount used growing the crops. Better known as the whole crop utilization approach, that really is again a part of a very successful effort. So I'm very supportive of S. 1860, but for one small amendment. Thank you, Mr. Chairman.

The CHAIRMAN. The problem is, that one amendment will yield another amendment, will yield another amendment, and we'll probably have to take all of them out.

Senator CRAIG. That sounds also reasonable.

The CHAIRMAN. We're speaking of the laboratories, obviously, in any event. Let's move ahead.

Senator Martinez, did you have something?

**STATEMENT OF HON. MEL MARTINEZ, U.S. SENATOR FROM FLORIDA**

Senator MARTINEZ. Sir, I appreciate very much you calling this hearing. And thank you, Ranking Member Bingaman. I believe it's a problem that our Nation faces. Certainly, the State of Florida very much faces this issue. It is one that is of great, compelling importance to us, as we grow as a State.

You know, Mr. Chairman, the State of Florida in the next census is anticipated to surpass New York and be the third largest State of the Union. As that occurs, about 1,500 new people each and

every day make Florida their home, and as they do, the demands for water in our State are dramatically increasing. So we are very concerned.

I have a fuller statement that I would like to make a part of the record, if you don't mind, sir, but I just believe that it is important that we look at ways in which we can provide for agriculture, for consumption by new residences, and for business users, as well as for environmental protection.

We have in Florida the tremendous environmental issues relating to the Everglades and Lake Okeechobee, which is a large body of water, but controlling that flow of water and maintaining the comprehensive Everglades restoration program, which requires an awful lot of water, are issues that concern us greatly.

We have some utility entities in Florida that are looking to begin operation of desalination plants, but still don't find it cost-effective, because of the high cost of energy associated with that. And I just wondered if, in the research that any of you may be doing, or in the work that you're seeing others do, there is any anticipation on the horizon of how we can make cost-efficient the desalination of water?

Dr. ROBERTO. I would like to take at least one brief shot at that. At Oak Ridge we've been working for a very long time on inorganic membranes, which could also be used in the reverse osmosis process. The difference is that these membranes are more robust, they can operate at a much higher temperature, and they have other properties, such as being much more resistant to corrosion.

As a result, we believe that these membranes have the potential to lower the energy cost, lower the maintenance cost and increase the out time of these plants. And this could be one technology breakthrough that could help make the difference in those plants and others around the country.

Senator MARTINEZ. What is the horizon of that kind of research, that kind of breakthrough?

Dr. ROBERTO. We know how to make the membranes now. The technology of applying them on that scale has not been developed. And so I think we're talking about a time scale in years, not a time scale in the next few months. But I think it is—as you know, a lot of coastal cities in the United States are looking very seriously at desalination now, and I think that this will be a key technology that will be considered in that process.

Senator MARTINEZ. Any others?

Dr. LONG. At Lawrence Livermore, we are also working in the area of desalinization, both in the electrostatic desalination technique, which is like electrodialysis, like an artificial kidney. And as well, our previous technology in this area, took a few years from benchmark to success. So I think it is a similar timeframe.

As I mentioned before, we're also looking at selective membranes where Livermore's computational ability is being used to actually design the way the membrane works to target only the contaminants that you want to remove, so that you're not spending the energy on contaminants that you don't want to remove.

And I think this is in an early stage, but it's very promising in terms of potential efficiency.

Senator MARTINEZ. That's great.

Dr. Shephard.

Dr. SHEPHARD. If I may make a comment or two. In 2003, Sandia, along with several other agencies, jointly prepared what is called the Desalination Technology Roadmap, which is really an attempt to bring focus from a variety of different perspectives on a systems approach as to those innovative technologies that in fact must be invested in over the course of the next 20 years to address exactly the types of problems that you are finding in Florida today.

This first roadmap in 2003 is now being updated with interactions with the Bureau of Reclamation, with the America Reuse Water, and the American Association of Water Users, collectively, and with the input from the National Academy of Sciences, to ensure that the five or six key objectives that must be met to address the problems being encountered in Florida and elsewhere, not only in this country, but elsewhere in the world, in fact are being addressed. And there is a direct linkage between the basic fundamental research that Dr. Roberto and Dr. Long have explicitly discussed, relative to their laboratories, work that's going on at the universities as well, to address this larger systems approach toward this particular problem.

Senator MARTINEZ. Thank you, Mr. Chairman.

The CHAIRMAN. Senator, might I say, on many fronts, the United States has finally gotten on the bandwagon of trying to desalinate, in funding—putting some real money in for a change. I regret to tell you that, in my opinion, the lead money is being put in by the U.S. Navy, and it sounds kind of wild, but actually when you think about it, they really—they need to desalinate and have emergency equipment of large capacity. The most active major project is a U.S. Navy project, and it happens to be going on on a desalinization pond in New Mexico, very dry country.

But nonetheless, they're putting it together and they're making headway. But they're right. It's a——

Senator MARTINEZ. You know, Senator, a little historical note about the Navy on that is Guantanamo Naval Base in Cuba, in the early 1960's, when our era of confrontation with Mr. Castro began, the water used to come to the Navy base from Cuba and it was cut off. And we, in a matter of a few days, put together a desalination plant there that still operates to this day. And so I guess that's where they got their beginning on that, I suppose.

[The prepared statement of Senator Martinez follows:]

PREPARED STATEMENT OF HON. MEL MARTINEZ, U.S. SENATOR FROM FLORIDA

Mr. Chairman and Senator Bingaman, I want to thank you for willingness to hold this important hearing today. The Full Committee will hear testimony from water utility operators and representatives from our National Laboratories on a crisis that I believe is looming on the horizon—the availability of drinking water.

Drought, increasing population, and competing demands from business, agriculture and the environment for limited water supplies has taken us to the brink. The economic, social, and environmental consequences of a water supply crisis are not local or regional in nature. Most experts, including the Department of the Interior, agree that large portions of the Untied States are facing a water supply crisis of potentially immense proportions as our population continues to grow and few new sources of water are developed. It is a national problem and I believe that it demands the attention of Congress.

There is a critical shortage of water in Florida, because of the lack of access to waters that flow into the Everglades and the explosion in the state's population. The state of Florida consumes over 8 billion gallons of freshwater a day, with 92 percent

of it coming from aquifers and we are starting to run out of a once unlimited supply of water. It has been estimated that over 1,500 people a day move to Florida, which is putting an ever increasing strain on limited supplies of potable drinking water. In the next U.S. Census, it is expected that Florida will surpass New York as the third most populous state with over 21 million people. Complicating these problems for communities in Florida, is meeting their drinking water needs and carefully managing the levels of water in Lake Okeechobee in order to comply with the requirements of the Comprehensive Everglades Restoration Program (CERP); the largest ecosystem restoration recovery effort in our nation's history.

It is my belief that the answer, in part, to averting future water supply crises and ensuring that water is available to families, farms, and businesses lies in desalinating seawater and brackish surface and groundwater and making that water available for municipal and industrial uses.

To meet these challenges I introduced S. 1016, the Desalination Water Supply Shortage Prevention Act to encourage the development of environmentally sound and economically feasible desalination projects. I am proud to say that my colleague from California, Senator Feinstein, announced her support and has agreed to cosponsor this legislation.

It will provide energy assistance grants to qualified entities such as local water agencies and public utilities in the amount of 62 cents per 14 Kilowatt Hours of electricity consumed by the facility for the initial ten years of a project's operation. 14 Kilowatt Hours in the amount of electricity needed to desalinate 1,000 gallons of water. The rationale for this approach is that while the cost of desalinating water has dropped dramatically over the last decade, the energy costs associated with desalination are still quite high. Waiting for the cost of desalination to go down is a luxury that, in my opinion, we cannot afford. A modest investment to jump-start the development of these projects today is the most prudent alternative.

It is true that the approach suggested in my legislation is different from the traditional approach of providing construction grant funds. That difference is intentional. First, while the availability of energy assistance grants will encourage the development of desalination projects, these grants will be performance based. These facilities will not receive assistance until they are actually constructed. Under this legislation, only the very best projects that received all of the required permits and environmental approvals will get built by local sponsors and only those will receive financial support.

All over the nation we have municipalities, cities, and utilities with the capability of making desalination from brackish water and seawater on a large-scale. Florida has historically been a leader in the development and use of desalination technology. I am happy that Jim Reynolds, Executive Director of the Florida Keys Aqueduct Authority, has come a long way to testify before this Committee on the importance of providing meaningful assistance to make desalination a viable alternative for cities struggling to meet their water needs.

I want thank you again, Chairman Domenici, for your leadership on this issue and bringing water policy into a more prominent role for this Committee. Although we have different proposals to promote desalination, our objectives are the same. As our urban areas continue to grow, we must make a commitment to meeting our water infrastructure needs. I am committed to working with the Committee and our nation's scientists and water utilities to find solutions to the urgent lack of drinking water.

The CHAIRMAN. Last Senator. Senator, you've got your laboratory here. Do you have any questions?

Senator ALEXANDER. Of course, Mr. Chairman. I want to begin by thanking you for putting the spotlight on the relationship between energy and water. And of course, I'm delighted that Dr. Roberto is here representing the Oak Ridge Laboratories, as well as representatives of the other distinguished laboratories.

We've been talking a lot around here about clean energy, and I heard Senator Craig talking about it as well. And unless you've already discussed this, one of the things I've been impressed with about the Oak Ridge Laboratory is its ability to be a lead laboratory, that is to work with other laboratories, other universities and tackle a project. Neutron sources is a great example of that.

But on the energy and water relationship, I've just got one question to any of you, but maybe I'll start with Dr. Roberto. What can

you say to me about the importance of this research and development on the relationship of energy and water to our ability to produce the clean energies that we must have?

I think those of us who are here right now all agree that the only way is to produce large amounts of clean energy, carbon-free energy in a reliable way. The amounts we need right now are nuclear and coal. And how will this research and development accelerate our ability to produce larger amounts of carbon-free, and low-emission energy from those two sources?

Dr. ROBERTO. I think that what we understand is that clean coal and nuclear are very intensive water users. And so research of the energy/water nexus is very important in terms of trying to develop those technologies in a way in which we use the water most efficiently.

When you get into cleaning the coal, whether it's removing the sulfur and nitrous oxides, or dealing with other emissions, you will find that those technologies are water intensive. And we need to develop new technologies that can do this more efficiently and use less water. I think one of the opportunities of this R&D effort is to make those new technologies that we're going to need for clean energy for the future more attractive and make them possible, because we will be using water at a rate that is sustainable.

Dr. LONG. I would like to add a little bit to that. As we begin to look at the energy/water problem, we need to look at the whole spectrum of energy/water problems as a system, as Dr. Shephard has pointed out. And one of the areas that I think will be fruitful for examination is what water you use for what.

For example, we don't necessarily require as much for cleanliness as water for cooling, for power purposes, as we might use for drinking water. And to look at the whole system and to maximize the amount of water that's available for drinking and what quality that needs to be, versus what kind of quality you might need for other industrial and important energy uses is going to be part of the problem.

The whole system involves more than energy and water. It also is linked to climate. As we produce the energy and the climate is affected by the energy use that we have, we have increased dryness, requiring more energy. So the system is very self-reinforcing. And to interrupt this cycle, we're going to have to be much more clever about how we manage that as a system.

Dr. SHEPHARD. The comment I would have is I'd go back to an earlier remark that this Nation responds well to crisis, and crisis management. And as I look back over 30 years, when we had the first oil embargo, of course, through the efforts—the sustained leadership, in fact—of this committee, we now have an energy policy act that was signed in August of this year.

I believe we are at this same junction, relative to how we address the issues associated with water, and its coupling with advancements of technology in the commercialization process.

One of the appealing aspects, I believe, of the current proposed legislation is, in fact, that strong focus on the coupling of commercialization with the initial concepts of research that must go on so that, in the longer run, that becomes much more effective and much more efficient, specifically to allow us to address the types

of issues that you've pointed out in terms of climate change, and in terms of impacts to carbon emissions and greenhouse gas emissions.

At the same time, it's important to recognize that as part of the review of our desalination roadmap, the National Academy of Science has explicitly identified your point: that unless we go forward and find other ways to reduce the release of carbon and greenhouse gases as part of this process of generating new supplies of water, we are not doing ourselves, as a society, the type of benefit that we deserve, so we can't leverage the investment that we need.

Mr. FAULKNER. Sir, I see you're out of time, but do I have time for a comment?

The CHAIRMAN. Yes, you do.

Mr. FAULKNER. You're absolutely right, that to get the big amounts of power quickly, coal and nuclear are what's on the table now, but we should not lose sight of the fact that down the road, technologies like solar and wind can be used for desalination or producing power without a reliance on the heavy use of water. So it's important to keep our eye on that ball, too, as we go down the road.

The CHAIRMAN. Very good point. Anybody else have anything here? I'm going to submit some additional questions to all of you, but before we let you go, Mr. Faulkner, S. 1016, with reference to the Florida Keys Aqueduct Authority, you commented on that briefly, indicating that the administration did not support it and you stated why; is that correct?

Mr. FAULKNER. I commented in general about the subsidy, sir.

The CHAIRMAN. Yes, sir. What if there was a construction assistance, instead of subsidy, would that deserve another look?

Mr. FAULKNER. It could, sir. I don't know if I can give a definitive answer on that.

The CHAIRMAN. So that's a little bit——

Mr. FAULKNER. I think, in general, the thought here is a concern in this tightening fiscal environment about resources and, you know, new missions, new responsibilities without maybe the resources to do that. And I know the Congress is looking at that, too, but that's a concern of the administration.

The CHAIRMAN. I understand. Senator Martinez, you understand that legislation was directed at a problem you have and we will work with you and the administration to see what we can do. We understand the position that they took and it's probably—I assumed it was going to be forthcoming, not only because of what he said, but where do you stop? If you do it there, where else do you have to do it? So we'll work on that.

Mr. FAULKNER. Mr. Chairman, I appreciate that, and I hope that there's a way that we can accomplish what we're trying to do, which is kick start some projects so we can get this moving down the road. The research might come by the time that we've got so many people in Florida that we've got a crisis, not a problem.

The CHAIRMAN. Okay. Let me say to all of you, thank you for coming. Sorry about the way things were split up today, but you understand that we very much appreciate the emphasis and help you give us by your presence and your testimony. We'll continue to

inquire of you. You're excused and the next panel, please take the podium. Let me see if I can announce them here.

The second panel is made up of Jim Reynolds, executive director, Florida Keys Aqueduct Authority, Key West, Florida; Edmund Archuleta, El Paso Water Utilities general manager, Dr. Pankaj Parekh, director of drinking water quality compliance, Los Angeles; and Colin Sabol, chief marketing officer, GE Infrastructure Water & Process. We've got you there now. Please take your seats and we'll start.

Okay. Mr. Reynolds, same instructions. Your statement will be made part of the record. Summarize.

**STATEMENT OF JIM REYNOLDS, EXECUTIVE DIRECTOR, FLORIDA KEYS AQUEDUCT AUTHORITY, KEY WEST, FL**

Mr. REYNOLDS. Chairman Domenici and members of the committee, my name is Jim Reynolds. I am the executive director of Florida Keys Aqueduct Authority and I serve on the board of directors of the U.S. Desalination Coalition. I very much appreciate having the opportunity to testify today in support of S. 1016, the Desalination Water Supply Shortage Prevention Act of 2005.

The Florida Keys Aqueduct Authority is the sole provider of potable water for all the residents of the Florida Keys. As water resource managers throughout the United States, we are struggling to address the long-term challenges posed by drought, increasing population, and competing demands from business, agriculture, and the environment. These challenges led us to join together with water agencies and utilities from other States, including California, Texas, Hawaii, and New Mexico, to form the U.S. Desalination Coalition, a group dedicated to advocating an increased Federal role in advancing desalination.

Drought, increasing population, and competing demands from business, agriculture and the environment for limited water supplies has taken us to the brink. The economic, social, and environmental consequences of a water supply crisis are not local or regional in nature. It is a national problem and I believe that it demands the attention of Congress.

The recent hurricanes and the one now bearing down on the Florida Keys have highlighted, in the most dramatic way, the extraordinary importance and value that water plays in our lives.

The ultimate goal of the U.S. Desalination Coalition is to encourage the Federal Government to create a new program to provide financial assistance to water agencies and utilities that successfully develop desalination projects that treat both seawater and brackish water for municipal and industrial use.

The Desalination Water Supply Prevention Act of 2005, introduced by Senator Martinez, and co-sponsored by Senator Feinstein, will achieve this goal in a fiscally responsible way.

Despite the tremendous advances in desalination technology that have reduced the costs of desalinating water, energy costs remain quite high and are responsible for more than 30 percent of the overall cost of desalinated water. S. 1016 directs the Secretary of Energy to provide incentive payments to water agencies and utilities that successfully develop desalination projects. This would be a competitive, performance-based program that will help to offset

the costs of treating seawater and brackish water. The legislation would also ensure that there is a balance in the amount of money going to seawater and brackish water projects in any 1 year.

Most experts believe that the cost of desalinating water will continue to come down over time and that desalination will eventually be widespread. But waiting for this to occur is a luxury that, in my opinion, we cannot afford. A modest investment to jump-start the development of these projects and stimulate advances in desalination technology today is the smart thing to do.

It is true that the approach suggested in S. 1016 to encourage the development of seawater and brackish groundwater desalination projects is different from the traditional approach of providing construction grant funds. That difference is by design. While the availability of energy assistance and incentive payments will encourage the development of desalination projects, these grants will be performance based.

In other words, the Federal Government will bear none of the risk of project permitting and construction as it does under the construction grant approach. Only those projects that are technically, environmentally and economically sound, and have actually been constructed will be eligible to apply for the incentive payments. I am proud that the Florida Keys has historically been a leader in the development and use of desalination technology. In fact, the very first seawater desalination plant ever built in the United States was constructed in the 1840's to provide water to Fort Zachary Taylor in Key West. Today, the FAA maintains desalination plants on Stock Island and in Marathon for use in case of emergencies or a disruption in service of our main pipeline that is 130 miles long and crosses 42 overseas bridges. These facilities produce freshwater from seawater, as a limited emergency source of potable water for the Lower and Middle Keys.

Passage of S. 1016 is of vital importance to the future of the Keys. The Aqueduct Authority currently obtains its water from the fresh groundwater from the Biscay Aquifer in Dade County. However, because of skyrocketing growth in south Florida and the needs of Everglades National Park, the South Florida Water Management District is setting limits on the amount of water our agency can withdraw from the aquifer.

As a result, we are moving forward with a plan to supplement our water supplies by building a new brackish water desalination facility in south Dade County that will produce 7 million gallons per day of fresh drinking water. S. 1016 will allow us to meet the needs of the environment without subjecting our customers to a massive increase in water rates that would otherwise result.

Mr. Chairman, the U.S. Desalination Coalition also supports the enactment of S. 1860. I support increased research in this area and believe that the goals of your legislation are consistent with and complementary to the goals of S. 1016.

In conclusion, thank you again for holding today's hearing on these important pieces of legislation. We very much appreciate your leadership on this important issue and hope that the committee will move promptly to pass both S. 1016 and S. 1860.

[The prepared statement of Mr. Reynolds follows:]

PREPARED STATEMENT OF JIM REYNOLDS, EXECUTIVE DIRECTOR, FLORIDA KEYS AQUEDUCT AUTHORITY, ON BEHALF OF THE U.S. DESALINATION COALITION

Chairman Domenici and Members of the Committee, my name is Jim Reynolds. I am the Executive Director of Florida Keys Aqueduct Authority and I serve on the Board of Directors of the U.S. Desalination Coalition. I very much appreciate having the opportunity to testify today in support of S. 1016, the Desalination Water Supply Shortage Prevention Act of 2005.

The Florida Keys Aqueduct Authority is the sole provider of potable water for all the residents of the Florida Keys and presently serves over 44,000 customers in Monroe County. Like water resource managers throughout the United States, we are struggling to address the long-term challenges posed by drought, increasing population, and competing demands from business, agriculture, and the environment. These challenges led us to join together with water agencies and utilities from other States including California, Texas, Hawaii, and New Mexico to form the U.S. Desalination Coalition, a group dedicated to advocating an increased Federal role in advancing desalination. Seawater and brackish water are virtually inexhaustible resources that can be tapped as a viable long term tool for meeting our Nation's growing water supply needs.

Drought, increasing population, and competing demands from business, agriculture and the environment for limited water supplies has taken us to the brink. The reservation of fresh water for the natural systems to maintain a sustainable environment and protection against drought are concerns throughout the Country. The economic, social, and environmental consequences of a water supply crisis are not local or regional in nature. It is a national problem and I believe that it demands the attention of Congress.

The ultimate goal of the U.S. Desalination Coalition is to encourage the Federal government to create a new program to provide financial assistance to water agencies and utilities that successfully develop desalination projects that treat both seawater and brackish water for municipal and industrial use. The Desalination Drought Prevention Act of 2005, introduced by Senator Martinez, will achieve this goal in a fiscally responsible way. Similar legislation has been introduced in the House of Representatives by Representatives Jim Davis of Florida and Jim Gibbons of Nevada and now has approximately 30 cosponsors. I am delighted to be here today in support of this legislation and tell you how it will positively affect the Florida Keys Aqueduct Authority and the State of Florida.

Despite the tremendous advances in desalination technology that have reduced the costs of desalinating water, energy costs remain quite high and are responsible for more than 30% of the overall cost of desalinated water. S. 1016 directs the Secretary of Energy to provide incentive payments to water agencies and utilities that successfully develop desalination projects. This would be a competitive, performance-based program that will help to offset the costs of treating seawater and brackish water. Under the proposed program, qualified desalination facilities would be eligible to receive payments of $0.62 for every 14 kW of electricity used for the initial ten years of a project's operation. The legislation would also insure that there is a balance in the amount of money going to seawater and brackish water projects in any one year.

The rationale for this approach is that while the cost of desalinating water has dropped dramatically over the last decade, the energy costs associated with desalination are still quite high. Most experts believe that these costs will continue to come down over time and that desalination will eventually be widespread. But waiting for this to occur is a luxury that, in my opinion, we cannot afford. A modest investment to jump-start the development of these projects and stimulate advances in desalination technology today is the smart thing to do.

It is true that the approach suggested in S. 1016 to encourage the development of seawater and brackish groundwater desalination projects is different from the traditional approach of providing construction grant funds. That difference is by design. While the availability of energy assistance grants will encourage the development of desalination projects, these grants will be performance based. In other words, the Federal government will bear none of the risk of project permitting and construction as it does under the construction grant approach. Only those projects that are technically, environmentally and economically sound, and have actually been constructed will be eligible to apply for the grants.

I am proud that the Florida Keys has historically been a leader in the development and use of desalination technology. In fact, the very first seawater desalination plant ever built in the United States was constructed in the 1840s to provide water to Fort Zachary Taylor in Key West. Today, the FKAA maintains desalination plants on Stock Island and in Marathon for use in case of emergencies or a disrup-

tion in service of our main pipeline that is 130 miles long and crosses 42 overseas bridges. These facilities produce freshwater from seawater, as a limited emergency source of potable water for the Lower and Middle Keys.

Passage of S. 1016 is of vital importance to the future of the Keys. The Aqueduct Authority currently obtains its water from the fresh groundwater Biscayne aquifer in Dade County. However, because of skyrocketing growth in south Florida and the needs of Everglades National Park, the South Florida Water Management District is setting limits on the amount of water our agency can withdraw from the aquifer. As a result, we are moving forward with a plan to supplement our water supplies by building a new, brackish water desalination facility in south Dade County that will produce 7 million gallons per day of fresh drinking water. S. 1016 will allow us to meet the needs of the environment without subjecting our customers to a massive increase in water rates that would otherwise result. I hope that you agree that potable water is not a luxury and that it is a necessity that must remain affordable especially too many of our citizens who are on low or fixed incomes.

Mr. Chairman, the U.S. Desalination Coalition also supports the enactment of S. 1860, the Energy—Water Efficiency Technology Research, Development, and Transfer Program Act of 2005. We support increased research in this area and believe that the goals of Senator Domenici's legislation are consistent with and complementary to the goals of S. 1016. As important as enhanced research of desalination technology may be, however, we do not believe that additional research should come in lieu of a federal investment of the development of actual projects that will provide clean and reliable water to families and businesses. In fact, a strong case can be made that we will learn a great deal about how to improve the efficiency of desalination technology through the development and operation of large-scale seawater and brackish groundwater desalination facilities.

We are very supportive of the program grants that would be authorized under S. 1860. We would hope that a significant portion of the grant funds to be made available under this program would be directed to water agencies and utilities developing desalination demonstration projects. These projects are often a precursor to the development of full scale desalination projects. The information derived from such projects can be very helpful in the continuing improvement of membrane technology, energy recovery systems, and pre-treatment techniques.

In conclusion, thank you again for holding today's hearing on these important pieces of legislation. We very much appreciate your leadership on this important issue and hope that the Committee will move promptly to pass both S. 1016 and S. 1860.

**STATEMENT OF EDMUND ARCHULETA, GENERAL MANAGER, EL PASO WATER UTILITIES, ON BEHALF OF WATEREUSE, EL PASO, TX**

Mr. ARCHULETA. Mr. Chairman and Members of the Committee, I am Ed Archuleta, general manager of the El Paso Water Utilities and I'm a current member of the board of directors of the WateReuse Foundation. I appreciate the opportunity to testify before you today on behalf WateReuse in support of S. 1860.

We're a non-profit organization whose mission is to advance the beneficial and efficient use of water resources through desalination, recycling, reuse, for the benefit of our members, the public, and the environment.

We've worked for a number of years with the Bureau of Reclamation, and a number of other agencies. And what I'd like to do, Senator, and members of the committee, is make certain points.

In El Paso, we have to work with multiple agencies, with Mexico, with New Mexico, with other counties in Texas. We also face a growing population much like Senator Martinez indicated in Florida. So we're all looking for new solutions and I think this bill and the opportunity it brings will allow for that. So we're in very strong support of S. 1860.

In El Paso—you talked a few minutes ago about arsenic. The Rio Grande has faced, for a number of years now, significant drought.

Three years ago, we had to go beyond our surface water supplies from the river, plus the ground water. We knew that we had some wells that had had brackish ground water intrusion. They have been "abandoned" for some time.

And we decided, why not put those back in service, installing skid mounted reverse osmosis. They also happened to be high in arsenic compared to the new standard. So we put in 11 wellhead reverse osmosis units and we solved three problems—one of salinity, one of arsenic, and the third important one, which is, of course, drought.

So we were able to get through the drought, simply by applying this type of technology. We purchased the—in this case, the General Electric Osmonic system, and they work perfectly fine. We started a few years ago to work with Fort Bliss, which is a military installation, to develop a large scale desalination plant. We just started construction of that in July, on what's going to be the world's largest inland desalination plant.

We knew through geology that there were some areas within Fort Bliss property that would be ideal for concentrated disposal by deep well injection. And that's how we're going to be able to deal with that concentrated waste. But we are looking for the research that's going to give us better solutions to the disposal of this concentrate. And that's one of the prime reasons we support this type of legislation.

We've worked, as have others, with the national laboratories, particularly Sandia National Laboratories, and we understand and appreciate the expertise that they bring.

However, members of the committee, one of the things that we'd like you to consider is to partner with the water utilities that make up the WateReuse, as we have for example on the arsenic research, and involve us in this process so that we become part of the solution, if you will, with real-life-type implementation of the research to see if we can get these to market sooner.

For example, we recently developed a partnership between our utility, El Paso Water Utilities, the New Mexico State University, the University of Texas at El Paso, and the city of Alamogordo, New Mexico, to develop a partnership with Sandia Labs on three initial projects. So the partnership could use the support of S. 1860.

Certainly, in times of Federal deficits, we believe the best way to address these national priorities is to create this Federal/local research partnership. And WateReuse stands ready, both with its research expertise as well as a portion of the utility generated income, to support the goals of good legislation.

Again, WateReuse thanks you, Mr. Chairman, and Senator Bingaman, who has left the room. I know, Senator, that both you and Senator Bingaman will be with us in Albuquerque in early December when the Multi-State Salinity Coalition, which is a national coalition of water agencies interested in desalination, meets in Albuquerque on December 8 and 9.

So with that, Mr. Chairman, I would be pleased to respond to any questions you or the other members may have.

[The prepared statement of Mr. Archuleta follows:]

PREPARED STATEMENT OF EDMUND ARCHULETA, GENERAL MANAGER, EL PASO WATER UTILITIES, EL PASO, TX, ON BEHALF OF THE WATEREUSE ASSOCIATION

Mr. Chairman and Members of the Committee, I am Ed Archuleta, General Manager of the El Paso Water Utilities and a current member of the Board of Directors of the Water Reuse Foundation (WateReuse). I appreciate the opportunity to testify before you today on behalf WateReuse in support of S. 1860, the *Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005*.

The WateReuse Association (WateReuse) is a non-profit organization whose mission is to advance the beneficial and efficient use of water resources through education, sound science, and technology using reclamation, recycling, reuse, and desalination for the benefit of our members, the public, and the environment. Across the United States and the world, communities are facing water supply challenges due to increasing demand, drought, and dependence on a single source of supply. WateReuse addresses these challenges by working with local agencies to implement water reuse and desalination projects that resolve water resource issues and create value for communities. The vision of WateReuse is to be the leading voice for reclamation, recycling, reuse, and desalination in the development and utilization of new sources of high quality water.

WateReuse assists its members in implementing projects that solve these water supply challenges for local communities by:

- sponsoring research that advances the science of water reuse and focuses on the Association's commitment to providing high-quality water, protecting public health, and improving the environment;
- reaching out to members, the public, and local leaders and officials with information that communicates the value and benefits of water reuse; and
- encouraging additional Federal support for water reuse, including funding for research and local projects.

WateReuse members use advanced treatment processes and monitoring to produce water of sufficient quality for the intended purpose from treated municipal and industrial effluent, storm water, agricultural drainage, and sources with high salinity such as seawater and brackish water.

The Association's membership is growing rapidly as more communities around the nation recognize the need to reuse water and develop alternative supplies. WateReuse now has more than 310 organizational members nationwide, including more than 150 local water and wastewater agencies.

The Association has developed a successful cost-shared research program with the U.S. Bureau of Reclamation (USBR) and other research organizations through its WateReuse Foundation. The Foundation is engaged in conducting "leading edge" applied research on important and timely issues, including: 1) evaluating methods for managing salinity, including the disposal of concentrates from membrane treatment systems; 2) working cooperatively with USBR, Sandia National Laboratories, and through the Joint Water Reuse & Desalination Task Force (JWR&DTF) to implement the *Desalination and Water Purification Technologies Roadmap* developed in 2003 by Sandia and USBR; 3) evaluating ways to advance public acceptance of indirect potable reuse; 4) understanding the occurrence and fate of emerging contaminants, such as endocrine disrupting compounds, in conventional and advanced water recycling systems; and 5) gaining a better understanding of water quality changes that might occur in aquifer storage and recovery (ASR). The WateReuse Foundation currently has a water reuse and desalination research portfolio consisting of more than 50 active projects with a value of more than $10 million.

My utility in El Paso must work with multiple jurisdictions including the United States and Mexico, Texas and New Mexico, and multiple counties, all of which face the challenge of providing water resources to a growing population in an arid region of our country. This experience, and my service as Chairman of the AwwaRF Board of Trustees and as a Board Member of the Water Reuse Foundation has convinced me that it is essential for our nation to identify and develop new technologies to treat new sources of water, including brackish groundwater, and to do so in the most energy efficient manner possible. Senator Domenici, the water community is deeply appreciative of your leadership and vision as exhibited in S. 1860 that provides the framework for this crucial enterprise.

S. 1860 AND THE IMPORTANCE OF A COMPREHENSIVE APPROACH TO THE NATION'S ENERGY-WATER NEEDS

The importance of the energy-water nexus has become apparent to water and energy professionals at all levels of government. Water is critical to the production of energy and, conversely, energy is needed for water production. Water and waste-

water utilities consume approximately 3% of the nation's electrical energy to pump, treat, store, and distribute water.

In the future, the nation will depend more and more on the availability of "alternative water supplies," primarily reclaimed and reused waters and the desalination of seawater and brackish groundwater. In order for these two sources of "new water" to be cost-effective, research is needed to drive down the costs. For example, the new Tampa Bay Water desalination facility will produce water at a currently estimated cost of $2.54/1000 gallons. By contrast, the cost of wholesale water from the Metropolitan Water District of Southern California to its customers is approximately $1.50/1000 gallons. It is this differential of about a dollar per thousand gallons that must be addressed through research.

Similar research is needed for water reuse since many of its applications require membrane applications. For example, Orange County Water District in California currently is designing and constructing its Groundwater Replenishment System (GWRS) at a cost of $487 million. The technologies utilized are microfiltration, ultraviolet irradiation, and reverse osmosis—technologies that also are used in desalination.

In El Paso, we are in the process of constructing what will be the world's largest inland desalination facility. One of the technologies featured will be reverse osmosis. One of the greatest challenges facing us will be the disposal of concentrate resulting from the removal of salts and other solids. The types of research envisioned in S. 1860 would likely benefit El Paso in two very tangible ways: 1) reduction of the energy costs of the membrane technologies employed; and 2) development of better and less expensive means of the disposal of concentrate.

WateReuse is strongly supportive of S. 1860 for two basic reasons. First, we believe that research will benefit the entire water community by driving down costs and facilitating the development of new technologies that will allow water utilities to resolve difficult challenges such as concentrate disposal. Second, in the arid West and Southwest, the annual rainfall ranges from about seven inches to 12 inches per year. To accommodate the rapid population growth that is occurring in Texas, New Mexico, Arizona, Nevada, and southern California, we need to be able to reclaim and reuse our wastewater and we need to be able to desalinate water in a cost-effective manner. Only research will allow us to do that.

According to the *Desalination and Water Purification Technology Roadmap*, "by 2020, desalination and water purification technologies will contribute significantly to ensuring a safe, sustainable, affordable, and adequate water supply for the United States." For this to happen, however, a substantial research investment will be needed to find a way to reduce the capital and operating costs. Although desalination has several advantages, it will always have two huge technical challenges: 1) removal of as much as 35,000 milligrams per liter (i.e., 3.5% by volume) of salt and other impurities; and 2) disposal of the brine concentrate that is a by-product of the treatment process. The WateReuse Foundation, working in conjunction with Sandia National Laboratories and the U.S. Bureau of Reclamation through the JWR&DTF, is heavily engaged in conducting research on innovative, cost-effective methods of concentrate disposal and sponsoring research on membrane technologies and alternative technologies.

The scientific expertise of our national laboratories is something that we all recognize and we are excited over the prospect of having some of these capabilities focused upon developing new, energy efficient water treatment technologies. The purpose of my testimony today to better acquaint the Committee with what we consider the other crucial aspect of this enterprise which is to ensure that these new technologies are applicable to, and implementable by, water agencies. Based upon my experience in running a water agency and also in working with my fellow Board Members at WateReuse and Trustees at AwwaRF, there is often a wide gap between what seems to work in a laboratory and what does indeed work at a water treatment facility and also what will be approved for use by state regulatory agencies.

S. 1860 challenges three of our national laboratories to identify groundbreaking new approaches to water treatment. I believe they will be successful in this endeavor. But it is also essential that the research expertise of the water community, as embodied by organizations such as WateReuse, should also be made a part of the research agenda. I am not referring here to technology transfer activities, but rather how S. 1860 can create the framework for a true working research partnership between the national labs and the water community. For example, within the past three months, a partnership of El Paso Water Utilities, New Mexico State University, Texas A&M, the University of Texas at El Paso, and the City of Alamogordo (CHIWAWA) have initiated three desal research projects with Sandia Labs. We will be meeting in Albuquerque in early December at the time of the Multi-State Salin-

ity Conference to discuss the parameters of the research program and agree on our research schedule. This partnership could use the support of S. 1860 could provide.

CHIWAWA's (Consortium for High Tech Investigations of Water and Wastewater) work with Sandia is aimed at ensuring that cutting edge next generation technologies developed by the national laboratories also have the benefit of the practical research expertise offered by our research organizations. WateReuse has a proven track record of cooperation in developing and executing research that is of direct practical use by the very utilities that provide their financial support. For example, it has enabled water utilities to comply with an ever expanding regulatory scheme at a cost less than the expected compliance cost without such research. Direct involvement by utilities assures that research is driven by practical need rather than academic interest and increases dramatically the likelihood of adoption and implementation by the water community.

In addition to WateReuse and research management capabilities, the financial support from our more than 1000 subscribing water and wastewater agencies allow us to provide local funding to leverage those of the federal government. The WateReuse Foundation, through contributions from its Subscribers, local water and wastewater agencies, and state agencies, has leveraged funds received from the U.S. Bureau of Reclamation by a factor of more than 3:1. We believe that in these times of federal deficits the best way to address the national priorities outlined in S. 1860 is to create a federal-local research partnership which includes investment from all levels of government. WateReuse stands ready with both its research expertise and a portion of its utility generated income to support the goals of your legislation.

WateReuse notes that today's hearing is also examining innovative ways to finance desalination technologies. Specifically, S. 1016 would, if enacted, provide operating subsidies for facilities to subsidize energy costs. WateReuse has supported strong federal partnerships for water supply facilities and during these times of fiscal austerity, we believe that creative financing mechanisms hold the promise of maintaining a federal partnership. At the same time, the ability to drive down the overall costs of producing alternative water supplies ranging from technology to disposal of byproducts is equally important. Research and technology demonstration holds the promise of delivering on this priority. We hope that as the committee considers tools like operating subsidies that it also target research needs.

Again, WateReuse thanks you, Mr. Chairman and Senator Bingaman, for convening this hearing. We would be pleased to work with you in addressing critical issues related to energy-water efficiency and water technology research. We strongly support the Committee's leadership efforts to ensure adequate and safe water supplies for the entire country in the 21st century. Also, I want to thank you both for agreeing to be speakers at the Multi-State Salinity Conference in Albuquerque on December 8 and 9.

At this time, Mr. Chairman, I would be pleased to respond to any questions you or the other members may have.

**STATEMENT OF PANKAJ PAREKH, Ph.D., DIRECTOR OF DRINKING WATER QUALITY COMPLIANCE, ON BEHALF OF THE AWWA RESEARCH FOUNDATION**

Mr. PAREKH. Mr. Chairman and members of the committee, I am Pankaj Parekh of the Los Angeles Department of Power and Water, and also chair of the Awwa Research Foundation's committee for tailored collaboration.

I appreciate the opportunity to testify before you today on behalf of the AwwaRF and in strong support of S. 1860. There is a consensus among the water supply community that it is essential for our Nation to identify and develop innovative technologies to treat new sources of water, including brackish groundwater and sea water, and to do so in the most energy-efficient manner possible and with the least disruption of the environment. The water supply community is deeply grateful and appreciative of the leadership and vision as exhibited in S. 1860 that provides the framework for this crucial enterprise.

AwwaRF's priority is to address, through research, the most pressing needs of the water community. Over the past decade and

a half, these challenges have included the control and reduction of disinfection byproducts, cryptosporidium, perchlorate, and arsenic, to name only a few.

In each case, AwwaRF-sponsored research has taken a leading role in ensuring that water utilities have had the tools necessary to meet these challenges and to continue to fulfill their obligation to provide safe and affordable drinking water to the public. We believe that S. 1860 offers not just the vision and promise of how to achieve these ends, but also a practical roadmap for a Federal-local partnership that will allow the water supply community to meet its obligations to the public.

AwwaRF is a member-supported, international, non-profit organization that sponsors research to enable water utilities, public health agencies, and other professionals to provide safe and affordable drinking water to consumers. Our more than 900 subscribing water utilities in the United States and in seven foreign countries invest $2.05 per every million gallons of delivered water into the research subscription program administered by AwwaRF. This produces over $13,000,000 in income each year, which we leverage with in-kind contributions from researchers and in funding partnerships, which include a number of Federal agencies.

Over the past quarter of a century, AwwaRF has invested and leveraged over $370 million in over 900 research projects which address desalination and water treatment other programs. This includes a number of projects which address arsenic treatment and treatment technologies, including our current research partnership with Sandia National Labs and WERC at New Mexico State University and our cooperative agreement with Sandia National Labs, U.S. Bureau of Reclamation and WateReuse through the Joint Water Reuse and Desalination Task Force to implement the Desalination and Water Purification Roadmap developed in 2003 by Sandia and USBR.

All AwwaRF research is done by sub-agreement with water utilities, universities, private research organizations, consulting engineering firms. This sub-agreement approach allows the Foundation to avoid the cost of equipping and maintaining separate laboratories and instead enables us to leverage existing facilities throughout the academic and water supply communities in support of our research.

AwwaRF's staff of over 50 manages this research. The results are published in the form of a final report which is widely disseminated. AwwaRF also conducts an ongoing program of technology transfer conferences and periodicals that bring the latest in priority research directly to water agencies. AwwaRF holds no patents on any technology that is developed through our research but instead publishes and disseminates its research results to a wide audience.

The scientific expertise of our national labs is well recognized and we are excited over the prospect of having some of these capabilities focused upon developing new, energy efficient water treatment technologies. The purpose of my testimony today is to better acquaint the committee with what we consider the other crucial aspect of this enterprise to ensure that these new technologies are applicable to, and implementable by, water agencies.

Less than 2 weeks ago, AwwaRF, as part of the Arsenic Water Technology Partnership, was privileged to participate in an arsenic workshop in Albuquerque attended by you, Mr. Chairman. The topic of concern was the pending EPA arsenic regulation and how utilities, particularly smaller ones, are going to meet the new Federal standards.

There were dozens of representatives from New Mexico water agencies at the workshop and it was obvious how much these agencies are in need of affordable technologies which will enable them to comply with the EPA-mandated arsenic standards. Their concern reminded us of how crucial it is that the knowledge that will be produced by S. 1860 be applicable and usable at the local level and with all sizes of utilities to solve water supply problems.

But based upon my experience, both with my own water agency and with the larger water supply community, there is often a wide gap between what seems to work in a lab and what does indeed work at a water treatment facility, and also what will be approved for use by State and Federal regulatory agencies.

S. 1860 challenges three of our national laboratories to identify groundbreaking new approaches to water treatment. But it is also essential that the research expertise of the water community, as embodied by organizations such as AwwaRF, be a partner in this research. I am not referring here to technology transfer activities, but rather how S. 1860 can create the framework for a true and dynamic working research partnership between the national labs and the water community.

This ensures that cutting-edge, next-generation technologies developed by the national laboratories also have the concurrent benefit of the practical research expertise offered by AwwaRF. With more than a third of a billion dollars in either completed or ongoing research backed by hundreds of researchers and thousands of project advisory volunteers, AwwaRF offers this capability to the S. 1860 process at the outset of this journey.

As a long-standing and familiar supporter of good and useful water research, I cannot overemphasize how much the early and direct involvement of utilities during technology research and development dramatically increases the likelihood of adoption and implementation of the new technologies by the water supply community.

In addition, such collaboration expedites the application of research results in the field. In addition to AwwaRF's groundbreaking research, expertise and management capabilities, we offer the financial support of our more than 900 subscribing water agencies. Their annual investment in the research subscription program allows us to offer a local leverage for Federal funds.

In closing, we wish to once again express our appreciation to you, Mr. Chairman, and the committee, for holding this hearing and for the introduction of S. 1860. We hope that this testimony has provided the committee with some food for thought with regard to the need to drive the research strategy to its ultimate application at a utility level, and also consider the readily available venue offered by AwwaRF to further leverage the cost-sharing potential with water utilities in support of the goals of S. 1860.

The challenges and the vision embodied in this legislation are as important to the water community as those of a century ago when drinking water disinfection rapidly became the norm and saved countless lives. The resulting public good was crucial for our national well-being in the 20th century. We believe that S. 1860 is a true bridge to helping us meet the challenges of the 21st century in providing adequate water supplies and energy to the Nation and we thank you for the opportunity to present our thoughts.

[The prepared statement of Mr. Parekh follows:]

PREPARED STATEMENT OF PANKAJ PAREKH, PH.D., ON BEHALF OF THE AWWA RESEARCH FOUNDATION

Mr. Chairman and Members of the Committee, I am Pankaj Parekh of the Los Angeles Department of Power and Water, and also Chair of the Awwa Research Foundation's committee for tailored collaboration. I appreciate the opportunity to testify before you today on behalf of the Awwa Research Foundation, [AwwaRF] and in strong support of S. 1860, the Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005. There is a consensus among the water supply community that it is essential for our nation to identify and develop innovative technologies to treat new sources of water, including brackish groundwater and sea water, and to do so in the most energy-efficient manner possible and with the least disruption of the environment. The water supply community is deeply grateful and appreciative of the leadership and vision as exhibited in S. 1860 that provides the framework for this crucial enterprise.

AwwaRF's priority is to address, through research, the most pressing needs of the water community. Over the past decade and a half, these challenges have included the control and reduction of disinfection by-products, cryptosporidium, perchlorate, and arsenic, to name only a few. In each case, AwwaRF sponsored research has taken a leading role in ensuring that water utilities have had the tools necessary to meet these challenges and to continue to fulfill their obligation to provide safe and affordable drinking water to the public. S. 1860 focuses not just on drinking water contaminants but how our nation can access previously unusable water sources to meet the water supply challenges of the 21st century. One of the few certainties that we all live with is the fact that there is no "new" water on the face of the earth. Faced with this reality there is no alternative but to identify and develop cost-effective treatments that will allow our nation to make use of all available water sources to help us meet the 21st century needs of our growing population. The prospect of cost-effective and energy-efficient technologies to address this challenge is truly exciting to all of us. We believe that S. 1860 offers not just the vision and promise of how to achieve these ends but also a practical roadmap for a federal-local partnership that will allow the water supply community to meet its obligations to the public and to do so well into the 21st century.

AwwaRF is a member-supported, international non-profit organization that sponsors research to enable water utilities, public health agencies, and other professionals to provide safe and affordable drinking water to consumers. Our more than 900 subscribing water utilities in the United States and in seven foreign countries invest $2.05 per every million gallons of delivered water into the research subscription program administered by AwwaRF. This produces over $13,000,000 in income each year which we leverage with in-kind contributions from researchers and in funding partnerships which include a number of Federal agencies. Over the past quarter of a century, AwwaRF has invested and leveraged over $370 million in over 900 research projects on all aspects of drinking water treatment and supply. This includes a number of projects which address desalination and arsenic treatment, including our current research partnership with Sandia National Labs and WERC at New Mexico State University and our cooperative agreement with Sandia National Labs, U.S. Bureau of Reclamation (USBR) and WateReuse through the Joint Water Reuse and Desalination Task Force to implement the Desalination and Water Purification Roadmap developed in 2003 by Sandia and USBR.

All AwwaRF research is done by sub-agreement with water utilities, universities, private research organizations, consulting engineering firms, and other qualified organizations. This sub-agreement approach allows the Foundation to avoid the cost of equipping and maintaining separate laboratories and instead enables us to leverage existing facilities throughout the academic and water supply communities in support of our research. AwwaRF's staff of over 50 manages this research. The results are published in the form of a final report which is widely disseminated

throughout the water community and with federal and state agencies. AwwaRF also conducts an ongoing program of technology transfer conferences and periodicals that bring the latest in priority research directly to water agencies. AwwaRF holds no patents on any technology that is developed through our research but instead publishes and disseminates its research results to a wide audience. Interested parties are then free to use this knowledge and develop these technologies for commercial application that ultimately improve protection of public health.

The scientific expertise of our national labs is well recognized and we are excited over the prospect of having some of these capabilities focused upon developing new, energy efficient water treatment technologies. The purpose of my testimony today is to better acquaint the Committee with what we consider the other crucial aspect of this enterprise to ensure that these new technologies are applicable to, and implementable by water agencies. Less than two weeks ago, AwwaRF, as part of the Arsenic Water Technology Partnership was privileged to participate in an arsenic workshop in Albuquerque attended by you, Mr. Chairman. The topic of concern was the pending EPA arsenic regulation and how utilities, particularly smaller ones, are going to meet the new federal standards. There were dozens of representatives from New Mexico water agencies at the workshop and it was obvious how much these agencies are in need of affordable technologies which will enable them to comply with the EPA mandated arsenic standards. Their concern reminded us of how crucial it is that the knowledge that will be produced by S. 1860 be applicable and usable at the local level and with all sizes of utilities to solve water supply problems. But based upon my experience both with my own water agency and with the larger water supply community, there is often a wide gap between what seems to work in a laboratory and what does indeed work at a water treatment facility and also what will be approved for use by state and federal regulatory agencies.

S. 1860 challenges three of our national laboratories to identify groundbreaking new approaches to water treatment with particular emphasis on desalination technologies. I believe they will be successful in this endeavor. But it is also essential that the research expertise of the water community, as embodied by organizations such as AwwaRF, be a partner in this research. I am not referring here to technology transfer activities, but rather how S. 1860 can create the framework for a true and dynamic working research partnership between the national labs and the water community. This ensures that cutting edge next generation technologies developed by the national laboratories also have the concurrent benefit of the practical research expertise offered by AwwaRF. With more than a third of a billion dollars in either completed or ongoing research backed by hundreds of researchers and thousands of project advisory volunteers, AwwaRF offers this capability to the S. 1860 process at the outset of this journey. As a long-standing and familiar supporter of good and useful water research, I cannot over-emphasize how much the early and direct involvement by utilities during technology research and development dramatically increases the likelihood of adoption and implementation of the new technologies by the water supply community. In addition, such collaboration expedites the application of research results in the field.

AwwaRF has pioneered the transfer of membrane technology from other industries into the water supply sector. Membranes hold the promise of drastically reducing the cost of utilities in meeting EPA's Surface Water Treatment Rule and are the backbone of desalination efforts in turning brackish waters into pure drinking water. AwwaRF research proved the efficacy of UV light to inactivate Cryptosporidium, which is a much more cost effective technology and will likely save water and wastewater utilities hundreds of million of dollars. When perchlorate threatened several California water supplies, AwwaRF research developed practical removal methods using available technology to save millions of dollars and provide safe water to affected communities.

In addition to AwwaRF's ground breaking research expertise and management capabilities, we offer the financial support of our more than 900 subscribing water agencies. Their annual investment in the research subscription program allows us to offer a local leverage for federal funds. Since 1983, AwwaRF has provided a nearly seven to one match for EPA and DOE funding which it has received from the Congress. The goals embodied in S. 1860 are so important to water agencies throughout the United States and the world that AwwaRF would be willing to provide a substantial cash and in-kind match along with our research management expertise in support of the initiatives addressed in S. 1860. We believe that in these times of federal deficits the best way to address the national priorities outlined in this legislation is to create a federal-local research partnership which includes investment from all levels of government. AwwaRF stands ready with both its research expertise and a portion of its utility generated income in support of the goals of your legislation.

AwwaRF is also aware that the Committee is considering 5.1016 today and that this legislation provides for incentive payment to owners of qualified desalination facilities to partially offset the cost of electrical energy required to operate their facilities. S. 1016 calls attention to a large and growing concern among water utilities which is how to pay for the cost of electricity associated with water treatment. The development of innovative technologies under discussion today at this hearing will require ever growing amounts of electrical power which will grow increasingly expensive in the future. Funding partnerships between water agencies and the federal government, as proposed by S. 1016, are one option for addressing this challenge. AwwaRF has long been involved with the research aspects associated with the cost of electricity, including $6M invested in 18 projects and research partnerships with interested parties such as the California Energy Commission. Paying for the energy costs associated with water treatment is a major concern and priority throughout the water supply community and we appreciate the fact that the Committee is addressing this issue in its hearings today.

In closing, we wish to once again express our appreciation to you, Mr. Chairman and the Committee for holding this hearing and for the introduction of S. 1860. We hope that this testimony has provided the Committee with some food for thought with regard to the need to drive the research strategy to its ultimate application at a utility level and also consider the readily available venue offered by AwwaRF to further leverage the cost-sharing potential with water utilities in support of the goals of S. 1860. The challenges and the vision embodied in this legislation are as important to the water community as those of a century ago when drinking water disinfection rapidly became the norm and saved countless lives. The resulting public good was crucial for our national wellbeing in the 20th century. We believe that S. 1860 is a true bridge to helping us meet the challenges of the 21st century in providing adequate water supplies and energy to the nation and we thank you for the opportunity to present our thoughts.

**STATEMENT OF COLIN SABOL, CHIEF MARKETING OFFICER, GE INFRASTRUCTURE WATER & PROCESS TECHNOLOGIES, TREVOSE, PA**

Mr. SABOL. Thank you, Mr. Chairman, and members of the committee, for inviting me to appear here today before you. GE Water is a leading provider of water treatment systems and services, with over 6,000 working in 50 countries around the world.

We create new sources of fresh water for millions of people living in water-scarce regions of the world and conserve billions of gallons of water annually. Membrane technology is the key to creating new water sources, but remains a costly alternative to surface water treatment.

GE and others are making great strides in reducing the cost of these technologies, but we have a long way to go to achieve the levels that will drive broad adoption, and doing so requires much greater levels of investment.

The 2,500 scientists at the GE Global Research Center are pursuing a number of longer-term water scarcity research programs that could substantially lower the overall cost of new water. Such programs include nanotechnologies, smart membranes, advanced pretreatment processes and remote monitoring and diagnostics. We have reviewed the two bills and would like to share our perspective on some aspects of each.

With respect to S. 1016, we recognize the value of subsidies, and given the inflated cost of energy, short term assistance, via these subsidies, will help water-scarce communities more rapidly adopt today's current technologies. It seems possible, however, that S. 1016 could cause unintended consequences, such as encouraging communities to install current technologies that are less efficient

and dissuade them from implementing more efficient technologies when they come in the future.

The long term solution to producing economical sources of new water lies in developing advanced energy-efficient technologies, and S. 1860 represents an incredibly important step in that direction. We are confident that this funding is very likely to drive a 30 percent reduction in operating costs and a 25 percent reduction in capital costs in the next 5 years.

We believe that it is essential for the bill to focus more on the process of driving commercialization of funded research proposals. Based on GE's experience developing and commercializing technologies around the world, we'd like to suggest that you consider the following:

No. 1, lead laboratories and advisory panel should select at least one industry partner to participate in every program, to guide and validate the commercial aspects from initiation through commercialization.

No. 2, to encourage full engagement from companies with global commercialization experience and technical depth. Grants to these parties should be at least a million dollars per year.

No. 3, a stage-gate development process. Administration of the research grants should be separated into phases, and aligned with a classic stage-gate product development process. GE's adoption of such a product development process has dramatically increased our commercialization success rate. Funding for each stage of the grant should absolutely be contingent on successfully meeting the requirements of each gate.

GE looks forward to working with policymakers, users, and the technical community to create safe, affordable new water sources for this country and the world. Thank you, Mr. Chairman and members of the committee. I'm happy to take questions.

[The prepared statement of Mr. Sabol follows:]

PREPARED STATEMENT OF COLIN SABOL, CHIEF MARKETING OFFICER, GE INFRASTRUCTURE

INTRODUCTION

Chairman Domenici, Senator Bingaman and members of the Committee, today it is my honor to share with you GE's thoughts on both the recently submitted "Energy-Water Efficiency Technology Research, Development, and Transfer Act of 2005" (S. 1860) and the "Desalination Water Supply Shortage Prevention Act of 2005" (S. 1016).

BACKGROUND

By way of background, GE is a global leader in diverse technologies and one of the world's most recognized brands. Through our Research and Product Development programs, we consistently provide our customers with advanced technologies to generate power, purify and treat water, reduce emissions, increase energy efficiency, enhance safety and security, and improve health care.

GE Water & Process Technologies is a leading global provider of water treatment systems and services. Our treatment systems create safe, affordable "New Water" for millions of people living in water-scarce regions of the world from many sources, including ground water, surface water, sea water and recovered wastewater. In addition, water is the lifeblood of industry, and our products and services conserve billions of gallons of water annually for our industrial customers. GE creates this New Water using multiple technologies, including reverse osmosis, electrodialysis, and treatment systems that remove impurities and improve water quality.

WATER SCARCITY IS SPREADING

As population increases and industrial development expands, the stress on water resources will continue to increase. According to the World Meteorological Organization, the number of people living in regions defined as "stressed" and "high stress" will increase from 4 billion in 1995 to nearly 6 billion in 2025—an increase of 50% in 30 years. (Figure 1).*

This is a global trend that can also be felt in the U.S. due to shifts in population and impairment of existing water resources. For example:

- Increasing populations and high demand are depleting freshwater aquifers in the southwest U.S.;
- Groundwater contamination is a growing problem in New England;
- Competition for water access in the Colorado river basin have created far-reaching economic and political tensions in that region;
- Lead and bacteria contamination have affected drinking water supplies in areas, including here in Washington DC.

Paradoxically, many regions of high stress have abundant water supplies nearby. The problem is one of access to clean, usable water. There are technology solutions to this problem. GE and other companies are able to provide technologies to convert seawater, brackish water and recovered water into useful water supplies. As demand increases, it will become increasingly important to reduce the cost to treat and purify water.

ECONOMICS OF WATER TREATMENT AND DESALINATION

Water treatment costs vary by the amount of salt removal, cost of energy, size of plant, as well as the type of treatment technology. As shown in Figure 2, different water resources require different treatment technologies, and higher salinities have higher costs.

Desalination costs are dominated by capital investment, energy and maintenance costs. (Figure 3) Reverse osmosis systems, which utilize membrane technology for water treatment, have the lowest cost of operations, especially in areas with high power cost.

TECHNOLOGY ADVANCES HAVE REDUCED COST OF CLEAN WATER

GE and others have made great strides in reducing the cost of desalinating seawater using membranes, from over $20/K-gal in 1980 to under $4/K-gal today (Figure 4).

While membrane technology advances have resulted in significant cost reductions, energy still accounts for up to 60% of the operating cost (Figure 5). Further improvements in energy efficiency will deliver sustainable reductions in operating cost. Along with improvements in energy efficiency, improvements in membrane performance and membrane life through integrated treatment systems can reduce capital cost and life cycle cost.

ROADMAP FOR SUSTAINABLE REDUCTION IN CLEAN WATER COSTS

Membrane-based treatment solutions are essential to creating new water sources such as brackish water aquifers, seawater, and even wastewater. Membrane based desalination and reuse is a proven solution, but a broader application of these technologies to create meaningful new water sources requires investment to further reduce the energy consumption associated with the operation of membrane systems.

Significant improvements in clean water cost can be achieved by investing in the development of:

- New membrane and other separation technologies that require less energy than today's best available technology.
- New longer life membrane technologies that are resistant to chlorine and other chemicals to reduce maintenance and replacement costs.
- Advanced membrane systems with increased capacity per capital cost;
- Higher efficiency of energy recovery systems to reduce energy costs;
- Integrated water-treatment, energy-generation systems to increase overall energy and water production efficiency.

GE is already investing in research to develop membranes that have lower energy consumption, improved life, and innovative integrated treatment systems such as

*Figures 1-6 have been retained in committee files.

the integration of membrane-based desalination and energy generated from wind turbines.

GE is also evaluating whether to embark upon a number of far-reaching, longer-term water scarcity research programs that could result in disruptive desalination and reuse technologies that would substantially reduce energy consumption, increase throughput, and thus substantially lower the overall cost of New Water. Such potential programs include nanotechnologies; "smart" membranes (with pores that adjust so that they can perform selective separation); a 10X simplification in pretreatment processes; and advanced remote monitoring and diagnostics.

We are committed to continuing our efforts in these areas, but government support would enable us to accelerate existing programs, and to pursue altogether new research programs.

COMMENTS AND RECOMMENDATIONS

We have reviewed the "Desalination Water Supply Shortage Prevention Act of 2005" (S. 1016) and the "Energy-Water Efficiency Technology Research, Development, and Transfer Act of 2005" (S. 1860), and we would like to share our perspectives on certain aspects of each.

With respect to the "Desalination Water Supply Shortage Prevention Act of 2005" (S. 1016), we recognize the value of subsidies as effective means to encourage early adoption and deployment of water treatment solutions that exist today. And for communities in need, especially given the inflated costs of energy today, short-term assistance with energy subsidies will help those communities more rapidly adopt today's technologies.

However, it seems possible that S. 1016 could inadvertently drive undesirable outcomes. For example, it is possible that energy subsidies would encourage certain communities to implement inefficient New Water technologies. Once such technologies are installed, they could dissuade a community from implementing newer, more efficient technologies.

Consequently, we believe that the long-term, sustainable solution to producing economical sources of New Water lies in developing more advanced, energy-efficient technologies to treat multiple water sources. And, we believe that the "Energy-Water Efficiency Technology Research, Development, and Transfer Act of 2005" (S. 1860) would be an important step towards realizing such new energy-efficient technologies.

As a practical matter, we believe that substantial incremental funding for research and development would significantly accelerate the development of economical sources of New Water. We further believe that the S. 1860 is focused on the right set of research and development programs. More specifically, we believe that a broad research and development program aimed at membrane advancements, improved 'Total System' energy efficiency, and integrated water-renewable energy systems could lead to a 30% reduction in operating costs and a 25% reduction of capital costs in the next five plus years, with significant reductions achievable in the next one to three years. Such advances would be consistent with what GE and others in the industry have achieved in the past. (As Figure 4 showed, the cost of desalinating seawater using membranes has dropped from over $20/K-gal in 1980 to under $4/K-gal today.)

We also believe that it makes sense to begin with a Technology Roadmap. However, the development of this roadmap could be expedited by building on the Desalination and Water Reuse Technology Roadmap that was published by the U.S. Bureau of Reclamation and Sandia National Labs in 2003. The new Roadmap should—in addition to definitively outlining the current state of best available technologies and near-term technological advancements—take a longer-term view and explore potential breakthrough areas for energy-water efficiency technologies.

In addition, we believe that it is absolutely essential for the Bill to focus more on the process of driving commercialization of funded research proposals. Based on GE's own experience developing and commercializing technologically advanced products around the world, we would like to share the following suggestions for enhancing the prospects for successful technology transfer and commercialization:

1) Grant Size: Private sector grants should be at least $1,000,000 per year. Such a grant size will encourage "bigger ideas" and draw proposals from a wider base of experienced research and development organizations.

2) Industry Partners: The Lead Laboratories and the Advisory Panel should select at least one Industry partner to participate in each program. The Industry partners could participate as advocates, advisors, joint research partners or subcontractors to the principle research entity. The input of such industrial

partners would especially help guide and validate the commercial aspects of the technology programs.

3) Stage-Gate Development Process: Administration of the research grants should be separated into phases and aligned with a classic 'Stage-Gate' product development process. GE's adoption of a 'Stage-Gate' product development process, which is based on our leading efforts in Design For Six Sigma practices, has dramatically increased our commercialization success rate. Funding for each stage of the grant should be absolutely contingent on fully satisfying the requirements of each stage. This process could be simplified into the following six Stages:

- Market Development
- Assessment & Initiation
- Development
- Scale-up & Sampling
- Commercialization
- Production

Thus, for a given government grant, if the research entity fails to meet the requirements of any stage, the administrator would have the ability to terminate the remainder of the grant.

As a leader in the industry, GE looks forward to working with policymakers, users, and the technical community to continue to improve desalination and reuse technologies and increase the availability of economical New Water and energy. Thank you, Mr. Chairman and members of this committee, for your time.

The CHAIRMAN. Thank you very much. Let me apologize to you, Mr. Sabol. I had not read your testimony and I wrote down what I was going to ask you, and actually it was, how do we make sure that research is directed in areas that are most apt to be commercialized soonest and with some degree of success?

I understand your suggestions as I see them, and are directed somewhat in that direction. We do need to end up with products. We need to end up with the technology that's usable, and the laboratories aren't going to use it, because they're not in the business of buying and selling and generating water. So we've got to have somebody with them to make sure we're doing the right thing.

So your suggestions are going to be taken very seriously, and we'll see how they set with others. But clearly, they make sense to me. Let me say that I have about 10 or 15 questions. I think I'm going to submit them. First, I'm going to yield to the Senator from Florida and then come back for a couple here. Senator, would you like to make any comments or anything else you would like right now?

Senator MARTINEZ. Mr. Chairman, I would just real briefly say to Mr. Reynolds, I appreciate him traveling such a long distance, particularly when his home community is being threatened by Hurricane Wilma. Thank you very much for coming and lots of luck. I may see you down there. Let's hope that's not the case.

Mr. Chairman, I think rather than ask any questions, because of the hour I will simply just make a comment that I recognize the point that Mr. Sabol makes, that it would be nice to wait until the new technology comes in. It's like I always do with my new computer. I say I'm not going to get this one with the video camera, because there's going to be a better one coming next week that will also sing music to me, and now in fact cell phones do that.

The problem with that is in the meantime, you don't have a camera to take the video of your children as they grow. And so likewise, Mr. Reynolds and I think Mr. Archuleta's problem to some degree is that if you tell me there's going to be wonderful new technology available in a year, maybe that's fine. If it's 10 years, then

what do we do with the people of Key West and the people of El Paso to provide a steady, available and frankly affordable supply of potable water?

And so that's the dilemma we're in, Mr. Chairman, why it prompts me to want to jump start some of this with what S. 1016 attempts to do to give the opportunity to these places which are strapped and in need of something now to be able to do something.

Mr. Reynolds, I appreciate your pointing out in your testimony some of the difficulties. It's hard to conceive that too many communities in Florida have to pipe their water 145 miles over the Florida Straights. It's not exactly over land, either. With how many—did you say 43 bridges?

Mr. REYNOLDS. Yes.

Senator MARTINEZ. It's beautiful. I invite you all to come. But it is a tough way to get your water, and the reliability of that, frankly, with hurricanes in the area, becomes really a challenge and a problem. So, Mr. Chairman, thank you very much for your indulgence, I appreciate it.

The CHAIRMAN. Mr. Archuleta, I failed to mention, and you corrected it without indicating that my statement needed correcting, when I talked about the largest desalinization effort, I should have said portable. The portable one is being built by the Navy. The permanent one, which is larger, is being built by the military, or the Army, and in partnership, or in community with your groups. And that is in El Paso and it's not the one that's at Alamogordo being done by the Navy, but the combination of the two means that right there in our area is probably the biggest expenditure by the Government of desalinization technology research money.

Mr. ARCHULETA. Absolutely.

The CHAIRMAN. We hope that yours succeeds. I look forward to coming down there. I have not yet, but I'm going to make an effort to do that. We'll probably see you there.

Mr. ARCHULETA. That's great. Thank you, Senator.

The CHAIRMAN. The laboratory people, I see most of them are still here. I want to talk with you a little bit more, Mr. Sabol. The primary purpose, I think, of the bill is to ensure that the Federal investment in water research resources is ultimately adopted and used by industry to address real-world problems.

In your experience, what is the greatest impediment to the transfer of technology from the Government to the private sector, and how would you improve that, if you know, and how do you plan to evaluate technologies that are developed under this program to see if they have application?

Mr. SABOL. Well, Senator, I think the area that I'm probably best qualified to answer this question is from inside of General Electric Company.

The CHAIRMAN. Yes, sir.

Mr. SABOL. We struggle with the same sort of issues that the Government transferring technology to the private sector struggles with. We have global research centers, very much like your national labs, and the business units are responsible for taking technology that they develop and bringing it to market.

And what GE has done, and I've outlined a bit in my testimony, is connect those business units to our global research center very

early in the process. Eighty percent of the money that that global research center spends is directed by the businesses toward projects that their customers are asking them to work on, and those 80 percent of the dollars that GE spends at the global research center have a very high hit rate in the marketplace once they get there.

The primary reason is because they're connected to customer needs from the beginning, and the sales force and the business teams are engaged in the process and believe in it from the beginning.

It is important to note, though, that 20 percent of the money is spent without guidance from the business, so that we have a creative engine that's not encumbered by what customers think they really want, but really looking beyond that.

So I think it's important to have both. But connecting the business to the technical development very early on is the key.

The CHAIRMAN. I think that maybe this is right—that you have raised concerns that there does not exist in the national laboratories an adequate review process of the success in obtaining, getting to research objectives. How would you suggest that we instill in this program that link, if it's missing? Are there any business models that you can suggest that might instill that kind of discipline?

Mr. SABOL. I can't speak directly to how the process works in the national labs, I don't have visibility to it, but I do think that given the magnitude of some of the investment dollars contemplated in this bill, that it's important to make sure you get a return on that investment.

And the way we've done it in GE, and many companies around the world have used a stage gate process that simply breaks the development and commercialization process into steps, where there's a rigorous review at each step to make sure that the project is still on track, that the customer still wants it when it comes out based on the way it's being developed and that there's adequate review at each step.

Projects can go on far too long and spend too much money if they aren't reviewed at critical milestones. So we would strongly recommend that that same sort of process be implemented, if it doesn't exist already.

The CHAIRMAN. Now, tell me about that review. Who does the review and what are you looking for?

Mr. SABOL. The review is conducted with the technologists that are actually developing the technology, the sales force that's actually responsible for selling the technology and, importantly, with customers. The customers actually come in and give their own point of view based on what they're hearing. So getting that team, all three of those parties, engaged very early on, and at each critical step, there's little chance that the project can fall off the tracks.

The CHAIRMAN. Thank you very much. Frankly, it's interesting. That question doesn't only apply to this. I have the same problem with big projects that are built for the Department of Energy, with high technology as a goal. It takes a long time to get from the start to the end, and we're getting fooled along the way into thinking

we're getting where we aren't. And that ends up not achieving on time, sometimes not achieving at all, and sometimes costing way too much.

The problem I'm stuck worrying about is this, how do I find that out as soon as possible, that what I just described is occurring? And we haven't solved that yet, but I've gotten my dander up because it's happened too much and I'm not going to let it happen anymore. I don't know how we're going to fix it, but we're going to stop at some points and take a real look.

There's one thing that you have that we don't have in the regular science projects. Frankly, you have commercial users and that's really interesting, because they come along and they could stop something. Because you're making headway, but they could tell you, look, the door and that knob that you've got all the way, but that door isn't going to work. Right? Everything else is beautiful, but if you need that door—I'm just giving you something, they'll tell you. We're not sure we know that in the big science projects, nor do we know how to find out about it. We'll be conferring with you.

Do any of you have comments regarding the issue I'm speaking of? Maybe it doesn't apply to your work. That is, how do we make sure that the money we're spending on research is being spent for something that is apt to achieve, and that we know as soon as we can whether it's on the right track?

Mr. Reynolds?

Mr. REYNOLDS. I think through constructing projects and having the water utilities use the technology to see how it actually performs in use is very beneficial. And even when we build projects with the Aqueduct Authority, we have all the users involved. The maintenance guys, the operations guys, everybody is involved, the engineers, get everybody's perspective to make sure what you're designing is really what you need and that's the——

The CHAIRMAN. But you're not really doing research, are you? You're applying it all right now, when you're talking about it, aren't you?

Mr. REYNOLDS. Yes, we're in application and we believe that by investing in desalination technology that the manufacturers will in turn also invest in trying to make more efficient products.

The CHAIRMAN. Mr. Archuleta.

Mr. ARCHULETA. Let me add to that, Senator. I mentioned this partnership that we have with the universities, and all that, you know we're really kind of a research triangle there involving our desert area there, the opportunities and challenges that we bring.

But, for example, in brackish groundwater, silica is an issue in terms of feed water going into it. And that's one of the projects that we identified with Sandia. And I think that's very promising in terms of having a utility working with laboratories.

The other one is in the concentrate disposal. There are issues about the downhole, you know, implications of that, and the whole regulatory scheme. I can tell you that one of the big challenges we have, too, is convincing the regulators that some of these things are not harmful to the environment. We can work with them and firm it, and streamline that process so we get there faster.

The other issues on membranes, we don't see ourselves, we see more the General Electrics, and other kind of folks working on the next—and the laboratories working on the next generation of membranes, or some other device maybe besides membranes.

So I think there's a little bit of a split between some of the local people—can work with others on some of those local problems. And I think the next generation of membranes is probably left more to the laboratories than to the private sector.

Mr. PAREKH. Mr. Chairman, I couldn't have framed the concern any better than you did. I think you're right on the mark with the challenge that is offered when you have Federal funding available for research. And I think it's absolutely essential that obviously the national labs be involved, because they have a tremendous knowledge base behind them to help us with this.

The point I would like to make to help this along is not too dissimilar to what Mr. Sabol has said, to include—from the initiation of the funding, the inclusion of partnerships that are going to be most relevant to this research.

And in our case, just like Mr. Archuleta explained, we think the American Waterworks Research Foundation brings a tremendous amount of history and expertise in terms of what is actually going to be applied and what is needed by the drinking water utilities that are going to ultimately use these products.

The CHAIRMAN. Okay. Could I ask one last question of you, Mr. Sabol? You've explained in general terms what General Electric Water Resources Division or whatever its formal name is—in terms of people. What are the volume of sales? Did you tell us that?

Mr. SABOL. The water business in General Electric is approximately $2.2 billion dollars in revenue. Of that, approximately half is in membrane-based equipment.

The CHAIRMAN. So, in that regard, what do you do? You make it and sell it, is that it then?

Mr. SABOL. We do. We engineer the pieces of equipment to the customer's specifications, and we build the actual devices, membranes, and equipment and then install it and operate it in some cases.

The CHAIRMAN. Would you envision that your company could form some relationship, if we wanted it to go that way, with one of the research teams or entities that we're funding so that you would work together on research and toward an end?

Mr. SABOL. Absolutely.

The CHAIRMAN. Do you do that now, with pure institutional research institutions?

Mr. SABOL. We do.

The CHAIRMAN. Like?

Mr. SABOL. General Electric works with everything from the national labs to State and local entities that do research to other companies that we work with to develop research. It's a fairly common process, and as long as the goals are aligned, it's very achievable.

The CHAIRMAN. Do you think—if I heard you right, you're saying that certain projects that are being funded—that research projects they come and go, some are started and die, some are funded partially, but don't get completed, which I gather means, you make de-

cisions, before you waste all the money, use all the money, that it just isn't going to work at different points; is that correct?

Mr. SABOL. That's absolutely correct. It's very difficult to walk away from a project that's partially completed, but if the customer is saying we're not going to hit the cost point they need, or not going to meet the functional characteristics that they need, we pull the plug on the project.

The CHAIRMAN. I'm going to say this right now, and then I'm closing the record, and if it goes in the ears of the laboratories and they worry about this segment—but you're going to have to think about it. I have a suspicion that one of the problems in funding big laboratories, national laboratories and projects like this, is it's very hard to stop a project midway and it's very hard to say this isn't going to work.

Maybe I'm wrong, but I'm going to get that answered before we finish this legislation, because there's got to be a way to stop things without 10 years elapsing, and then finding that something else passed it by, and you could have found out 3 years into it that it was moving in the wrong direction. I just think private sector does it—you've already said you make mistakes—so I'm not trying to tell the laboratories you never do and they always do, I'm not saying that. But I think it's a lot harder for the private sector to make—to continue to do it, because pretty soon you get fired.

Mr. SABOL. Absolutely.

The CHAIRMAN. I mean, they look at you and say every year, is this the right guy for this job, right?

Mr. SABOL. That's right.

The CHAIRMAN. And you're young, which means they look for young people, that means they got rid of somebody else. I don't know who, maybe they were old people. Anyway, maybe we need that. Maybe we need a way of holding those in charge, and letting them go, instead of the project. Maybe they get their job terminated. But we can't do that either. That's enough of me. We stand in recess until call of the chair. Thank you.

[Whereupon, at 4:10 p.m., the hearing was adjourned.]

# APPENDIX

## RESPONSES TO ADDITIONAL QUESTIONS

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EL PASO WATER UTILITIES,
PUBLIC SERVICE BOARD,
*El Paso, TX, November 3, 2005.*

Hon. PETE V. DOMENICI,
*Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.*

DEAR SENATOR DOMENICI: I wish to thank you and your staff for allowing me the opportunity to appear before the Senate Committee on Energy and Natural Resources on Thursday, October 20, 2005. As you know, I was there as a representative of the WateReuse Association and its Foundation, but also as the General Manager of the El Paso Water Utilities.

The purpose of this letter is to respond to your letter of October 24, 2005 on questions you asked me to respond for the record.

Since I testified on behalf of the WateReuse Association and its Foundation, many of the questions that you asked will be responded to by Mr. Wade Miller, the Executive Director. However, the questions that you ask specific to El Paso Water Utilities, I am responding to per the attachment.

Again, it was good seeing you and I am glad that I was able to perhaps provide some information to you and your Committee that is useful on these Bills. I also informed our Mayor and Public Service Board members of your interest in visiting El Paso some time in the near future as our Desalination Plant moves further into construction. We would welcome your visit any time your schedule permits. We do a lot of good regional planning with New Mexico and you are extremely well thought of and regarded in this region and this community for the outstanding leadership that you have provided on water policy and energy management. I also look forward to seeing you at the Multi-State Salinity Coalition meeting in Albuquerque in early December.

Sincerely,

EDMUND G. ARCHULETA, P.E.,
*General Manager.*

[Enclosure.]

### QUESTIONS FROM SENATOR DOMENICI

*Question 1a.* The two bills we are considering today take two different approaches to meeting water supply challenges. It is my understanding that the City of El Paso recently began construction of a desalination facility which is expected to cost $87 million.

Do you believe the federal government should focus its investment on subsidies or water technology research and development?

Answer. The El Paso Water Utilities ("EPWU") believes that federal investment in desalination should be in research and technology development because that is the most beneficial way to bring down the cost of ocean and inland desalination.

*Question 1b.* Assuming that S. 1016 is passed before the El Paso facility begins producing desalinated water, how much help would S. 1016 provide?

Answer. Obviously, any subsidies would help, but because the energy costs of inland desalination are lower than ocean desalination, I do not believe that S. 1016 would have a substantial impact on the EPWUI-Fort Bliss operation. The estimated capital plus operating costs of approximately $500 per acre-foot ($1.53 per 1000 gallons) is affordable to the consumer. Also, subsidies would send the wrong energy use signal.

*Question 2.* What has been your experience in your past partnerships with the national laboratories?

Answer. EPWU along with its CHIWAWA partners (New Mexico State, Texas A&M, UTEP and the City of Alamogordo) are currently developing three research programs related to inland concentrate disposal: deep hole injection, silica removal and salt tolerant plants. Initially, the CHIWAWA partners had hoped to gain some research funding through Sandia National Laboratories. Without an increase in Sandia's research account for this specific purpose, this will not happen in this initial phase of our collaboration.

As the past Chair of the AWWA Research Foundation, I have worked with Sandia National Laboratories on cost-effective methods for arsenic treatment. This has been a great and positive partnership.

*Question 3.* How would you recommend ensuring that the research undertaken pursuant to S. 1860 address real-world problems?

Answer. In the El Paso region, both El Paso and Alamogordo are building large desalination plants (ours is under construction and Alamogordo's is under design), the biggest area that we want to cut costs and find a better approach is in concentrate disposal. Finding better, cheaper, perhaps more useful methods, will not only conserve water, but also save energy and better protect our environment.

With the Tularosa Desalination Research Facility under construction and with El Paso's TecH20 Center under design, we are the perfect model to advance the science of concentrate management in an inland area. Technical advances in this area would be of great value to cities in this country and around the world.

With the technical capabilities of national labs and universities, plus the practical need of cities, we believe our consortium. (CHIWAWA) is a good model to begin this work where the need is the greatest and the talent/human resources are there.

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GE INFRASTRUCTURE,
WATER & PROCESS TECHNOLOGIES,
*Trevose, PA, November 4, 2005.*

Hon. PETE V. DOMENICI,
*Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.*

DEAR MR. CHAIRMAN: Thank you again for the opportunity to appear before the Senate Committee on Energy and Natural Resources on Thursday, October 20, 2005, to give testimony on S. 1016 and S. 1860. We were honored to appear before your Committee and provide our views on these two bills.

We are also pleased to respond to the follow-up questions that Senator Bingaman submitted for the record, and we are attaching our responses, which we have written beneath each of his questions.

Please let us know if we can provide any further information.

Sincerely yours,

COLIN R. SABOL,
*Chief Marketing Officer.*

[Enclosure.]

QUESTIONS FROM SENATOR BINGAMAN

*Question 1a.* It appears that GE is already investing significant amounts in water technology research.

Is most of GE's water technology research being done here in the United States?

Answer. We conduct between 60-70% of our research here in the United States. We conduct most of our domestic research in two locations: (1) GE's Global Research Center in Niskayuna, New York; and (2) GE Water's headquarters in Trevose, PA. However, we are very interested in expanding our research presence in key water-scarce regions, including New Mexico, where we recently applied for a grant that would fund water scarcity research.

*Question 1b.* To date, has any Federal funding been available to advance that research? If so, from what source?

Answer. GE Water has responded to Request for Proposals (RFPs) from the Bureau of Reclamation, but the size of the grants we sought were too small to support meaningful R&D efforts in the areas of desalination and reuse.

GE Water has in the past also solicited funding from DOE and NIST, but the RFPs that we have responded to have not been directly related to desalination or water reuse.

*Question 2.* Your testimony in several places mentions "integrated water-treatment, renewable energy systems". I can think of a lot of potential applications for

these type of systems—particularly in rural areas and Indian reservations in New Mexico.

Are such systems readily available at the present time, or is more research needed to make them economically viable?

Answer. We are very much aware of the need for integrated water-treatment, renewable energy systems in rural areas and Indian reservations, and we are interested in implementing a number of demonstration projects, including at least one in New Mexico. However, we do believe that it is necessary to conduct further research focused on the electromechanical interfaces (i.e., pumps, controls, power storage & conversion) between the renewable sources and water systems.

*Question 3a.* In your testimony you suggest that the "Lead Laboratories and the Advisory Panel should select at least one industry partner to participate in each program." The bill calls for industry to be represented on the Advisory Panel and to be eligible for the competitive grant program.

Do you think that a specific industrial advisory group is needed for each area of R&D that would develop under S. 1860?

Answer. We do believe that a specific industrial advisory group is needed for each major area of R&D that would develop under S. 1860. We further believe that each of the groups should include participants from industry.

In addition, we believe that projects run by the lead laboratories would benefit from industrial partnerships. Such partnerships would help to ensure that the research performed by the laboratory has commercial value.

*Question 3b.* To achieve your goal of helping to guide and validate the commercial aspects of the technology programs, do you think it also necessary to include industry representatives in the process to develop the technology roadmap?

Answer. We do believe that it is necessary to include industry representatives in the process to develop the technology roadmap. Such industry participation would increase the likelihood that the roadmap would result in commercially viable desalination and reuse products and services. GE Water participated in the development and refinement of the Desalination and Water Reuse Roadmap already completed by Sandia and the Bureau of Reclamation, and we found this to be a very positive experience.

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UNIVERSITY OF CALIFORNIA,
LAWRENCE LIVERMORE NATIONAL LABORATORY,
*Livermore, CA, November 7, 2005.*

Hon. PETE V. DOMENICI,
*Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.*

Hon. JEFF BINGAMAN,
*Ranking Member, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.*

DEAR CHAIRMAN DOMENICI AND SENATOR BINGAMAN: Thank you for the opportunity to appear before the Senate Committee on Energy and Natural Resources on Thursday, October 20, 2005, to give testimony regarding S. 1016, to direct the Secretary of Energy to make incentive payments to the owners or operators of qualified desalination facilities to partially offset the cost of electrical energy required to operate the facilities, and for other purposes; and S. 1860, to amend the Energy Policy Act of 2005 to improve energy production and reduce energy demand through improved use of reclaimed waters, and for other purposes.

I am pleased to submit the attached responses to your additional questions, to submit along with my written testimony for the record.

Should you require any further information, please do not hesitate to contact me.

Sincerely,

DR. JANE LONG,
*Associate Director.*

[Enclosure.]

QUESTIONS FROM SENATOR DOMENICI

*Question 1.* A significant portion of this bill is dedicated to technology transfer and commercialization of water supply technologies.

How do you plan to make the information garnered as a result of this bill available to the public?

Answer. The success of the program depends wide dissemination of results as well informed input, so we will use a variety of means of communication. Of course, our

detailed plans will be coordinated with other R&D centers in the overall national program. In addition to presenting research results at technical conferences, we plan to communicate the activities of the center to the user communities in less formal meetings with individual water districts, water agencies, power companies, and engineering firms. Widespread acceptance and use of new technologies for water treatment depends upon favorable recommendations from the responsible individuals in specific water supply utilities that have experience with the new technologies. Because of this, we will continue to work closely with water agencies and water utilities on a local level to stay informed of their technology needs, provide assistance and troubleshooting for pilot and demonstration tests of new technologies, and continue to help utilities to optimize treatment methods for cost and safety. In support of these outreach efforts to users, others in the technical community, and the general public, the Laboratory's R&D center will maintain a web site, which will provide our research results as well as the results from pilot and demonstration tests.

Our R&D center will have an advisory board, separate from the one described in the legislation, with representatives from water and power agencies, water districts, industry and academia. This board will review the direction and progress of our research and development efforts, and provide guidance to ensure that the technologies and tools we develop will be adopted by the user community. An additional benefit to having a board is that the board members, chosen on the basis of their influence in the water resource community, will help to ensure wide dissemination of information about our activities.

*Question 2.* Do you believe your past and present partnerships with industry, government agencies and water organizations help you promote the real-world application of technologies developed as a result of S. 1860? If so, how?

Answer. As I highlighted in my written testimony, we are working with local water utilities to test our own new technologies, and in troubleshooting current problems with contaminant removal. We are also partnering with several engineering companies, local water agencies and utilities on proposals for new technology development. These partnerships are absolutely essential to the viability of a R&D center. They are needed to focus technology development on areas of need, guide laboratory development of technologies that are most likely to be workable in real-world applications, and gain from the wealth of practical experience of individuals employed by industry and the utilities.

*Question 3.* How can the technologies developed as a result of S. 1860 address global water shortages?

Answer. Providing cheap, potable water to reduce or eliminate global water shortages is a key goal of the program. For example, in our R&D center, we plan to develop inexpensive technologies to allow safe water re-cycling, to develop 'smart' membranes to carry our selective extractions from 'impaired water' contaminated for example with arsenic or nitrate, and to reduce the energy cost of desalination of brackish and ocean waters. Large reductions in the amount of energy needed for desalination are possible. Current technologies are at least a factor of 5 times higher in energy usage than what is thermodynamically possible. There is no global shortage of water—the shortage is of safe potable water. We need to reduce the cleanup cost to increase that supply. The development of commercially available, cost-effective, low-maintenance systems will constitute a significant contribution to the issue of safe global water supplies.

*Question 4.* What application do the technologies that would be developed as a result of S. 1860 have with respect to homeland security?

Answer. Real-time information on the quality of water entering and distributed in the public water supply system is a clear need both for accidental and intentional contamination. A focus area for our technology center will be the development of in-line sensors to replace conventional sampling and remote chemical analyses, which have up to several day turn-around. This is an area of synergy between current U.S. Department of Homeland Security (DHS) funded R&D, where sensor development for chemical and biological warfare applications is being carried out, and water supply R&D. The same methods used for Chem-Bio sensing can be modified for sensing contaminants of concern in water supply systems. This is already an active area at Livermore and other laboratories, but would be greatly accelerated through the establishment of an R&D center. Similarly, treatment systems developed through this program would be most useful for emergency response in instances where water supply has been compromised.

*Question 5.* In your testimony, you state that the national laboratories have a proven track record of developing new technologies. How will you ensure that these technologies are engineered in an economically-viable manner?

Answer. As in many past and current activities, we will partner with engineering firms that focus on construction and operations of water treatment plants, with public water providers and with agencies, utilities and private corporations in the energy arena. Guidance on economics and operational constraints will be obtained from industry/agency partners and advisors at multiple stages of development. Each technology will require an economic assessment and comparison to conventional methods for efficiency, cost savings and overall benefit. Such assessments are likely to require updating as the technologies approach commercial technology transfer. In order to insure that our program's R&D results reach the public, our role must cross-cut from laboratory R&D through end user needs. We will use our center's resources and to help promising new technologies survive the so-called 'Valley of Death', the difficult transition from proof-of-concept to commercialization.

*Question 6.* It is my understanding that Lawrence Livermore National Laboratory currently has a significant amount of water resources research underway. What research capabilities does Lawrence Livermore National Laboratory have that are not available in the private sector?

Answer. LLNL has specific capabilities not available in the private sector including unique computational and analytical laboratories as well as special expertise in particularly important, relevant areas of chemistry and materials science. I believe an even more important strength is the Laboratory's ability to integrate these capabilities to provide solutions to problems of national interest.

As an example, LLNL licensed an innovative approach to capacitance deionization (CDI) to desalt water using aerogels. In 1995, this technology was selected as one of the top 100 technology innovations of the year (R&D 100 Award). Next-generation and spin-offs from this original technology are under development. Because electrodialysis (ED) processes have fundamental efficiency advantages over reverse osmosis (RO), LLNL is integrating its special capabilities in molecular modeling with membrane science and engineering expertise to improve energy efficiency potentially by an order of magnitude over current ED processes. We are pushing the ion selectivity and transport thresholds for ED closer to theoretical limits. (This effort was highlighted in the National Nanotechnology Initiative at Five Years: Assessment and Recommendations of the National Nanotechnology Advisory Panel, prepared by the President's Council of Advisors on Science and Technology, May 2005 (pg. 37) (which can be found at *http://www.nano.gov/html/news/PCASTreport.htm*)). In addition, using internal (LDRD) funds, LLNL has recently developed a new energy-efficient electrodialysis technology for selective removal of contaminants such as nitrate. With local water utilities, we are seeking outside funding for pilot-testing of this technology. We are also beginning a project, funded by the California Department of Water Resources, to develop a potentially very energy efficient desalination technology called 'ion pumping'.

These projects have clearly benefited from the broad range of technical capabilities that exist at a national laboratory such as LLNL, and that do not exist in the private sector. For example, we can call on experts in all aspects of technology development to help us; hydrodynamics experts to optimize fluid flow properties, synthetic chemists for membrane functionalization, polymer engineers to select durable membrane materials, and others. We also leverage off R&D in other areas. For example, we are able to modify sensor technologies currently being developed for DHS applications for water monitoring applications. We can apply computational fluid dynamics codes currently being used for a wide range of applications including nuclear testing, to model concentration polarization at membrane surfaces, a key limitation on the energy efficiency of membrane-based separation processes.

In addition, we can take advantage of our world-class computational resources to carry out first-principles modeling of potential technologies to evaluate their potential performance before using resources for materials synthesis and laboratory testing. This is the approach we used to develop our new electrodialysis technology, and the approach is currently being used for our ion pump work. Modeling has not been used in this manner in the past. Technologies have mainly been developed through trial and error. We believe the computational approach is now sufficiently mature to significantly benefit future technology development for water treatment.

(For more information on LLNL's water technology development capabilities, please see the short description, attached.)

*Question 7.* Which of the missions contained in S. 1860 do you believe Lawrence Livermore National Laboratory would be best qualified to undertake?

Answer. The key elements in S. 1860 include an advisory panel, assessment of current efforts, identification of research and development priorities, development of a technology roadmap to guide program activities, a directed research, development, demonstration, transfer and commercialization effort and a grants program. LLNL has led or participated in assessment, prioritization and technology roadmapping ac-

tivities such as those described in S. 1860. We bring to the effort wide ranging expertise in many relevant science and technology areas. An equally important aspect of roadmap development is the involvement of a wide range of stakeholders from the energy and water communities. LLNL's partnerships span across the multiple stakeholder communities whose involvement will be necessary for these efforts. This familiarity with the stakeholders and their diverse perspectives will be important to the success of the roadmap developed and the program itself.

With respect to the directed R&D program, LLNL has extensive capabilities and a strong track record in both the development and commercialization of technologies and management tools, including those in water treatment and energy arenas (please see other responses for details). We also have a proven track record in successfully collaborating with industry, universities and agencies at the diversity of levels described in S. 1860. The technology roadmap that will be developed as part of the S. 1860 activities will prioritize the missions of this legislation. LLNL will focus its efforts on identified high priority R&D topics.

*Question 8.* How will you coordinate research currently underway with the authority provided by S. 1860?

Answer. In its expanded role as part of the national program, LLNL will continue current activities in the area of water and energy supply technology, which are funded with a mixture of state and federal funds. We would expect these activities to broaden over time and address the priorities defined by the roadmap. An important aspect of our role as an R&D center would be to coordinate LLNL's R&D activities with program collaborators (partnering with universities and other national laboratories, public/private partnerships with industry, water and energy utilities and agencies). Efforts in all program elements—as well as work other agencies—need to be complementary. Working with the broader energy and water communities will ensure improved communication, and it will aid in leveraging other ongoing efforts. The roadmapping process will take into consideration other recent or ongoing research prioritization and roadmapping efforts (e.g., the USBR-Sandia Desalination Roadmap completed in 2003 and DOE's Water-for-Energy roadmap currently in progress). (See also response to Senator Bingaman's questions).

Our current activities would be enhanced by the authority provided by S. 1860 in that it includes commercialization issues, which are not supported through current funding.

*Question 9.* How will Lawrence Livermore's significant super-computing capability be brought to bear in carrying out S. 1860?

Answer. As described above, our resident super-computing capabilities allow us to evaluate new ideas for treatment technologies by carrying out first-principles computer simulations, the results of which can be used to screen and select the best approaches for design. The same computational methods can then be used to optimize technologies that are undergoing laboratory and field testing. We believe the computational approach is now sufficiently mature to significantly benefit future technology development for water treatment.

*Question 10.* What do you believe are the most promising technologies to accomplish the objectives of S. 1860?

Answer. The roadmapping effort will integrate the prioritized needs of the energy and water communities, provide an understanding of existing efforts, and define promising areas to pursue. We have described some areas of technical promise both in this response and in the description of LLNL's water technology development capabilities, attached. Integration of energy efficiency will be essential (see our response to Senator Bingaman as well.) Perhaps the greatest benefit of the proposed national program is the integrated approach to simultaneously address energy and water issues.

For example, the implementation plan for the USBR-Sandia Desalination Roadmap has defined several promising areas for R&D. Some of LLNL's efforts in these areas include the following:

Energy costs for desalination can be reduced significantly. New technologies are needed that take advantage of new materials and new understanding of physical processes at the molecular level to reduce the energy use to levels two to three times lower than at present. Technologies that use electrostatic fields to manipulate and separate ions from water show great promise in this area.

The use of species selective 'smart' membranes for removal of contaminants is a promising more energy-efficient treatment technology. Such membranes have been developed for sensor applications. LLNL is evaluating promising separations technologies to identify those that could be modified to remove toxic species from water.

Technologies are needed to minimize and dispose of concentrates (saline brines) produced from desalination. A promising approach combines selective extraction of contaminants and production of high-purity, marketable by-products with computer-

optimized brine reduction processes. Overall, the approach could significantly reduce the volume of produced brines, and enable efficient salt management in the watersheds of inland urban areas. Marketable by-products can offset treatment costs.

QUESTIONS FROM SENATOR BINGAMAN

*Question 1.* Obviously with the existence of a National Laboratory Energy-Water Nexus team, the Labs have been looking at these water and related energy issues for some time.

Given that, how long will it take to develop the technology roadmap called for in the bill, which is intended to establish the framework for investing the resources provided to the program?

Is anything currently underway in this area? If so, does it include representatives from government, the academic community, and industry?

Answer. The current legislation allows for a two-year window. As I stated in my written testimony, rapid completion of the assessment and roadmap development is challenging, but necessary and appropriate, given the urgency of the problem. The effort will greatly benefit from the fact that some aspects of this technology roadmap are already in various stages of development and involve members of the Energy-Water Nexus Team. Specifically, the USBR-Sandia Desalination Roadmap completed in 2003 and DOE's Water-for-Energy roadmap currently in progress will be available and need to be integrated into the Energy-Water roadmap called for by this bill. Regional differences and synergies will need to be considered and included in a national roadmap. This will require review and integration of state and regional efforts. An example is the CA Energy Commission's white paper on the Water-Energy Relationship (which can be found at *http://www.energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011.PDF*), which is summarized in the Integrated Energy Policy Report (and can be found at *http://www.energy.ca.gov/2005*__energypolicy/index.html).

*Question 2.* S. 1016 focuses on the need to provide federal assistance to address the high energy costs associated with desalination. At the same time, GE's testimony indicates that over the past 25 years, the cost of seawater desalination has dropped from $20/1000 gallons to $4/1000 gallons.

Based on the current state of research and development, is there a significant chance that we will be able to significantly reduce desalination energy costs further in the next decade?

Answer. There are opportunities to reduce energy costs in at least two ways: optimizing operations to lower energy costs by utilizing off-peak or renewable energy sources, and through improving technologies that directly reduce energy requirements. As noted in the CA Dept. of Water Resources 2005 CA Water Plan Update, unlike every other type of water facility, where staffing edges out energy use as the main operating expense, desalination's primary operating cost is for energy. In a recent summary by the Joint Water Reuse and Desalination Task Force (2005), energy costs for currently operating brackish water desalination systems accounted for 11% of the total costs; for seawater desalination it was 44%. Most desalination plants operate continuously, so electricity is used during all seasons, and all times of the day. Current plants are operating 90 percent of the time to maximize return on capital costs, with downtimes only for maintenance. If financing schemes that consider entire life cycle costs for a plant (including energy costs for operation) could be devised, it would be feasible to run plants during off-peak power periods, and/or to utilize intermittent power sources such as wind or solar. Integrated energy-desalination planning tools would optimize the performance of such systems so that desalination could take advantage of lower priced power, facilitate development of alternative energy sources, and relieve peak grid demand periods.

In addition, in spite of the many improvements in membrane design that have increased the energy efficiency of RO, we are still at least 5 times above the theoretical energy minimum for salt removal. For RO, there also are energy improvements to be made in other parts of process train (e.g. pumps, alternative power systems, waste heat, energy recovery devices). For example, current energy recovery devices in RO systems recover only about 40% of the energy. There are also many opportunities to move away from RO altogether, to improve other existing technologies such as ED/EDR, to explore innovative concepts, and to improve water recovery (thereby increasing water/energy ratio). Water recovery is limited by mineral scaling issues and concentrate disposal options. It is a fruitful area for technology research and development.

[Attachments]*

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SANDIA NATIONAL LABORATORIES,
ENERGY, SECURITY & DEFENSE TECHNOLOGIES DIVISION,
*Albuquerque, NM, November 7, 2005.*

Hon. PETE DOMENICI,
*Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.*

DEAR MR. CHAIRMAN: I am pleased to provide the answers to your questions relating to my testimony of October 20, 2005. The attached document contains the responses to your questions as requested in a letter to me dated October 24, 2005.

Again, thank you for the opportunity to participate in this very important process. If you have any questions, please feel free to contact me at (505) 845-9064.

Sincerely,

LES E. SHEPHARD,
*Vice President.*

[Enclosure.]

QUESTIONS FROM SENATOR DOMENICI

*Question 1a.* In your testimony, you suggest that without significant technological advances, we may not be able to meet our energy and water needs in the next 20 years.

Will you please explain?

Answer. In simple terms, water and energy production are interdependent. An inadequate supply of one often affects the supply and cost of the other. Estimates show that the energy demands of the United States will increase by approximately 30% over the next 20 years. Today, thermoelectric power production accounts for approximately 40% of the freshwater withdrawals in the United States, a number roughly equal to the agricultural sector. In a growing number of regions in the United States, all available water is completely allocated. Without some combination of significant new water supplies and more water-efficient power generation technology, the United States cannot economically meet the projected growth in power generation capability

The energy required for the withdrawal, conveyance and treatment of water is 4% of the total U.S. electric power generation. In the future, the projected energy requirements for water and waste water treatment for non-traditional water resource utilization, including desalination and waste water reuse, are projected to increase to 6-10% of the total electricity generated. Populations continue to grow, particularly in water stressed areas such as the west, southwest, and Florida. A major factor in creating affordable new water to meet these growing population demands is reducing the amount of energy required to pump, treat and distribute impaired water.

The interdependency can be simply summarized, no water—no electricity. Clearly technology advancements are required to keep energy costs and water costs, both in terms of actual dollars and competition amongst sectors, from derailing continued economic growth.

*Question 1b.* How would S. 1860 help meet this need?

Answer. The proposed legislation, S. 1860, would provide a systematic approach to solving to this problem by designating the authority for the Department of Energy (DOE) to engage in this critical mission space, by drawing on the assets of the national labs and universities and, by leveraging other research and development efforts through a grants program with other federal agencies and private industry. A key element of the program established by S. 1860 is the inclusion of an explicit commercialization and tech transfer task. Coordinating this work through road mapping activities will enhance the impact of the federal investment by prioritizing activities to get the greatest return for the federal investment dollar today and into the future. This bill will create breakthrough technologies by tightly coupling research, development and technology transfer in the energy and water sectors. For example, considering inland brackish water or other impaired sources, the water supply could be dramatically increased through research on advanced technologies with the potential for significant reduction of water desalination or treatment costs and energy requirements, followed by pilot scale testing of the most promising technologies, followed by active technology transfer and commercialization.

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*Attachments have been retained in committee files.

*Question 2a.* Since Fiscal year 2002, Congress has appropriated over $23 million for Sandia National Laboratories to undertake research on arsenic removal, advanced desalination, to aid in the planning of the Tularosa Desalination Facility and to undertake an energy-water supply roadmap.

Has the funding you have received for water technology enhanced Sandia National Laboratory's ability in this area, and how?

Answer. Yes. This funding has solidified a water program at Sandia that is strongly focused on key water technologies and strong partnerships, both inside and outside of the government, with industry, and with end-users. The program has significant leveraging of diverse capabilities across the labs, pulling significant technological advances from areas such as computational methods, nanoscience technologies and microsystems. This program has attracted the engagement of top researchers at Sandia, including one of the three Sandia Fellows, several Senior Scientists and Distinguished Members of the Technical Staff to develop advanced concepts. This investment has enabled us to focus our historic water-related research in radioactive waste management, environmental remediation, basic geosciences, sensor development, vulnerability analysis and other security technologies, and modeling of complex and interdependent systems, such as energy and water, on the problem of domestic and international water supply shortages and conflicts. Our leadership in this area continues with our road mapping activities. As a result of the growing program in desalination and treatment, several laboratories have been refocused and reconfigured to focus exclusively on advanced water treatment technology development. Finally, Sandia senior management has made strategic decisions to support the development of this integrated water initiative with Laboratory Directed Research and Development (LDRD) and program development funds.

*Question 2b.* What is the status of each of water technology-related activities currently being undertaken by Sandia National Laboratories?

Answer. Sandia National Laboratories has provided leadership and has had impact in five major areas: 1) Desalination roadmap development and design and development of the Tularosa Desalination Facility with the Bureau of Reclamation, 2) Advanced desalination technology development, 3) Arsenic treatment technology development and demonstration, 4) Energy and water interdependencies including technology road mapping and developing a report to congress and, 5) Engagement with the Office of the State Engineer (OSE) in New Mexico. Each of these is described in more detail below.

The original funding allowed the creation of the Desalination and Water Purification Technology Roadmap which was published in partnership with the Bureau of Reclamation and reviewed by the National Research Council. A second generation Desalination and Water Reuse Roadmap is currently being developed with four of five scheduled workshops completed. This roadmap will be completed in May 2006. An additional part of the original funding supported Sandia's leadership in the development and design of the Tularosa Desalination Facility. The Bureau of Reclamation now has total responsibility for this project. Groundbreaking for the facility was June 29, 2004 and the first experiments using the Office of Naval Research system are underway.

In the desalination program arena, we are pursuing fundamental desalination research in such areas as biomimetic membrane nanomaterials, clathrates ("freeze distillation"), and capacitive deionization here at Sandia. We are working with Los Alamos to develop subsurface wastewater injection strategies and expect in the next year to begin working with University of Texas at El Paso researchers to identify new silica removal strategies (the latter project will be joint funded by Sandia and the City of El Paso). In the coming year, we will have ready for pilot-testing new technologies using centrifuges and electrodialysis to remove salts from inland brines. In addition, we have several projects underway with universities and industrial partners.

In the area of arsenic removal, Sandia National Laboratories, in partnership with the American Water Works Association Research Foundation (AwwaRF) and WERC: A Consortium for Environmental Education and Technology Development, have made significant progress in helping communities deal with the new Environmental Protection Agency (EPA) standard. Sandia has fielded three pilot tests (Soccoro, Desert Sands, and Rio Rancho) which have begun to yield results. Additional pilots are planned in New Mexico and at other locations around the country. While some media performs better than others, all of the commercially available media that have been tested in the Soccoro pilot have not performed to expectations. The media were chosen from peer reviews as part of the Arsenic Vendors Forums, the third such forum was held Nov. 2-4, 2005 in Albuquerque. Sandia has worked with some of the vendors to help diagnose production issues. Regional workshops have been and are continuing to be held around the state in order to help New Mexico commu-

nities assess the proper approach that they should take in addressing compliance with this issue. The research at AwwaRF has yielded new materials that will be included in the second phase of pilots at the New Mexico sites. The Sandia developed SANS material will also be tested in the second phase of the pilots. In addition, Sandia in partnership with the New Mexico Environment Department (NMED) has begun an individualized rural outreach program where Sandia will analyze water quality in local communities and help them decide which technology or other management approaches may be best for them.

The energy water technology roadmap process is underway. Regional workshops across the country are scheduled for November, December and January. The executive board, a collection of key individuals from government including DOE, academia, and industry, have met and are helping to guide the road map process. A technical innovation workshop is scheduled for April 2006 based upon needs from the Regional workshops and the final roadmap detailing research priorities will be published in September 2006.

A report to congress, to be published by DOE in February 2006, is being written under the leadership of Sandia National Laboratories. Significant engagement with Los Alamos National Laboratory and National Energy Technology Laboratory as well as advice from the rest of the multi-lab team supports this effort.

Finally, locally in New Mexico, in collaboration with the Office of the State Engineer (OSE) and Interstate Stream Commission, we are currently developing decision support models to assist in water resources management planning for the Gila River Basin, a critical basin in southwestern New Mexico. We have worked closely with the OSE to help train staff in the use of this modeling tool. We have developed web based tools to allow real-time collaboration with geographically separated institutions as they jointly develop complex water system models.

*Question 2c.* What missions contained in S. 1860 do you believe Sandia National Laboratories would be best qualified to undertake?

Answer. As noted in the previous two answers, Sandia National Laboratories extensive and diverse water program qualifies us for a lead lab role within this new program including the technology transfer mission and allows us to partner effectively and engage in the grants portion of this legislation. Specifically, we have demonstrated success in developing a systems approach to understanding water that enables us to identify technology needs early and systematically in a prioritized manner. We have actively and successfully engaged with a broad community on arsenic. We are actively and successfully engaged with industry at a very early stage in our desalination research and we are a DOE complex leader in technology transfer. Our qualifications are based in our successes in building a national partnership with the water treatment community; in addressing water needs in conflict-rich but water poor regions; in undertaking and coordinating fundamental research taking place at multiple universities, private companies, and national labs; in moving technologies from bench-scale to pilot-testing; developing strategies and designs for the Tularosa Desalination Facility; and, in leading three water technology road map activities.

Sandia National Laboratories is well qualified to lead and engage in water treatment areas to reclaim and improve access to previously unusable and non-traditional water sources. By developing and piloting technologies that increase the amount of available water for human uses (e.g. inland desalination and produced water treatment) Sandia National Laboratories can impact the supply of water. Sandia's record in the road map arena demonstrates our ability to partner and to lead activities with multiple organizations, including the coordination and integration of research. Our leadership in developing water resource management models to aid decision-making in water-short regions is also an area where we have outstanding capabilities. Our ability to effectively model complex systems qualifies us for the systems analysis role called out in the legislation. This activity, coupled with sensor development activities, will impact water quality issues. Sandia National Laboratories has an outstanding track record for technology transfer creating real-world applications. While we are still at a relatively early stage, technology transfer and substantial industry engagement is already under way. A major Cooperative Research and Development Agreement (CRADA) for commercialization of microchemlab technology for real-time water monitoring is about to start Phase II activities. Desalination jump start activities and arsenic treatment pilot testing both have substantial industry engagement focusing on bringing new technologies in to application.

*Question 3a.* A large portion of S. 1860 is dedicated to technology transfer and commercialization of technologies to ensure that the technologies can be used in real-world applications.

Do you feel that this bill goes far enough to encourage the commercialization, technology transfer and dissemination of information?

Answer. The true measure of success for this activity will be the technology transfer from the research institutions evidenced in the deployment of new technology by the end-user community. The bill addresses key issues which can be barriers to technology transfer. First, the technology development is guided by an end-user identified, needs-driven roadmap which is created with a partnership amongst industry sectors, national labs and universities, and other federal agencies. Secondly, the identification of a percentage of funds to support technology transfer and deployment is crucial. In the accounting of percentages within the bill, there is five percent of the funding that is not directly allocated and these funds should be applied to the technology transfer mission. Thirdly, the research from the grants program must reach the end-users through a technology transfer process. The identification of lead labs to provide the connection with the technology transfer mission and our ability to provide technical integration creates a stable technical maturation process in this program. Finally, the guidance of the advisory panel, which can enhance connection to influential market drivers, also supports the technology transfer mission.

*Question 3b.* How do you plan to partner with communities to ensure that technologies developed under S. 1860 address real needs?

Answer. Partnership with communities is essential to understanding real needs. Our arsenic program has given our scientists and engineers the "on the ground" understanding of the real world needs and constraints. While individual contact with every community is not possible in a national program, some amount of direct community interaction is quite valuable. In order to extend the insights gained from individual community engagement to a much larger number of communities, we draw on our relationships with industrial organizations that serve these communities, such as AwwaRF, WateReuse and the Rural Water Users Association, to broaden our impact. By involving organizations such as these in the roadmap development, the real needs can be identified. This coupled with our working knowledge and individual experiences will make Sandia National Laboratories effective in developing the right technology.

*Question 3c.* How do you plan to coordinate your activities with water resources research being undertaken by other agencies and research undertaken by entities that receive grants under S. 1860?

Answer. Partnerships are foundational to the successful development and deployment of technology in this area. Sandia believes this and it is shown in our actions as seen in our previously stated response on the description of the status of the congressionally funded water projects. We have many partnerships within the water initiative including work with government agencies, state agencies, national labs, universities, and industry. For example, in our water treatment program alone, Sandia National Laboratories is formally partnering with many research foundations: the American Water Works Association Research Foundation (AwwaRF), the WateReuse Foundation and National Water Research Foundation, the Water Environment Research Foundation, and WERC: A Consortium for Environmental Education and Technology Development. In addition, we also partner with the Bureau of Reclamation, the Office of Naval Research, and the Tank Automotive Research, Development and Engineering Center (TARDEC). Further, we have further formed partnerships and linkages with the California Energy Commission, the California Department of Water Resources, and the Texas Water Development Board. We are working with the Interstate Stream Commission and the Office of the State Engineer in New Mexico. Our industry alliances include the General Electric and Dow. Partnerships with universities include Massachusetts Institute of Technology, University of New Mexico, Arizona State University and, the University of Illinois WaterCAMPWS, a consortium of 10 university partners. A complete list can be found at our website *www.sandia.gov/water*. Working closely with the grant recipients, we can enhance the impact of each organization's effort in this area.

*Question 4a.* You state in you testimony that the program created by S. 1860 must engage end-users early to define research priorities.

Do you feel that this can be accomplished by their participation in the advisory panel created by the bill?

Answer. Yes, provided that the advisory panel has the right people, has well defined processes for review of the program and effective communication of the future needs of the program, and is well connected to the lab research development and the grants portion of the program. The diversity of opinion, the connectedness to the realities of water and energy supply, including the constraints of the regulatory environment, and the continued engagement that can be realized with an active advisory panel warrants the creation and continuation of this body. This advisory panel can provide a continued perspective on all parts of the research to development to demonstration to application cycle. These perspectives include keen insight to the future direction of research and early engagement of the market makers, the key

leaders of industry that will be essential in the successful introduction of high impact technology. While the initial road mapping activities will provide a basis for the program execution through the identification of research priorities, the advisory panel will be able to provide a periodic and continuous feedback and guidance to the DOE to enhance the probability of success of this effort. Participants in the roadmap guiding executive councils will likely provide an important source for advisory panel membership.

*Question 4b.* Should industry and end-users also be included in the road mapping called for by S. 1860?

Answer. Yes, for two primary reasons. First, a road mapping activity that includes industry and end-users has the potential for completely identifying the true needs of the industry. Secondly, the roadmap activity energizes and creates a new community, from research institutions to end-user organizations, who are involved in the road map development. This is particularly important in this diverse area of the energy and water interdependency. Our experience with the first and second desalination roadmaps has strongly demonstrated the value of industry and end-used involvement. The identification of key research areas and the broad community engagement in the process, including the formation of key partnerships to address key areas, are some of the major outcomes of these activities.

## QUESTIONS FROM SENATOR BINGAMAN

*Question 1.* Obviously with the existence of a National Laboratory Energy-Water Nexus team, the Labs have been looking at these water and related energy issues for some time. Given that, how long will it take to develop the technology roadmap called for in the bill, which is intended to establish the framework for investing the resources provided to the program, is anything currently underway in this area? If so, does it include representatives from government, the academic community, and industry?

Answer. Yes, there are currently two roadmap activities underway addressing energy-water related issues and both have representatives from government, academia and industry. The first is an updating of the Desalination and Water Purification Technology Roadmap which we and the Bureau of Reclamation first issued in 2003. That Road map was favorably reviewed by the National Research Council in 2004. Sandia, AwwaRF, the WateReuse Foundation, and the Bureau of Reclamation will issue the updated Desalination Roadmap in May, 2006. The second roadmap effort is focused on evaluating the issues surrounding future water availability for energy production and electric power generation. Like the Desalination Road map efforts, this roadmap effort includes industry, university, and federal and state agencies in definition of needs and technology direction needed. This second roadmap was initiated in August 2005, with needs definition workshops in November, December and January. This roadmap will be published September, 2006. Building on these two roadmap efforts, a third roadmap to address energy-for-water issues could be developed and completed in 12-18 months, as identified in the current legislation. Including all stakeholders in problem identification and recommendations of solutions has been shown to be a valuable process and should be included and continued in future efforts.

*Question 2.* S. 1016 focuses on the need to provide federal assistance to address the high energy costs associated with desalination. At the same time, GE's testimony indicates that over the past 25 years, the cost of seawater desalination has dropped from $20/1000 gallons to $4/1000 gallons.

Based on the current state of research and development, is there a significant chance that we will be able to significantly reduce desalination energy costs further in the next decade?

Answer. Yes. While the science and engineering associated with the desalination of sea water have made significant advancement over the past 25 years, the rate of decrease in cost has been approximately 4% per year. At $4/1000 gallons, the cost of desalinated water is still too expensive, prompting a need for incentives to cover energy costs. When published in 2003, the Desalination and Water Purification Technology Roadmap called for a goal of a 5 times reduction in the cost of reclaimed waters before 2020. Reduction in energy costs and brine disposal costs, particularly for inland desalination, are required to bring the cost of water to competitive levels. The Desalination and Water Purification Road map highlighted many advanced concept improvements capable of revolutionizing the science and practice of desalination. Following the road map principles, we are pursuing those concepts with the combination of the highest likelihood of success and highest impact. Examples of potential major breakthroughs in the long term include the development of nanostructured membranes based on the same principles used in the human body

and the development of a lower energy intensive, zero liquid discharge system which would greatly enable inland desalination by reducing or eliminating the brine disposal problem.

*Question 3a.* Please briefly explain some of the promising technologies that are being developed for assisting communities with arsenic removal.

Answer. During the Environmental Protection Agency's (EPA) review of the new arsenic standard, the best available technologies included: Ion Exchange, Activated Alumina, Reverse Osmosis, Modified Coagulation/Filtration, Modified Lime Softening and, Electrodialysis Reversal. In addition to these processes, the EPA identified other emerging technologies, including conventional iron removal processes, manganese greensand process, coagulation-assisted microfiltration, and iron-based media adsorption.

Projected costs associated with these technologies were prohibitively high, especially for small systems. Reduction of these costs requires improvements in treatment processes including 1) fixed bed adsorbent media with higher selectivity and greater capacity and durability 2) batch systems with superior coagulation/flocculation or membrane filtration efficiencies, or 3) electrochemical systems with increased efficiencies and lower power requirements.

*Question 3b.* Will any of those technologies be deployable on a commercial basis within the next 5 years?

Answer. Yes, but the issue is about cost and the appropriateness of the treatment technology for each water system. New EPA regulations go into effect on January 1, 2006, with a provision for approved delays in implementation for cases where improved technology will be available at a later date. This regulation provides the market driver and commercially available technologies are available now to address this market. However, the issue is not commercial availability. The issue is cost. Sandia National Laboratories continues to develop technology-specific improvements, primarily using fixed bed absorbent media, targeting cost reduction in this area through the arsenic partnership with WERC and AwwaRF and our rural outreach program.

*Question 3c.* Are the issues faced with affordable arsenic removal systems similar to the issues being faced in the area of desalination? For example, are energy costs and concentrate disposal prominent issues in developing arsenic removal systems?

Answer. While the issues facing arsenic removal and desalination are similar, there are striking differences in the relative importance of the various factors. Energy consumption is a major factor in current desalination technologies (ranging from 40% for seawater desalination to 5 to 10% for the total cost for inland desalination). Energy consumption is a smaller concern for current arsenic removal technologies (ranging from 2 to 4% of the total cost for arsenic adsorptive technologies). Disposal costs profiles are also very different for arsenic and desalination technologies. Disposal costs for desalination vary from 5 to 50% of the total depending on regulatory barriers and accounts for 10 to 20% of the total for arsenic adsorptive technologies. The key target research areas to reduce cost in treatment of water involve reduction of energy use, reduction of disposal costs and cost effective material development for the treatment methods.

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AWWA RESEARCH FOUNDATION,
*Denver, CO, November 8, 2005.*

Hon. PETE DOMENICI,
*Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.*

DEAR SENATOR DOMENICI: Attached please find the responses of AwwaRF to the questions submitted by you and Senator Bingaman in follow-up to the public hearing held you held on October 20th with regard to S. 1860.

We believe that S. 1860 is a visionary legislation that will help the water community, along with local, state and federal governments to address the water supply challenges of the 21st century. New and energy efficient water technologies that can be adopted for daily use at water agencies and approved by state regulatory agencies hold the potential for us to make use of previously unusable sources of water including brackish groundwater and our oceans.

This will not be an easy task, either in identifying the most promising new technologies or in making sure that they are actually installed and made operational at the local level. S. 1860 is one of the most exciting developments in the water supply community for many years. Its potential impact ranks with the introduction of treated drinking water in the early 20th century and other milestones that have had such a positive impact on the life of our nation.

We believe that AwwaRF's experience in managing over a third of a billion dollars in drinking water research and over 900 projects will be a useful support in this process and we look forward to putting this expertise at the service of the goals of your legislation. It our hope that our answers to your questions will help to support the S. 1860 process and move it towards becoming law. Thank you again for the introduction of this bill and for the opportunity to share our ideas with you.

Sincerely,

ROBERT RENNER, P.E.,
*Executive Director.*

[Enclosure.]

AWWA RESEARCH FOUNDATION RESPONSES TO QUESTIONS FROM SENATOR DOMENICI AND SENATOR BINGAMAN

On October 20, 2005, the Awwa Research Foundation (AwwaRF) provided testimony, through Dr. Pankaj Parekh, Los Angeles Department of Water and Power, to the Senate Committee on Energy and Natural Resources, chaired by the Honorable Pete Domenici.

Following this testimony, Chairman Domenici provided additional questions to Dr. Parekh to supplement AwwaRF's testimony regarding Senate Bill 1860.

To better understand AwwaRF's response to the Chairman's questions, it is essential to first be aware of the important and unique capabilities of AwwaRF, which would ensure that the energy-water objectives of S. 1860 are achieved. AwwaRF's long-term success in the direct application and commercialization of promising technologies by water utilities in a timely manner is particularly relevant.

AwwaRF has a 40-year history of conducting research for the water supply community. AwwaRF has worked in partnership with all stakeholders associated with drinking water, including water utilities, consultants, academic researchers, manufacturers, national laboratories, industry associations, and regulatory agencies. To achieve the objectives of this bill, all of these stakeholders must be involved. Because of the good working relationships AwwaRF has already forged with each of these stakeholder groups, it is at the center of a wide stakeholder network.

AwwaRF has communication mechanisms in place to reach decision makers throughout the water supply community. We also work cooperatively with trade and professional societies that help establish the best practices and standards for the industry. AwwaRF is considered a reliable source of credible scientific information by water utilities, consultants, state regulatory agencies, EPA, and international groups.

Through AwwaRF research, emerging technologies such as ozone, membranes, and ultraviolet treatment were proven to be reliable and affordable drinking water treatment processes. These technologies are now widely accepted by utilities. AwwaRF not only supported the groundbreaking research on these technologies, but also performed the necessary research to prove efficacy and reliability so that water utilities, regulators, consultants, and equipment manufacturers had the confidence to implement them. AwwaRF's comprehensive research addressed not only the technical aspects of these technologies, but also how they work with existing processes, potential secondary impacts (waste products, etc.), and other implementation barriers that are apparent only by being intimately aware of the needs of the user community. The rapid commercialization and deployment of membranes and ultraviolet treatment processes was a direct result of AwwaRF's comprehensive research and the unique relationship that AwwaRF has with the various stakeholders and organizations.

AwwaRF's experience has determined that successful deployment and commercialization of new technologies require three components: 1) developing a viable, tested technology, 2) gaining acceptance by stakeholders (users, consultants, and regulatory agencies), and 3) rewards or other incentives for trying an innovative technology. Deploying a new technology vs. using a "tried and true" proven technology entails substantial risk. Therefore, all three components are necessary to minimizing the risk. Working with a trusted organization that has strong ties to the user community is essential. AwwaRF's 40-year history of conducting scientifically credible research in partnership with key stakeholders is essential for success of this program.

While it is important to identify and fund research on promising treatment technologies, it is equally important to address real-world issues of implementation and operations so that developed technologies will indeed operate as envisioned for end users. Such real-world research validates the actual performance of technologies, their energy requirements, operation and maintenance issues, and any unforeseen

problems. The ability to understand the user community's needs in all aspects of the research—from concept identification through commercialization—is required.

AwwaRF has established a much-emulated model for managing and administering research projects. Stakeholders are involved from the planning phase through to project completion. AwwaRF has a proven peer review process that obtains stakeholder input throughout a project's course. This allows for any corrections or adjustments to be made during the course of the research, not after the research is complete. AwwaRF has deployed an innovative approach for obtaining in-kind contributions to research projects that ensures end-user involvement while increasing the resources available to conduct the research.

AwwaRF would bring the critical component of active stakeholder involvement to S. 1860 by identifying the needs of the user community, funding and managing research that addresses the "real-world" issues of the water supply community, and communicating the results of the research findings to the water supply community and other key stakeholders. AwwaRF would ensure a robust synergy between the national laboratories and the end users of new energy-efficient, environmentally sound technologies.

RESPONSES TO THE QUESTIONS ARE PROVIDED BELOW

*Question 1.* How will your experience partnering with water suppliers be brought to bear in carrying out S. 1860?

Answer. AwwaRF has a long history of working with stakeholders in addressing barriers that can prevent or delay new technologies from reaching the market place. AwwaRF would provide a trusted link with the research and water supply community. In addition, AwwaRF can attract national experts and organizations that can bring expertise to bear because of first-hand experience working with them.

An important factor in the successful application of new technologies is the confidence of water suppliers that a new technology will solve their specific problems. An example is cost-effective compliance with meeting the new Maximum Contaminant Level for arsenic. Confidence in a new technology is based on case studies that demonstrate how the technology performs under the various stages of real-world conditions: treating the actual source water, monitoring the process, assessing the level of operation and maintenance needed to ensure the technology is working, "debugging" equipment, determining maximum and sustainable water production to meet water quality goals and community needs, waste products and projected disposal cost, the pilot and full-scale evaluations necessary to generate data needed, etc. AwwaRF understands the need to develop this real-world knowledge so that utilities, consultants, regulators, and manufactures will accept new technologies. For the past two decades, AwwaRF has involved these stakeholders in demonstration/field studies.

AwwaRF's proven expertise in partnering with the water supply community on new technologies is a vital element in ensuring the success of S. 1860.

*Question 2.* Based on your experience, does this bill go far enough to encourage relationships with water suppliers?

Answer. AwwaRF does not believe that S. 1860, as introduced, guarantees that the drinking water community's critical involvement will occur in the desired manner. Without the early inclusion of the major drinking water stakeholders, there is little chance that technologies identified by the national laboratories will rapidly move from the concept stage to commercialization. The national laboratories acknowledge that they currently have limited experience working with the water supply community and have approached AwwaRF in the past to help them forge that link.

AwwaRF's multi-staged research program has resulted in commercialization, wide-spread use, and world-wide acceptance of technologies as evidenced by the rapid deployment of membrane and ultraviolet technologies by the water supply community. For both these technologies, AwwaRF developed a long-term research strategy with key stakeholders to identify essential research before these technologies could be implemented by water suppliers. Using ultraviolet (UV) treatment as an example, the AwwaRF research strategy included: 1) proof that UV was effective in killing protozoans (*Cryptosporidium, Giardia*), 2) evaluation of UV lamps that were best suited for disinfection, 3) evaluation of on-line UV sensors to ensure the prescribed UV dose needed to achieve disinfection, 4) assessment of UV reactor design, 5) operation and maintenance of UV systems, and 6) development of a guidance manual to assist in the decision on use of UV to meet utility water quality requirements and compliance with EPA. In all stages of the research, the stakeholders (researchers, public health agencies, water utilities, regulators, manufac-

tures, and other research organizations) were involved to help ensure that UV treatment for drinking water would become a reality.

To best ensure that the objectives of S. 1860 are realized, AwwaRF should be specifically identified as an integral partner in the research effort with the national laboratories.

*Question 3.* Do you believe that a provision requiring outreach should be contained in S. 1860 or can this be accomplished by the advisory panel?

Answer. S. 1860 should include a provision requiring outreach in all aspects of program development. As described above, effective outreach is necessary for new technology to gain acceptance.

In this area, AwwaRF can greatly assist in meeting the objectives of S. 1860. AwwaRF has a long track history of communicating with water utility decision makers and other stakeholders and working in partnership with industry trade and professional associations. AwwaRF has proven mechanisms in place to obtain stakeholder feedback and has developed outreach projects based on this feedback.

*Question 4.* S. 1806 is intended to result in the development of economically viable products that are ultimately adopted by the water community. S. 1860 has a significant focus on technology transfer and commercialization of technologies.

Do you feel that S. 1860 goes far enough in this respect?

Answer. AwwaRF believes that additional attention should be given to the issue of technology transfer and commercialization. As currently introduced, S. 1860 describes the technology roadmap but not a commercialization roadmap. The terms for commercialization are not clear. Will the private sector or the national laboratories be responsible?

The commercialization of economically viable products or technologies is determined by a number of variables: 1) sufficient pilot-and full-scale utility-based experience that a technology is proven to justify commercialization, 2) a sufficient potential long-term market (i.e., public water suppliers) that could and would purchase a new treatment technology, 3) the technology is affordable and can be used with confidence by the expected user community, and 4) there are no unreasonable regulatory or other barriers in states where this technology would be best suited. AwwaRF understands these variables can significantly impact commercialization of technologies. The publication of reports or holding workshops on promising technologies is not adequate for the private sector to consider the commercialization of a new technology. S. 1860 should earmark appropriate resources to develop sufficient real-world knowledge on promising technologies so that the private sector can adequately determine economic feasibility.

*Question 5.* Based on your partnerships with communities, how would you bridge the gap between research and commercialization of technologies?

Answer. AwwaRF has been intimately involved in bridging the gap between research and the implementation of research findings by the water supply community. In 1994, AwwaRF launched an innovative research applications program to ensure that research on promising technologies will lead to adoption and commercialization of these technologies. AwwaRF has also established the trust of key stakeholders in providing credible, scientifically defensive, and practical research findings.

Other keys to closing the research/commercialization gap are as follows:

1) Know the audience and make sure the research addresses their needs. AwwaRF has analyzed the barriers to the implementation of new technologies. AwwaRF also has in place two-way communications mechanisms for gaining water community input through all aspects of the research program, from idea conceptualization to outreach.

2) Involve stakeholders in all aspects of the research program. It is critical to identify key stakeholders and then involve them in all aspects of the research program.

3). Use communication and outreach through multiple channels. In today's internet age, it is essential to provide information in user friendly formats. AwwaRF has developed "user friendly communications tools using with stakeholder feedback.

4) Work with trade groups, professional societies, and regulatory agencies to establish standards and industry "best practices" that promote the use of innovative technologies.

5) Work with different organizations through different phases of development and implementation. For example, most pioneering theoretical research is conducted in academia. Design and operations research is often lead by consultants or water utilities. AwwaRF's network of researchers covers all phases of development.

To restate, the drinking water stakeholders, including water suppliers, regulators, and consultants, need unequivocal proof and confidence that a new technology will perform as expected. For this reason, AwwaRF has historically funded pilot and full-scale projects on emerging technologies to provide stakeholders with the assurance they need to purchase, install, and operate new treatment technologies.

*Question 6.* Do you believe that more money appropriated to S. 1860 should be dedicated to competitive grants?

Answer. Yes. The evolution from research to commercialization requires many different skill sets, and no single organization can have the expertise on hand to address all aspects of the development cycle. Competitive grants provide the opportunity to involve the best and brightest experts and organizations. Also, because one of the most expensive aspects of research is capital equipment, the competitive process can bring in organizations that already have pre-existing capital equipment, staff, and facilities to perform the research on energy-efficient technologies. Competitive grants can optimize multiple resources.

AwwaRF has a much-emulated project management and competitive research program that complies with all government requirements. We have been contracting out research for over 25 years with major universities, consulting firms, and utilities.

Given the need for end users to field-validate promising energy-efficient technologies to better ensure future commercialization, AwwaRF believes that sufficient competitive grants are necessary. While the national laboratories, in concert with AwwaRF, can identify and manage projects on promising energy-efficient technologies, they may not have the long-term expertise that AwwaRF has in managing real-world demonstration projects that involve water supplies, consultants, state regulators, and manufacturers. AwwaRF has track record of bringing these stakeholders to develop, manage, and publish the results of both pilot and full-scale technology evaluations. AwwaRF recommends that S. 1860 stipulate that appropriate funds—$4-5 million annually—be allocated for competitive grants for the purpose of evaluating promising technologies in the field.

More may be necessary if the technical panel agrees it is needed to adequately evaluate promising technologies.

*Question 7.* In what areas should the federal government focus it research?

Answer. S. 1860 established an Energy-Water Efficiency and Supply Technical Advisory Panel to identify and recommend research priorities. AwwaRF believes that this panel would be best qualified to determine the research focus, with the following consideration.

The language of S. 1860 is not clear as to whether the AwwaRF is to be specifically included on this panel. Given AwwaRF credentials as the world's largest drinking water research organization and the inclusiveness of the drinking water community (utilities, consultants, researchers, health agencies, manufactures, water supply professionals) in AwwaRF research programs, We believe that AwwaRF should be named as a standing organization on this advisory panel.

*Question 8.* Do you believe that the scope of research authorized by S. 1860 is broad enough or should it include additional research areas?

Answer. AwwaRF believes that the scope of research authorized by S. 1860 should be broad given that the advisory panel, with appropriate representatives for the drinking water community, will provide the research focus and direction. The recent hearing, however, made it clear that S. 1860 should focus on new treatment technologies for ocean and brackish water desalination and also on energy technologies that will reduce the amount of power needed for treatment of these waters.

*Question 9.* Do you believe that the peer review required by the bill is adequate?

Answer. AwwaRF believes that the technical panel should be charged with ensuring that there is appropriate peer review of projects, whether conducted by the national laboratories or organizations receiving grants under this bill. The technical panel should have the authority to seek outside experts to provide peer review during project scope of work development, periodic review of project progress, and technical review of final reports. AwwaRF has had great success with building ongoing peer review processes that include both technical expertise and stakeholders. AwwaRF strongly recommends that stakeholders be included in the peer review process.

*Question 10.* In your testimony, you mentioned legal and regulatory barriers to using new technologies in real-world applications. S. 1860 directs an advisory panel to identify these barriers.

Do you believe that this bill goes far enough in addressing this issue? What additional steps would you suggest?

Answer. AwwaRF agrees that the panel should be charged with identifying promising technologies and addressing barriers to implementation. AwwaRF has inves-

tigated the barriers to new technologies and could bring this expertise to the technical panel.

Since AwwaRF has been involved in the development of emerging water treatment technologies and is fully aware of the difficult and lengthy road to acceptance and commercialization of these technologies, AwwaRF understands the many barriers that need to be overcome. In general, barriers include: 1) cultural barriers—water suppliers and regulators are cautious about new technologies, 2) lack of rewards for innovation—there is little incentive for water suppliers, consultants, or regulators to champion new technologies, 3) disconnect between organizations involved in technology development—a justification why AwwaRF is an integral component to the success of S. 1860, 4) market barriers—minimum venture capital and low return on investment, 5) regulatory barrier—states independently approve new technologies for drinking water, and 6) information explosion—multiple new technologies to address different and sometimes conflicting drinking water regulations.

It is recommended that S. 1860 consider approaches for eliminating some of these barriers, e.g., a national certification of new technologies that will enable states to more quickly approve these new technologies or possible economic incentives to the private sector for commercialization of new technologies where the potential market is unknown or uncertain.

*Question 11.* There are many utilities or local governments serving low-income communities that are facing significant water supply challenges in the future.

Does AwwaRF currently have a program in place to reach-out to these communities to help the water suppliers serving them take advantage of new and cost-effective technologies that are developed as a result of AwwaRF's research?

Answer. AwwaRF's membership consists of approximately 900 water utilities that serve approximately 80% of the U.S. population. AwwaRF also works closely with other water industry associations such as the American Water Works Association (and its local sections), National Association of Water Companies, and Association of Metropolitan Water Agencies to widely disseminate the results from its research efforts.

AwwaRF and its utility subscribers are keenly aware of the need to provide safe, affordable, and reliable drinking water to all citizens. The results of a large number of AwwaRF projects enable water utilities to improve water quality, optimize operations, and provide better customer service while maintaining affordable water rates. While AwwaRF does not have a research program specifically related to low-income communities, a report entitled Water Affordability Programs describes affordability/rates programs offered in the U.S. as well as case studies and criteria for establishing water rates.

In addition, many AwwaRF projects provide direct benefits to small and rural communities. Examples include the suitability of affordable membrane and ultraviolet technologies to treat drinking water for small communities, regionalization strategies, and innovative water distribution rehabilitation techniques. AwwaRF also provides copies of reports to all state drinking water agencies so that all public water systems can benefit from AwwaRF research.

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## RESPONSES OF THE OAK RIDGE NATIONAL LABORATORY TO QUESTIONS FROM SENATOR DOMENICI

*Question 1a.* Oak Ridge National Laboratory has been very successful in producing products that have great commercial value.

Do you believe that you will have similar successes in the commercialization of products with the authority provided by S. 1860?

Answer. If the proposed Water Technology Program is established, it will bring new programmatic direction from the U.S. Department of Energy (DOE) that will allow ORNL researchers to focus their efforts on important energy-water topics. Given the emphasis on technology transfer defined in the proposed Act, we would expect significant success in commercial end-products. ORNL is the nation's most successful multi-disciplinary science laboratory relative to partnering with industry to achieve commercialization of new technology and providing general technical assistance. Currently ORNL maintains 990 separate industrial partnerships where industry provides direct support, industry support is leveraged with federal support, or ORNL and an industry compete successfully together for sponsor support for technology development work. ORNL is second only to General Electric in the number of R&D 100 awards it has won—this "Oscar of Invention" recognizes both technical innovation and future value to the marketplace. Commercialization of technology for public benefit is an integral part of the corporate philosophy of Battelle,

one of the managing partners of ORNL. Our commitment to this philosophy will be important to the success of this new Program.

*Question 1b*. Based on your experience, which would be the best office within DOE to foster the application of new technologies for use in real-world applications?

Answer. There are several DOE Offices that need to be involved in the new Program, each of which has its own unique responsibilities and capabilities. The relevant offices include Science, Energy Efficiency and Renewable Energy, Fossil Energy, and Nuclear Energy. Because multiple offices are involved, coordination across several Assistant Secretaries will be essential to success. The current roadmapping exercise will better define the scope of the program and should be used to determine the appropriate lead DOE office for the program.

*Question 1c.* Which of the missions contained in S. 1860 do you believe Oak Ridge National Laboratory is best qualified to undertake?

Answer. We assume the missions are those listed under Section (b) Establishment. Although ORNL is well prepared for all of the missions, we are best qualified for: 1) R&D to promote the sustainable use of water for energy production activities, and 2) commercialization of newly developed energy-water efficiency and supply technologies. Our qualifications in the water-for-energy mission are based on our existing programs in Basic Energy Sciences for DOE's Office of Science and Energy Efficiency and Renewable Energy, as well as on related work for the Nuclear Regulatory Commission, the Federal Energy Regulatory Commission, and DOE's Fossil Energy and Nuclear Energy offices. ORNL is DOE's largest energy R&D laboratory, and our staff has excellent credentials in sustainable water research. ORNL is DOE's leading laboratory for energy efficiency R&D, which is interrelated to water-use efficiency. For example, in support of DOE's Industrial Technologies Program, ORNL has developed Best Practices tools, training, and information resources for energy efficiencies in industrial pumping, steam, process heating, fan, and motor systems. This expertise, combined with other water management experience at the Laboratory, is directly applicable to technological improvements in water-use efficiencies in many parts of the energy sector. In addition, ORNL is one of DOE's leading laboratories for hydropower R&D, where we are completing a state-of-science review on water-use efficiencies. In three decades of work for DOE, FERC, and EPRI on hydropower and thermoelectric cooling issues, ORNL staff have developed a unique understanding of the multiple-use challenges of water resource management in the U.S.

ORNL's qualifications for commercialization end-points stem from our strong commitment, experience, and performance in technology transfer, as well as our existing capabilities and experience in program evaluation, performance measurement for government programs, economic and policy analysis, and technology assessment. For example, ORNL has long and continuing experience in assessing economic, social, institutional, legal, and regulatory factors relating to the introduction and adoption of a variety of technologies. Much of that work has focused on energy-efficiency and supply technologies, primarily for DOE's Office of Energy Efficiency and Renewable Energy. Moreover, that work currently involves analysis of the limits to the penetration of a suite of energy-efficiency technologies that are, or are anticipated to be, in the market over the next 100 years. In addition, ORNL had developed and implemented models and metrics for ascertaining the benefits of varied DOE energy efficiency programs and initiatives. ORNL also has experience in a variety of natural resource assessment topics that includes analysis of fuels and renewable resources and tools to address related issues of public policy. Water policy studies that would impact commercialization activities would follow directly from this experience.

*Question 1d.* What research capabilities does Oak Ridge National Laboratory have that are not available in the private sector?

Answer. ORNL has research and development capabilities for inorganic membranes that exists nowhere else, advanced computational science capabilities for applications ranging from modeling nanostructures and microfluidics to regional forecasting of water and energy supplies and demands, multidisciplinary staff that can be directed to mission-critical activities that are long-term and high-risk, and unique strengths in separations R&D, neutron science, nanomaterials design, manufacturing and testing facilities, and experience running large multidisciplinary programs.

Compared to the private sector, ORNL offers a number of unique research facilities that would be very valuable in developing new water technology R&D. Our advanced user facilities are the most obvious of these, but not the only relevant ones. The official DOE-designated User Facilities applicable here include the Buildings Technology Center; the Center for Nanophase Materials Sciences; the Cooling, Heating and Power Integration Laboratory; the High Temperature Materials Laboratory;

the Physical Properties Research Facility; the Power Electronics and Electrical Machinery Research Laboratory; the Shared Research Equipment Collaborative Research Center; the National Center for Computational Sciences and its subsidiary parts, such as the Computational Center for Industrial Innovation and the Material Research Institute; and the new Spallation Neutron Source. We also have other, non-designated facilities that are applicable to water technology research, such our Seaflow Process Simulator, where we are studying gas hydrate formation at depths up to 2000 m, processes which can used to separate salts from freshwater. Each of these facilities contains the latest analytical and testing equipment to support cutting edge research. ORNL's uniqueness goes well beyond our physical facilities to the multi-disciplinary staff that we have working on the most challenging problems. We have a solid track record for successfully managing large, interdisciplinary research programs, and we have scientists experienced in solving water resource problems. Because our staff is relatively free from market-or profit-driven pressures, we can provide long-term continuity needed for success in high-risk research missions. ORNL's most important asset is the combination of outstanding facilities and highly qualified research staff.

*Question 2a.* S. 1860 emphasizes coordinating water resources research among federal agencies.

How do you plan to coordinate your activities with water resources research being undertaken by other agencies and research undertaken by entities that receive grants under S. 1860?

Answer. The specific means of coordination would depend on DOE direction and the organization of the new Program. However, we can speculate on several possible mechanisms, based on proven approaches from successful programs at ORNL. Different approaches would be needed for coordination among agencies, especially above the working level, and for coordination among other entities (e.g., academic institutions) and active researchers. In the case of agencies, an Interagency Working Group consisting of federal employees should be set up with DOE in the lead, to develop and implement something like a five-year coordination plan. The CENR Subcommittee on Water Availability and Quality (SWAQ) already appears to be headed in this direction on the broader topic of Grand Challenges in water information and research. Water technology development should be one of the SWAQ Grand Challenges.

To coordinate among active researchers, including the other entities to be funded, we recommend following successful models that we have participated in or led. One example is the current Environmental Remediation Sciences Division (ERSD) Field Research Center, supported DOE's Office of Science at ORNL. The ERSD FRC conducts subsurface science studies in the field or in the laboratory with field-collected samples. The ERSD holds annual Principal Investigator workshops to bring laboratory and academic researchers together with agency personnel to discuss progress. We also form topical working groups that meet semiannually to coordinate specific research. Another good example of research coordination was the DOE Environmental Management's (EM) Science and Technology Program that studied critical R&D needs for clean up of DOE facilities and sites. The equivalent of "roadmapping" was accomplished with DOE, Labs, Industry, and university participation. Various "lead labs" were selected for topical areas (robotics, subsurface science, separations, characterization/monitoring, etc.). Integrated demonstrations of new technologies were implemented with teams of several Labs and universities. The methods were tested and evaluated to determine the best practices. The safe and effective removal of radioactive tanks and residual contaminants at ORNL directly benefited from a robotic effort across several Labs, universities, and industries. Basic science on chemical separations at ORNL resulted in new methods implemented at the Savannah River Plant to process high-level waste in storage tanks for ultimate disposal.

*Question 2b.* Please describe the nature of the memorandum of understanding you recently entered into with the Corps of Engineers. How has this agreement promoted ORNL's relationships with other agencies?

Answer. The MOU is between ORNL and the two main Corps of Engineers laboratories: the Engineering Research and Design Center (ERDC) in Vicksburg, MS, and the Institute for Water Resources (IWR) at Fort Belvoir, VA. The MOU covers mutual interests in water resources, energy security, and environmental sustainability. It was signed on September 12, 2005, in Oak Ridge,. The first step in its implementation is to develop a white paper that will describe research opportunities in analysis, assessment, prediction and decision support, basic science, and technology innovation, all relevant to the energy-water nexus. A joint business plan will be completed over the next several months. We expect that ORNL will add scientific value to the engineering and environmental services that ERDC and IWR now pro-

vide and that ORNL's role in successful joint projects will be evident to other agencies associated with Corps activities. ORNL has already earned a strong reputation for science-based problem-solving with the Corps and other agencies, including NRC, FERC, EPA, and environmental NGO's. We hope to bring this positive reputation to bear on future joint projects with the Corps.

*Question 3.* In your testimony, you state that technology that would be developed as a result of S. 1860 would "have many important benefits beyond providing for water and energy needs."

What broader application would these technologies have?

Answer. Providing for the water and energy needs of citizens and industry is a critical part of national economic security and Homeland Security, including disaster response/recovery. One example of how new technology could help improve national security comes from the recent hurricane disasters on the Gulf Coast, where water and power were lost in large areas. Portable, low-power water treatment packages that could include new separations methods and new filtering materials from this Program would improve the response to these types of disasters by restoring critical services to disaster victims. On the international front, new cost-effective solutions for clean water are likely to come from this program, for example using inorganic membranes. New water sources in resource stressed regions of the developing world can improve public health, reduce political tensions, and ultimately help stabilize governments. New energy-water technology could also help Department of Defense facilities be more operationally secure and sustainable, both inside the U.S. and in other countries. These technologies would be applicable to military bases, reducing local competition over scare water resources, reducing the environmental footprint of bases, and ensuring dependable water resources.

*Question 4a.* Oak Ridge National Laboratory would contribute a different regional perspective than the other lead laboratories.

How would you bring your past and present partnerships to bear in solving regional water problems?

Answer. ORNL has well-established working relations with key organizations in the Eastern U.S. that will be critical in developing new water technologies. For example, in September of this year, ORNL signed a Memorandum of Understanding with the U.S. Army Corps of Engineers' Laboratories for cooperative work on energy, water, and environmental sustainability. An integral part of UT-Battelle's management structure for ORNL is a set of Core Universities that include Duke University, Florida State University, Georgia Tech, North Carolina State, Vanderbilt, the University of Virginia, and Virginia Tech, as well as the University of Tennessee and Oak Ridge Associated Universities. This established university network will be an important mechanism to bring the skills of academic institutions to bear on water problems. We have already begun to identify key researchers at these institutions and to involve them in the EWN Roadmapping to stimulate their interest in water technology.

ORNL has collaborative water-related research activities with many other entities, such as TVA, EPRI, USGS, NOAA, DOD and its Office of Naval Research, FERC, and others. ORNL also has a proven track record of cooperation with other DOE laboratories, as well as with the university-based Water Resources Research Centers in Tennessee, Georgia, and elsewhere in the southeast. We would take advantage of these relations in implementing any new water technology program.

*Question 4b.* What do you offer that the other laboratories do not?

Answer. Some of the answers to this question were provided in our response to Questions 1(c) and 1(d) above. ORNL is DOE's largest Office of Science Laboratory and one of the two leading Energy Efficiency and Renewable Energy labs (along with NREL). ORNL has a unique combination of expertise in materials science and separations science that is well aligned with the R&D needs for energy-water technology. ORNL is among the world's largest materials science laboratories, and our inorganic membrane technology does not exist anywhere else. Separations science has long been an ORNL leadership area, and our separations technology is being deployed on an industrial scale. With our private-sector partners, we recently completed a strategic planning report on "Materials Research for Separations Technologies: Energy and Emission Reduction Opportunities" that is very relevant to new water technology development. ORNL also has considerable expertise and experience in "closing the loop" between technology deployment and its effective use within social and institutional settings. We have been developing decision support tools, providing continuing decision support training and information, and meshing science and technology with users' needs for many water-related projects, including work for the Army National Guard, Department of Education, Department of Homeland Security, Department of Energy, and the multi-agency Strategic Environmental Research and Development Program. We are unique in having the full range of

water-relevant capabilities together with strong regional and national partnerships to advance the Water Technology Program.

RESPONSES OF THE OAK RIDGE NATIONAL LABORATORY TO QUESTIONS FROM SENATOR BINGAMAN

*Question 1a.* Obviously with the existence of a National Laboratory Energy-Water Nexus team, the Labs have been looking at these water and related energy issues for some time.

Given that, how long will it take to develop the technology roadmap called for in the bill, which is intended to establish the framework for investing the resources provided to the program?

Answer. Work has already started on an Energy-Water Technology Roadmap, coordinated by Sandia National Lab, by an independent Executive Committee with representatives from industry, academia, and other agencies (see: *www.sandia.gov/energy-water/*). The roadmapping process will produce an initial roadmap by the end of September 2006. We expect that this roadmap will define technical directions for new R&D relevant to at least the "water for energy" part of the Energy-Water Nexus. Vetting of these recommendations is expected by DOE offices and perhaps the National Academies. A technology roadmap suitable for guiding R&D investments of a new Water Technology Program should be achievable by mid-2007. That plan should be re-examined annually.

*Question 1b.* Is anything currently underway in this area? If so, does it include representatives from government, the academic community, and industry?

Answer. As stated above, roadmapping is underway. Representatives from other state and federal government agencies, academia, and industry have strong roles on the Executive Committee that will provide guidance and oversight to the roadmapping process and as participants in the regional Needs Assessment and Technology Innovation workshops that are part of the process. The federal agency representatives on the Executive Committee were chosen to provide continuity and coordination with the multi-agency planning that is happening in parallel within the Council on Environmental and Natural Resources' Subcommittee on Water Availability and Quality. ORNL staff serve on the roadmapping Advisory Panel of DOE national laboratory representatives, to provide planning and review support on all aspects of the needs assessment and technical innovation workshops.

*Question 2.* S. 1016 focuses on the need to provide federal assistance to address the high energy costs associated with desalination. At the same time, GE's testimony indicates that over the past 25 years, the cost of seawater desalination has dropped from $20/1000 gallons to $4/1000 gallons.

Based on the current state of research and development, is there a significant chance that we will be able to significantly reduce desalination energy costs further in the next decade?

Answer. There are significant opportunities to reduce desalination energy costs. In addition to reduced dollar cost of desalination, the benefits of new water technology R&D will also include reduced carbon emissions and reduced energy use in the water treatment sector. ORNL staff recently participated in a Task Force on Joint Water Reuse and Desalination. The consensus of that meeting was consistent with the GE testimony: current best practices in desalination yield costs of $4-5/1000 gallons. Near-term incremental improvements with currently available technology and no additional R&D investment will likely reduce costs further to about $2.5-3/1000 gallons. Challenging, but realistic, goals for future R&D are to reduce costs to $1/1000 gallons, to reduce energy use to 5 kwh/1000 gallons of water, and to reduce associated carbon emissions to 40% of current levels. It is noteworthy that brackish waters could become potable resources with even less energy input and lower cost, given new R&D investments. To achieve these ambitious goals, we need to apply substantial intellectual capital, including fundamental research and collaborative government-industry demonstration and testing. Advances beyond current technology are needed in: 1) control of biofouling and scaling, 2) treatment of mixed-quality waters, 3) new membrane design and construction, 4) new techniques for membrane regeneration, 5) reduced energy consumption and O&M costs, and other areas. An integrated, long-term, coordinated R&D program such as the new Water Technology Act is needed to meet these challenging goals.

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RESPONSES OF EDMUND ARCHULETA TO QUESTIONS FROM SENATOR DOMENICI

*Question 1a.* The two bills we are considering today take two different approaches to meeting water supply challenges. It is my understanding that the City of El Paso

recently began construction of a desalination facility which is expected to cost $87 million.

Do you believe the federal government should focus its investment on subsidies or water technology research and development?

Answer. The El Paso Water Utilities (EPWU) believes that federal investment in desalination should be in research and technology development because that is the most beneficial way to bring down the cost of ocean and inland desalination. It will also provide benefits to other communities by allowing such stakeholders to rely on effective research results.

*Question 1b.* Assuming that S. 1016 is passed before the El Paso facility begins producing desalinated water, how much help would S. 1016 provide?

Answer. Obviously, any subsidies would help, but because the energy costs of inland desalination are lower than ocean desalination, I do not believe that S. 1016 would have a substantial impact on the EPWU/Fort Bliss operation. The estimated capital plus operating costs of approximately $500 per acre-foot ($1.53/1000 gallons) is affordable to the consumer. Also, subsidies would send the wrong energy use signal.

*Question 2a.* S. 1860 provides that 40 percent of the funding made available for the bill would be for competitive research and demonstration grants while 30 percent of the funding would be made available for national laboratory research.

Do you believe that this allocation of money is correct?

Answer. Although there is substantial and unique expertise in the national laboratories, there is also a significant amount of existing and focused experience and expertise that can be utilized in non-profit water research foundations (e.g., the WateReuse Foundation and the Awwa Research Foundation), universities, and in local water/wastewater agencies. The WateReuse Association thus suggests that the allocation for competitive research and demonstration grants be increased slightly, perhaps to as much as 50%.

*Question 2b.* What technologies are the most promising to accomplish the objectives of S. 1860?

Answer. The Joint Water Reuse & Desalination Task Force (JWR&DTF), comprised of Sandia National Laboratories, the U.S. Bureau of Reclamation, the WateReuse Foundation, and the Awwa Research Foundation, recently convened three technical workshops on desalination technologies. The workshops focused on both membrane technologies (e.g., reverse osmosis) and alternative technologies (i.e., next generation technologies.

According to numerous experts from both the public and private sectors, membrane technologies will continue to be the most efficient, effective, and affordable technologies for many years. Many improvements can be made in the current generation of membranes to improve efficiency. The Task Force agreed, however, that work should begin now on identifying next generation "alternative technologies." Dr. Tom Mayer of Sandia prepared an excellent state-of-the-science paper on alternative technologies for use at the workshops. The Task Force would be pleased to make a copy of this report available to the Committee.

*Question 2c.* What has been your experience in your past partnerships with the national laboratories?

Answer. EPWU, along with CHIWAWA partners (New Mexico State, Texas A&M, UTEP and the City of Alomogordo) are currently developing three research programs related to inland concentrate disposal: deep hole injection, silica removal and salt tolerant plants. Initially, the CHIWAWA partners had hoped to gain some research funding through Sandia National Laboratories. Without an increase in Sandia's research account for this specific purpose, this will not happen in this initial phase of our collaboration.

As the past chair of the Awwa Research Foundation, I (Ed Archuleta) have worked with Sandia National Laboratories on cost-effective methods for arsenic treatment. This has been a great and positive partnership.

The WateReuse Foundation has partnered with Sandia National Laboratories as members of the Joint Water Reuse & Desalination Task Force (JWR&DTF) for about the past two years. The working relationship with the scientists and engineers at Sandia has been extremely positive. Members of the Foundation Board and staff also worked with Sandia on the development of the *Desalination and Water Purification Technologies Roadmap*. The working relationship with Sandia was excellent; they listened to input and suggestions and reacted positively.

Recently, Wade Miller, Executive Director of the WateReuse Foundation, was invited to serve on the Executive Committee of the Water-Energy Roadmap being developed by Sandia. The Foundation is pleased to be a part of this important effort to develop a roadmap that will define and characterize the energy-water nexus.

*Question 2d.* What research capabilities do the national laboratories have that are not available elsewhere?

Answer. Perhaps the greatest asset of the national laboratories is the collection of top scientists in fields ranging from geochemistry, physics, engineering, microbiology and other physical and biological sciences. These scientists possess in-depth expertise in basic and applied research and the breadth and depth of their collective capabilities is virtually unparalleled in the U.S. Examples of the "cutting edge" technologies in which the national laboratories have good expertise include nanotechnology and the computational chemistry needed for making designer materials. In aggregate, the national laboratories are an extremely valuable asset to the nation, both in terms of human capital and their ability to solve complex scientific and engineering problems.

*Question 3.* You state in your testimony that you have partnered with local entities to help them meet their water supplies. This relationship is very important to the success of S. 1860.

How would you recommend ensuring that the research undertaken pursuant to S. 1860 address real-world problems?

Answer. In the El Paso region, both El Paso and Alamogordo are building large desalination plants (El Paso's is under construction and Alamogordo's is under design), the biggest area that we want to cut costs and find a better approach is in concentrate disposal. Finding better, cheaper, perhaps more useful methods, will not only conserve water, but also save energy and better protect our environment.

With the Tularosa Desalination Research Facility under construction and with El Paso's TecH20 Center under design, we are the perfect model to advance the science of concentrate management in an inland area. Technical advances in this area would be of great value to cities in this country and around the world.

With the technical capabilities of national labs and universities, plus the practical needs of cities, we believe our consortium (CHIWAWA) is a good model to begin this work where the need is the greatest and the talent/human resources are there.

From the WateReuse Association and Foundation's perspective, S. 1860 should be modified to develop a mechanism to ensure that technologies are transferred to the entities that will utilize them, namely water agencies, wastewater agencies, and water management districts. Involving these organizational entities in the research and technology demonstrations envisioned in S. 1860 will help to promote "ownership" and acceptance by water/wastewater agencies. An emphasis should be placed on public-private partnerships; involving large stakeholders such as GE and Dow who have substantial expertise in membranes and membrane technology systems will ensure that whatever is developed will truly be "cutting edge" and applicable in local water/wastewater systems.

*Question 4a.* Constructing desalination plants is out of reach for many communities. The capital outlays required are too expensive for many small communities.

What are the major costs associated with in-land desalination?

Answer. The two major costs associated with inland desalination are concentrate disposal and energy. Capital costs account for approximately 50% while operating costs account for the remaining 50% of total costs. In southern California, total costs of a brackish groundwater desalting facility range from $650 to $800 per acre-foot (approximately $1.99-2.45/1000 gallons).

*Question 4b.* What breakthroughs in desalination technology would be required to allow more communities to adopt the technology?

Answer. Desalination is currently more expensive than other available sources of water. In terms of actual costs to produce and deliver, it may amount to as much as $1/1000 gallons. One of the initiatives of the Joint Water Reuse & Desalination Task Force (JWR&DTF) is to develop and implement a long-term integrated desalination research program that will ultimately result in substantially lower costs for desalination. At the recent workshops in San Diego, various desalination experts postulated that "step function" decreases in the costs of desalination are possible. Estimates of what can be achieved in cost reduction through research ranged from 20% to as much as 50% decreases. The working hypothesis of most water experts is that a significant decrease in desalination costs would result in more widespread use by communities.

With respect to impediments related to the advancement of desalination and reuse, one avenue of research involves the federal definition of concentrates otherwise known as brine residue produced through membrane dependent processes. These by-products must be disposed of in an environmentally protective manner. However, federal regulations have classified these waste products as industrial wastes. This regulatory designation requires disposal options that are more commonly applied to hazardous waste management and disposal. The disposal options under this scenario represent some of the most costly technologies to contain the

disposed of wastes. The issue for desalination and reuse water production is that a project sponsor must design and manage a disposal facility where the costs of disposal far exceed the environmental threats posed by the disposed waste or concentrate. This situation raises the cost of producing alternative water supplies because the costs of disposal must be imputed into the produced water price. We recommend that any final legislation should provide for an explicit statement that among the top priorities for research and technology demonstrations (and subsequent commercialization assistance) are efforts to develop processes and technologies that would either minimize or neutralize the production of concentrates. This kind of priority would hopefully lead to reduced concentrate production. This advancement would then reduce the costs of disposal and result in a reduction in the cost of alternative water supplies. It should also be noted that such advances in this area would enhance efforts to reduce arsenic removal costs because of the production of salts in this activity.

RESPONSES OF EDMUND ARCHULETA TO QUESTIONS FROM SENATOR BINGAMAN

*Question 1.* Both the WateReuse and AwwaRF testimony seem to indicate that the bill could do better job of integrating the private sector or water user community into the RD&D program? S. 1860 tries to do this through representation on the Advisory Panel, as well as eligibility for the competitive grant program.

Are there additional areas where you think that changes need to be made to address your respective concerns?

Answer. As noted in a response to a similar question by Senator Domenici, WateReuse would recommend the involvement of water agencies, wastewater agencies, and water management districts in the conduct of the actual research and technology demonstrations. The WateReuse Foundation, in its research program with the U.S. Bureau of Reclamation, requires a 25% cost-share by the successful research team. This requirement ensures participation by local water agencies since consulting engineering firms and universities have difficulty in providing this large a match. The cost-sharing requirement has the benefit of promoting collaboration between and among water agencies, the university community, consulting engineers, and even private manufacturers.

WateReuse very strongly supports the concept of public-private partnerships. In both of the coalitions in which our Foundation participates (JWR&DTF and the Global Water Research Coalition), we involve manufacturers such as GE and Dow Chemical to assure the public sector entities that the research being advocated is indeed "cutting edge" and will have a practical application. On the global front, Veolia Water and Suez Environment (both of France) are active participants and contributors to our Global Water Research Coalition.

*Question 2a.* Your testimony refers to a new desalination facility in Tampa, FL that produces water at an estimated cost of $2.54/1000 gallons, and compares that to the wholesale cost of water in California which is $1.50/1000 gallons. If the average household uses somewhere in the neighborhood of 12,000 gallons per month, it appears that desalination adds only about $12/month to the average household bill.

Is this correct (i.e. comparing apples to apples)? If it is correct, the desalination rate appears to be fairly reasonable given the long-term security of the supply—do you agree?

Answer. The comparison of $2.54/1000 gallons for desalinated Tampa Bay Water to the Metropolitan Water District's (MWD) wholesale price of $1.50/1000 gallons is really not a very good apples-to-apples comparison since one is a wholesale price and the other is a cost of production. What we were trying to illustrate in the testimony is that desalination costs would have to decrease by approximately $1.00/1000 gallons in order to be competitive with MWD wholesale water.

The average household generally consists of an average of 2.8 people and each person uses 125 per day. Thus, the 12,000 gallons per month per household number cited above is accurate. While $12/month seems palatable when one considers that 16 ounces of bottled water costs about $1.50, neither water utilities nor local politicians have done a good job of convincing the public of the value of water. In fact, water utilities deliver safe water of a very high quality on a 24/7 basis and the consuming public takes this valuable service for granted. In pricing water, economists often talk about the economic concepts of "ability to pay" and "willingness to pay." Consumers obviously have the ability to pay more for water, but do not have the willingness until and unless the water industry is able to demonstrate the value.

*Question 2b.* What type of monthly increase do you anticipate will have to be borne by the local ratepayers in El Paso as a result of the desalination facility you are bringing online?

Answer. El Paso Water Utilities increased water rates in 2004 to pay the anticipated debt service on the bonds plus expected operating costs. The average residential water bill increased by $4.01 from $20.57 to $24.58, or 19.5%.

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RESPONSES OF JIM REYNOLDS TO QUESTIONS FROM SENATOR DOMENICI

*Question 1a.* As communities run out of readily accessible fresh water, in many instances, desalination is the only option. S. 1016 would make payments to qualified entities for energy consumption associated with desalinating water.

Would the Authority be able to afford the construction and operation and maintenance costs of a desalination facility without the subsidy that S. 1016 would provide?

Answer. The rate payers living in the Florida Keys will ultimately be forced to shoulder the cost of desalinated water without the help of the federal government, due to the fact that the islands have no other means of providing water to meet their growing demands.

*Question 1b.* Would construction assistance be of greater assistance than an operational subsidy?

Answer. While we are not opposed to construction assistance grants from the federal government, we acknowledge the risk the taxpayers take when providing upfront costs for infrastructure improvement projects. S. 1016 provides assistance to facilities that have assumed the burden of such costs, as well as met all permitting guidelines and are actually producing water for public consumption.

*Question 1c.* If the Authority were to construct a facility in reliance on the subsidy provided by S. 1016 and funds were not available, would the authority be able to afford the operation and maintenance of the facility?

Answer. Again, the unfortunate truth is that the citizens of the Florida Keys will be forced to shoulder the cost of desalinated water whether we like to our not. As a utility, we have no other alternative due to the need to balance fresh water supplies in the fragile south Florida ecosystem with our demands, and the geological location and make up of the Florida Keys. That is, the islands of the Keys are remains of a once vibrant coral reef. Because of its extremely porous nature, the islands themselves are unable to retain fresh water.

*Question 1d.* What are the main costs of desalination?

Answer. The main difference in producing desalinated water opposed to drawing from fresh water sources is the high cost of electricity involved in the reverse osmosis process used to remove the saline and other minerals from the water. These costs can run as high as 40% of the overall cost of producing the water.

*Question 1e.* What breakthroughs in desalination technology would be required to allow more communities to adopt desalination technology?

Answer. The research and development of more efficient membranes and energy recovery systems have advanced the technology and lowered the cost significantly over the last twenty years. The ability to partner with corporations such as GE in the development, design and construction of working plants today, will go a long way in advancing the technology and lowering the cost of producing desalinated water in the future.

*Question 2a.* S. 1860 provide grants for projects demonstrating new technologies in real-world applications.

Would the development of cheaper desalination benefit the Authority? If so, how?

Answer. As I mentioned before, the Authority is limited by the amount of fresh water that is available for public consumption and because of our need to adopt alternative water supplies to meet our growing needs, advances in membrane technology and energy recovery would provide the most cost effective returns to the overall cost of producing desalinated water.

*Question 2b.* How would the Authority benefit from the grants provided in S. 1860?

Answer. We do not believe that the Authority would be eligible to receive the grants provided in S. 1860. The Authority is not an entity "with expertise in conduct of energy-water efficiency and supply technology research, development, and demonstration projects."

*Question 2c.* What has been the greatest difficulty in operating the Authority's two desalination plants?

Answer. The greatest difficulty in operating the plant is the cost of maintenance and our ability to hire skilled tradesmen such as mechanics and electricians to keep the plants operational in such a corrosive environment.

*Question 3a.* In your testimony, you state that an operational subsidy is favorable to a construction subsidy. This is different than traditional federal support.

Why is an operational subsidy preferable in providing Federal assistance for desalination?

Answer. While the availability of energy assistance grants will encourage the development of desalination projects, these grants will be performance based. In other words, the Federal government will bear none of the risk of project permitting and construction as it does under the construction grant approach. Only those projects that are technically, environmentally and economically sound, and have actually been constructed will be eligible to apply for the grants.

RESPONSES OF JIM REYNOLDS TO QUESTIONS FROM SENATOR BINGAMAN

*Question 1a.* Is it your view that valuable desalination projects will not be able to go forward in the near future if federal assistance is not provided to help pay for Project operating costs?

Answer. We believe the grants in S. 1016 will provide communities with the much needed financial assistance to compensate for the exorbitant costs currently associated with producing desalinated water, and in turn provide minimal rate increases to consumers while further research and development is taking place.

*Question 1b.* How was the $0.62/14 kilowatt-hour payment figure derived?

Answer. It takes approximately 14 kilowatt hours of electricity to desalinate 1000 gallons of seawater. We would recommend that the legislation be amended to correspond with H.R. 1071 to make the formula $0.62 per 1000 gallons. This would translate to $200 per acre-foot.

*Question 1c.* What happens after 10 years? Will the desalination plants developed pursuant to S. 1016 be able to operate without significant cost increases to local water users at the end of the incentive payment period?

Answer. The technological advances over the next decade in conjunction with the invaluable opportunities that lie with studying and refining actual production aspects of multiple working facilities throughout the U.S. will ultimately lower the cost of producing desalinated water.

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DEPARTMENT OF ENERGY,
CONGRESSIONAL AND INTERGOVERNMENTAL AFFAIRS,
*Washington, DC, February 16, 2005.*

Hon. PETE V. DOMENICI,
*Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.*

DEAR MR. CHAIRMAN: On October 20, 2005, Douglas L. Faulkner, Acting Assistant Secretary, Energy Efficiency and Renewable Energy, testified regarding S. 1016, to direct the Secretary of Energy to make incentive payments to the owners or operators of qualified desalination facilities to partially offset the cost of electrical energy required to operate the facilities, and for other purposes; and S. 1860, to amend the Energy Policy Act of 2005 to improve energy production and reduce energy demand through improved use of reclaimed waters, and for other purposes.

Enclosed are the answers to 26 questions that were submitted by you and Senator Bingaman to complete the hearing record.

If we can be of further assistance, please have your staff contact our Congressional Hearing Coordinator, Lillian Owen, at (202) 586-2031.

Sincerely,

JILL L. SIGAL,
*Assistant Secretary.*

[Enclosure.]

QUESTIONS FROM SENATOR DOMENICI

*Question 1.* You state in your testimony that S. 1860 places the National Laboratories in the "inappropriate roles for assessing Federal funding and activities across agencies.

Why are these roles "inappropriate" in your view?

Answer. The National Laboratories are engaged most effectively as centers of research excellence, integrating cross-cutting technologies, and coordinating with universities and industry. It is the responsibility of senior Administration officials to provide broader oversight and to assess Federal funding and research across agencies. With the exception of the National Energy Technology Lab, national lab directors and staff are contractors, not Federal officials.

*Question 2.* You state in your testimony that S. 1860 places the National Laboratories in the "inappropriate roles for assessing Federal funding and activities across agencies.

Do you not believe that the technical and research expertise contained in our National Laboratories should be brought to bear in assessing the research being performed in other Federal Agencies?

Answer. Although we recognize the breadth of the expertise offered by our National Laboratories, it would nonetheless be inappropriate to place the assessment of research at Federal Agencies under their purview. Cross-Agency assessments are most effectively conducted under the purview of such organizations as the OSTP and OMB. It is the responsibility of senior Administration officials to provide broader oversight and to assess Federal funding and research across agencies. With the exception of the National Energy Technology Lab, national lab directors and staff are contractors, not Federal officials.

*Question 3.* You state in your testimony that the Secretary of Energy should have sole discretion in determining funding levels, roles and responsibilities for the laboratories, universities and private sector.

How can we ensure that the private sector would receive any role or funding under the arrangement you suggest?

Answer. We would collaborate with industry, universities, and laboratories in a manner that would give us the best opportunity to achieve program goals. Utilizing competitive solicitations, we are best able to identify those partners that are most able to make valuable contributions. Cost-shared research and development partnerships with the private sector are an essential part of this effort. By partnering with the private sector, there is a greater chance that water technologies—sufficiently developed in the research effort—will be carried on to commercialization in the market. We have long successfully pursued this strategy across a broad spectrum of industries, carrying out the requirements of the Energy Policy Act of 1992, and we have used it for new national efforts such as the President's Hydrogen Fuel Initiative.

*Question 4.* Much of the DOE water resources research has been done within the Office of Science, which focuses on basic research. It is my belief that we need to promote more applied research.

What other offices within the DOE should be brought to bear in carrying out S. 1860?

Answer. The Secretary would make that determination should funds be appropriated to carry out S. 1860.

*Question 5.* Much of the DOE water resources research has been done within the Office of Science, which focuses on basic research. It is my belief that we need to promote more applied research.

Do you believe that the Secretary should be given discretion to determine which office within DOE should administer S. 1860 or should this be legislated?

Answer. The Secretary should be given the discretion.

*Question 6.* Much of the DOE water resources research has been done within the Office of Science, which focuses on basic research. It is my belief that we need to promote more applied research.

How would you ensure that the research carried out under S. 1860 would meet a practical need?

Answer. The Department has a track record in developing technologies that are effectively commercialized and meet practical needs. The most important elements of achieving this are to involve the key stakeholders in developing the technology roadmap for the R&D to be undertaken; and establish partnerships between the national labs, universities, and industry through open competition to develop the technologies. Full participation by the private sector is particularly important to enable effective commercialization.

*Question 7.* Many offices within the Department have talents and missions that could contribute to the success of S. 1860, including the commercialization of technologies developed under the authority provided by S. 1860.

Do you think that S. 1860 goes far enough in promoting the commercialization of technologies?

Answer. S. 1860 should allow greater flexibility and provide authority to the Secretary to conduct competitive solicitations with the private sector to develop technologies that can be commercialized.

*Question 8.* Many offices within the Department have talents and missions that could contribute to the success of S. 1860, including the commercialization of technologies developed under the authority provided by S. 1860.

How would you attract industry in order to encourage the commercialization of technologies developed under the authority provided by S. 1860?

Answer. We would attract industry by well-developed competitive solicitations based on needs and market opportunities identified by the broad community of stakeholders.

*Question 9.* Many offices within the Department have talents and missions that could contribute to the success of S. 1860, including the commercialization of technologies developed under the authority provided by S. 1860.

Do you believe that the laboratories should select a industry partner in addition to a university partner?

Answer. The appropriate industry partner will depend on the particular technology being developed, and even on the particular component in many cases. The best way to select the most capable performer in such cases is through competitive solicitations. If a laboratory determines that it needs an industry partner to put forward the best possible proposal, the lab should be given the flexibility to do so.

*Question 10.* Many offices within the Department have talents and missions that could contribute to the success of S. 1860, including the commercialization of technologies developed under the authority provided by S. 1860.

Do you believe that EERE's successful partnerships with industry and academia could be applied to promote the commercialization of technologies that would be produced under the authority provided by S. 1860?

Answer. EERE has developed a track record in developing successful partnerships with industry and academia that is now widely recognized. Similarly, FE, NE, and OE have demonstrated capabilities in forging such successful partnerships. Because of the many different technologies involved and the many industries that would be involved, coordination of this work at the Secretarial level will be necessary.

*Question 11.* Many offices within the Department have talents and missions that could contribute to the success of S. 1860, including the commercialization of technologies developed under the authority provided by S. 1860.

What activities is EERE currently undertaking that would fall under the authority of S. 1860?

Answer. EERE has modest activities on using water more efficiently in industry and in Federal and commercial buildings, and in using renewable energy to desalinate or otherwise clean up and supply water.

*Question 12.* Many offices within the Department have talents and missions that could contribute to the success of S. 1860, including the commercialization of technologies developed under the authority provided by S. 1860.

What other offices with the Department of Energy, if any, should be added to carry out S. 1860?

Answer. The Secretary should be provided broad authority to ensure appropriate coordination of this work across DOE offices as appropriate.

*Question 13.* A 2004 report by the National Research Council stated that the federal government will have to coordinate water resource research in order to meet our water problems. There are activities underway within the DOE and national laboratories that would fall under the authority provided by S. 1960, including an energy-water roadmap begun last month.

How will the Department coordinate the authority provided under Section 979 of the Energy Policy Act of 2005 and the authority provided by S. 1860?

Answer. The Department effectively coordinates work across multiple offices on a routine basis. For example, the work of the Hydrogen Program is coordinated across EERE, FE, NE, SC, and the Department of Transportation. The coordination of work under Section 979 of EPACT 2005 and under S. 1860 should not pose any problems that the Department does not regularly address, but to do this effectively requires that the Secretary have the necessary flexibility to allocate resources where they will be most productive.

*Question 14.* A 2004 report by the National Research Council stated that the federal government will have to coordinate water resource research in order to meet our water problems. There are activities underway within the DOE and national laboratories that would fall under the authority provided by S. 1960, including an energy-water roadmap begun last month.

How will the energy-water roadmap that is currently being drafted be coordinated with the roadmap called for by S. 1860?

Answer. DOE regularly develops a wide range of technology roadmaps across its various Offices and Programs. This frequently requires that new roadmaps build on, update, supplement, or fill gaps in existing roadmaps. This is done quite effectively by simply ensuring that the key managers are involved in the process and that all participants are aware of the work that has already been done so that unnecessary duplication is avoided.

*Question 15.* A 2004 report by the National Research Council stated that the federal government will have to coordinate water resource research in order to meet

our water problems. There are activities underway within the DOE and national laboratories that would fall under the authority provided by S. 1960, including an energy-water roadmap begun last month.

How do you believe inter-agency coordination can best be achieved?

Answer. The Administration began an extensive process of inter-agency coordination last year, forming a Subcommittee on Water Availability and Quality under the National Science and Technology Council Committee on Environment and Natural Resources. About 20 Federal Departments and Agencies are involved in this effort. A first report was put out in November 2004 and a second is in draft.

*Question 16.* A 2004 report by the National Research Council stated that the federal government will have to coordinate water resource research in order to meet our water problems. There are activities underway within the DOE and national laboratories that would fall under the authority provided by S. 1960, including an energy-water roadmap begun last month.

Do you believe that the inter-agency coordination required by S. 1860 will help achieve federal coordination of water resources research?

Answer. The Administration has already established an extensive program of coordination for its water-related research that is quite effective. Directing the appropriate agencies to collaborate through legislation like S. 1860 may be helpful.

*Question 17.* S. 1860 establishes an advisory panel consisting of industry, academia, non-governmental organizations and federal agencies to advise the Secretary on activities carried out under S. 1860.

How do you plan to solicit the opinions and recommendations of the advisory panel?

Answer. The Department has established many Federal Advisory Committee Act panels consisting of experts and representatives of industry, academia, non-governmental organizations, agencies, and others. Such panels are commonly formed by identifying the leading experts in the relevant field and the broad range of stakeholder interests and organizations. Regular meetings are held with the key managers overseeing relevant RD&D, following the terms and process of the Federal Advisory Committee Act.

*Question 18.* S. 1860 establishes an advisory panel consisting of industry, academia, non-governmental organizations and federal agencies to advise the Secretary on activities carried out under S. 1860.

Do you believe that the National Academy of Sciences and advisory panel peer review is adequate or should the bill require peer review from additional organizations as well?

Answer. Yes, the authorized reviews would be adequate.

*Question 19.* S. 1016 names Lawrence Livermore, Oak Ridge, and Sandia National laboratories as the lead laboratories to carry out the program established by the bill.

Do you believe that we should leave open the possibility of adding additional lead laboratories?

Answer. The contributions by any particular lab should be based on the merit of their particular capabilities. The Secretary should have the flexibility and authority to make this determination.

*Question 20.* S. 1016 names Lawrence Livermore, Oak Ridge, and Sandia National Laboratories as the lead laboratories to carry out the program established by the bill.

Do you believe that these laboratories are capable of undertaking the activities called for by S. 1860?

Answer. By themselves, these three labs do not have sufficient expertise to undertake the full range of activities identified in S. 1860 at the present. Other labs may have important capabilities to offer. More importantly, universities and the private sector also have very important capabilities and should be substantially involved

*Question 21.* S. 1016 creates a subsidy program within the DOE for energy consumption associated with desalinating water.

Do you believe that this bill would advance water resources technology research?

Answer. S. 1016 would subsidize energy consumption for desalinating water and thus would reduce the private sector incentive and possibly reduce the public sector resources to conduct the R&D needed for improving desalination technologies.

*Question 22.* S. 1016 creates a subsidy program within the DOE for energy consumption associated with desalinating water.

Do you believe that this bill promotes energy efficiency in the desalination of water?

Answer. S. 1016 would subsidize energy consumption for desalinating water and thus would reduce the private sector incentive to improve the energy efficiency of desalination.

QUESTIONS FROM SENATOR BINGAMAN

*Question 1.* Your testimony is not clear on the fundamental question of whether the Administration supports the creation of a comprehensive research, development, and demonstration (RD&D) program related to energy and water efficiency.

Notwithstanding your concerns with the current language of S. 1860, is the concept one that the Administration can support? If so, will DOE staff be available to help re-draft certain aspects of the bill to address some of your concerns?

Answer. The Department recognizes that research, development, and demonstration of energy-water-related technologies may be important. As with any bill, the Department would be pleased to provide input on S. 1860 if requested.

*Question 2.* One of the concerns you expressed is that the bill leaves the private sector out of the RD&D and commercialization aspects of the program. As I read it, the water utility and products industry is integrated into the program through representation on the Advisory Group and eligibility for competitive grants. I also believe that Section 988 of the recently-enacted Energy Policy Act applies as to cost-share requirements, thereby ensuring that industry is a partner in this program.

What is the basis for the concern expressed in the testimony and what further suggestions do you have to better integrate the private sector into the program? Do you agree that Section 988 of the Energy Policy Act of 2005 would apply to the competitive grant program created by S. 1860?

Answer. The Department is concerned that the allocation of funds within S. 1860 is too restrictive. The Secretary should have the flexibility to allocate these funds as appropriate for the particular technology and research area, and to do so through competitive solicitations, grants, or other financial instruments.

Yes, section 988 of the new EPAct would seem to apply.

*Question 3.* You mentioned that the White House Office of Science and Technology was working on a comprehensive research plan to support fresh water availability in the United States.

When is that plan due out?

S. 1860 is intended to develop a comprehensive research plan for water technology RD&D. Don't you think that the bill will help further the goals of the White House Office of Science & Technology?

Answer. A definitive time has not been set, but a draft should be available in mid-2006. Work on water-related issues is a focus of the White House Office of Science and Technology Policy (OSTP) purview. OSTP staff and the co-chairs and several other members of the NSTC Subcommittee on Water Availability and Quality have also been invited, and have joined the Executive Steering Committee for the current water-for-energy technology roadmap work being conducted by Sandia National Laboratory.

*Question 4.* The November 2004 report by the Office of Science & Technology indicates that we need "improved tools to predict the future of our water resources to enable us to better plan for the more efficient operation of our water infrastructure." Obviously global climate change has the potential to result in significant change to historical precipitation patterns, and thus water supply.

Do you know if aggressive research into the implications of climate change on water supply will be integrated into the comprehensive research plan you mentioned?

Answer. The implications of climate change on water supply is an important issue that is being considered as part of the research plan being developed by the Office of Science and Technology Policy/National Science and Technology Council Subcommittee on Water Availability and Quality.

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