The Linkage Between Water and Energy

Presentation to

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Dr. Allan R. Hoffman

U.S. Department of Energy

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Outline of Presentation

- A few simple messages
- Energy, water and security
- The linkage between water and energy
- Water: key facts and drivers
- The U.S. and global situations
- USG responses
- Research needs
- Concluding Remarks

A Few Simple Messages

- It doesn’t get any more basic than water and energy, the two factors critical to sustainable economic development

- Water and energy issues are inextricably linked

Energy, Water and Security

- Historically, security meant military security to most people
- A broadened definition today would also include energy security, water security, and environmental security
- A search of the literature reveals that no precise definitions exist for either energy security or water security
- For purposes of discussion we can define water security to mean "the ability to access sufficient quantities of clean water to maintain minimal standards of food and goods production, sanitation and health"

One Approach to Defining Energy Security:

- Recognize that energy is a means to an end, not an end in itself
- Energy is important only as it allows us to provide the services that are important to human welfare:
  - heating, cooling, lighting, communication
  - transporting people and goods
  - industrial and commercial processes
- Energy security thus must rest on two principles:
  - using the least amount of energy to provide a given service
  - access to technologies providing a diverse supply of reliable, affordable and environmentally benign energy

Implications for Energy Policy

- Priority #1 must be the wise, efficient use of whatever energy supplies are available (fossil, nuclear, renewable)
- Then, focus on new energy supplies that meet sustainability and environmental requirements
- **Note: water policy can be expressed in exactly the same terms**

Are Energy and Water In Short Supply?

- On a global basis, neither energy nor water are in short supply**:**
  - the earth intercepts 6 million quads/year from the sun (4 parts in 10 billion of the sun's output)
    - the world uses 460 quads (US: 100 quads)
  - the earth is a water-rich planet

- What is in short supply is inexpensive energy and water – energy and water that people can afford to buy

How Are Water and Energy Related?

- **Central to addressing issues of water security is having the energy to**
  - extract water from underground aquifers
  - transport water through canals and pipes
  - manage and treat impaired water for reuse, and
  - desalinate brackish and sea water to provide new fresh water sources.

- **Many forms of energy production depend on the availability of water:**
  - hydropower
  - cooling of thermal power plants
  - fossil fuel production and processing
  - biofuels
  - hydrogen economy

- **The linkage is clear** (but hasn't always been recognized)

But, The Message is Getting Through

- "A very close linkage exists between the Nation's energy future and water future – water is crucial to the production of energy; different energy sources have different water needs."

- "Conversely, many of the technologies for withdrawing, storing, or treating water consume large amounts of energy. Thus, the science of water availability and use is critical to the planning of our nation's energy future."

("Science and Technology to Support Fresh Water Availability in the United States," National Science and Technology Council, November 2004)

Water and Energy – Indirect Linkages

- Energy production and use can lead to contamination of underground and surface water supplies
- If competing water uses limit use of waterways for transport of goods, rail and truck will require more energy to move those goods
- Water and energy are the two critical elements of sustainable economic development – without access to both economies cannot grow, jobs cannot be created, and people cannot move out of poverty

Final Linkage-Global Climate Change

U.S. National Assessment, 1998:

> "The scientific evidence that humans are changing the climate is increasingly compelling. Complex impacts affecting every sector of society, including, especially, the nation's water resources, now seems unavoidable…. *In many cases and in many locations, there is compelling evidence that climate changes will pose serious challenges to our water systems."*

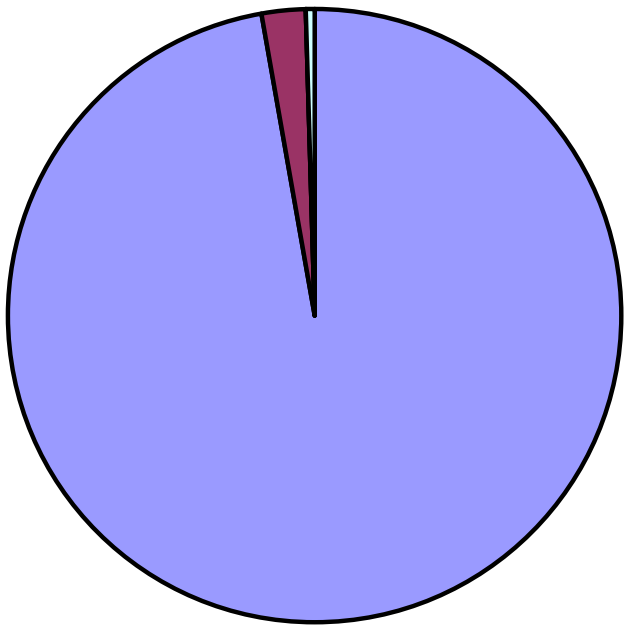
Water Supply and the Impacts of Climate Change

- Climate change has the potential to disrupt the hydrological cycle and impact global water resources long before other impacts are felt
  - By altering the timing of winter snows, snowmelt, and spring rains, climate change could overload reservoirs early in the season, forcing releases of water and leaving areas like California high and dry in late summer
  - Coastal areas and Island nations also face a serious threat. Rising water levels, before they destroy property and flood low-lying areas, will cause saltwater intrusion of freshwater supplies, putting the drinking water of millions of people at risk

Earth's Water Supply – Key Facts

Global Water Supply

(329 million cubic miles)*



- oceans (317)
- icecaps & glaciers (7)
- atmosphere (0.003)
- ground water, lakes & rivers (2)

*each cubic mile contains more than one trillion gallons

99.7% of all the water on earth is unavailable for human or animal consumption

Of the remaining 0.3%, much is not accessible due to unreachable locations and depths

The vast majority of water used for human and animal consumption, much less than one percent of the total supply, is stored in ground water

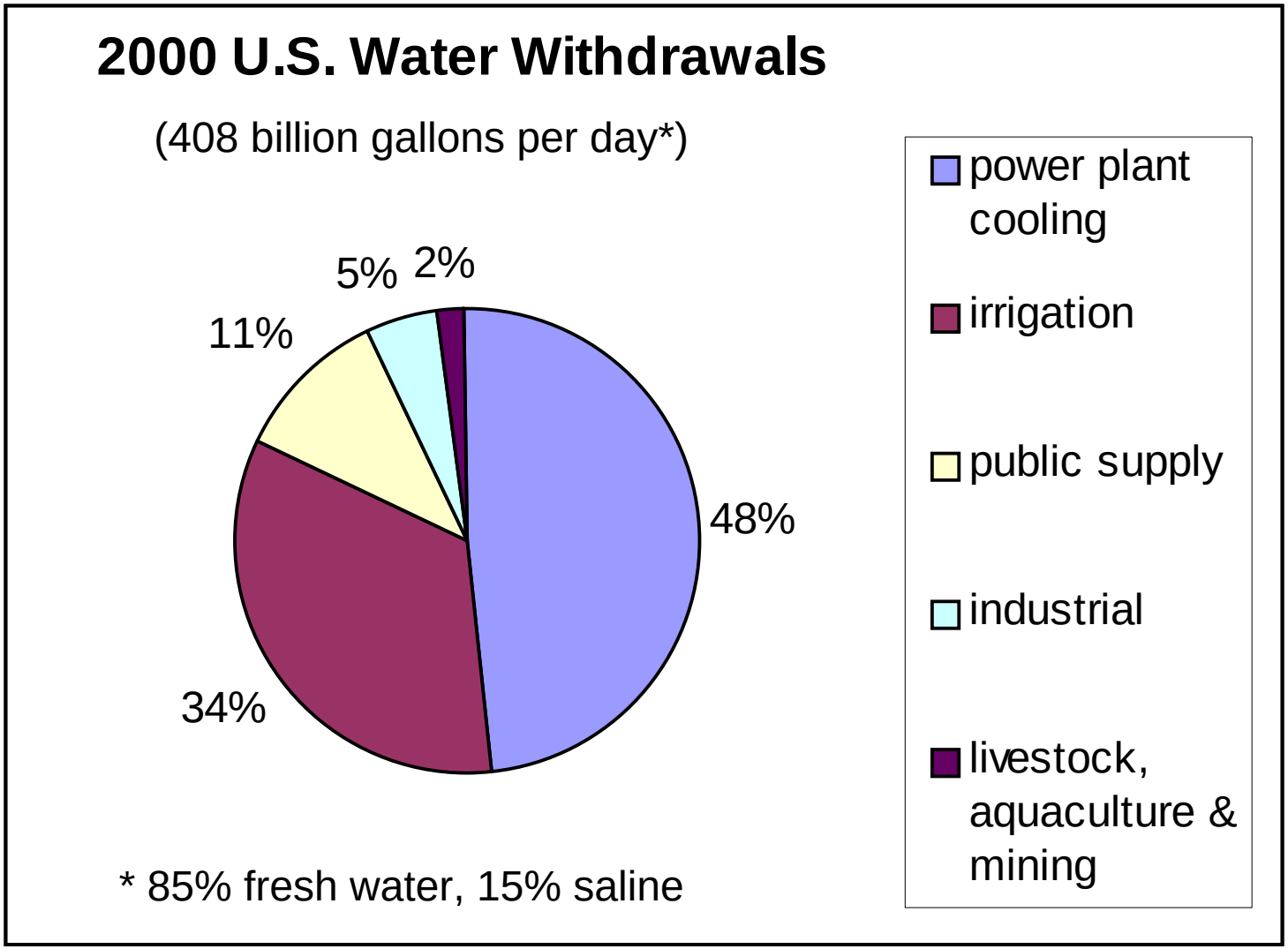
The Role of Water

- Water has always been mankind's most precious resource – there are no substitutes
- The struggle to control water resources has shaped human political and economic history
- Nevertheless, water availability is often undervalued and taken for granted
- "Water is fundamental to life and health. The human right to water is indispensable for leading a healthy life in human dignity. It is a prerequisite to the realization of all other human rights." (UN, 2002)

The Growing Demand for Fresh Water

- Population growth and growing economies **are driving a steadily increasing demand for new clean water supplies**
- **World water demand has more than tripled over the past half century**
- **Global water use in 2000 is estimated to be about 30% of the world's total accessible fresh water supply**
- That fraction may reach 70% by 2025

The U.S. Situation



The U.S. Situation (continued)

- Power plant cooling is the largest user when total withdrawals (fresh water + saline) are counted
  - 195 million gallons/day (70% fresh water, 30% saline)
- Only 2-3% of cooling water is actually consumed through evaporation
- Power plant cooling and agriculture each used 39% of U.S. fresh water supplies in 2000

The U.S. Has Water Supply Problems

- Chemical contamination of surface and ground water caused by agricultural, industrial and defense-related activities
- Biological contamination of drinking water associated with isolated septic tank or wastewater discharges
- The Ogallala fossil water aquifer in the Central Plains is being depleted by agricultural and urban extraction, with no effective recharge
- Water disputes with Mexico

U.S. Water Supply Problems (continued)

- Reduced Colorado River water allocation to California, resulting from inability of competing urban, agricultural & environmental interests to agree on conservation plan
- An increasing number of water disputes in the eastern part of the U.S. (VA vs. MD, VA vs. NC, GA vs. FL vs. AL)
- Large-scale sea or brackish water desalination is being implemented in Tampa, Florida, and is being planned for sites in California, Texas, Utah, New England and Hawaii
- Increasing age of much of the U.S. water distribution system will require significant rehabilitation investments ($800B - $1 trillion)

Competition For Water Is Limiting Electricity

- **Georgia Power Loses Bid to Draw Water from Chattahooche**
  - (*Miami Herald, February 2002)*
- **EPA Orders Mass. Power Plant to Reduce Water Withdrawals**
  - (*Providence Journal, RI, July 2002*
- **Idaho Denies Water Rights Request for Power Plants**
  - *U.S. Water News Online, August 2002*
- **Duke Power Warns Towns in Charlotte, N.C., Area to Cut Water Use**
  - *The Charlotte Observer, NC, August 2002*
- **Company Ends Fight for Power Generator on NJ-NY Border**
  - *The Record, NJ, September 2002*
- **New Mexico Utility Plans to Increase Power, Use No More Water**
  - *Albuquerque (NM) Journal, June 2003*
- **Pennsylvania Nuclear Power Plant to Use Wastewater from Coal Mines**
  - *The Philadelphia Inquirer, July 2003*
- **Utilities Warn of Power Crunch if Flows Are Cut**
  - *Greenwire, July 2003*

Private Power Sector Response

- The Electric Power Research Institute (EPRI) has underway a major research program to explore the connection between fresh water availability and economic sustainability

- The program focuses on
  - Integrated development, testing, and application of tools to forecast water availability and demand
  - Decision-support frameworks to analyze watershed management
  - Technologies that can reduce water use in power generation

Where Is the Federal Responsibility?

- *Many Federal agencies address water issues, but none currently at the water-energy nexus*
- ***No Federal agency is responsible for***
  - **Water-related impacts on energy policy**
  - **Water used for energy production**
  - **Energy used by water systems**

USG Responses

- Energy and Environmental Security Initiative
- National Laboratories' Energy-Water Nexus Program
- Report by Subcommittee on Water Availability and Quality/NSTC
- DoD Directive 3000.05
- Energy Policy Act of 2005: Sec. 979
- Senator Paul Simon Water for the Poor Act of 2005
- Water 2025: Preventing Crises and Conflict in the West (DoI)

Energy & Environmental Security Initiative (EESI)

- Was implemented under July 1996 MOU on Environmental Security Cooperation signed by DoD, DoE, EPA and supported by DoS

- "….EESI is the mitigation and prevention of energy and environmental risks and related stresses which contribute to political and economic instability or conflict in foreign countries or regions of importance to the United States. EESI uses DoE technology, capabilities and support linkages to address selected concerns which contribute to instability and factors inhibiting regional development."

- Middle East desalination project (Jordan, Palestinian Authority, Israel, U.S.) was carried out as an EESI activity.

THE ENERGY~WATER NEXUS

a strategy for energy and water security

Argonne National Laboratory
Operated by the University of Chicago

Berkeley Lab

Brookhaven National Laboratory

INEEL

Los Alamos National Laboratory

NETL National Energy Technology Laboratory

NREL

ornl Oak Ridge National Laboratory

Pacific Northwest National Laboratory

Sandia National Laboratories

DoD Directive 3000.05

- 1996 MOU reflected in Directive 3000.05:
  - Subject: Military Support for Stability, Security, Transition, and Reconstruction (SSTR) Operations – November 28, 2005

- **"It is DoD policy that:**

  4.1 Stability operations are a core U.S. military mission that the Department of Defense shall be prepared to conduct and support. They shall be given priority comparable to combat operations…..

  42. Stability operations are conducted to help establish order that advances U.S. interests and values. The immediate goal often is to provide the local populace with security, restore essential services, and meet humanitarian needs. ……..

  4.3 Many stability operations are best performed by indigenous, foreign, or U.S. civilian professionals. Nonetheless, U.S. military forces shall be prepared to perform all tasks necessary to establish or maintain order when civilians cannot do so……."

H.R. 6: Energy Policy Act of 2005

SEC. 979. ENERGY AND WATER SUPPLIES

- (a) In General- The Secretary shall carry out a program of research, development, demonstration, and commercial application to--
- (1) address energy-related issues associated with provision of adequate water supplies, optimal management, and efficient use of water;
- (2) address water-related issues associated with the provision of adequate supplies, optimal management, and efficient use of energy; and
- (3) assess the effectiveness of existing programs within the Department and other Federal agencies to address these energy and water related issues.
- (b) Program Elements- The program under this section shall include--
- (1) arsenic treatment;
- (2) desalination; and
- (3) planning, analysis, and modeling of energy and water supply and demand.
- (c) Collaboration- In carrying out this section, the Secretary shall consult with the Administrator of the Environmental Protection Agency, the Secretary of the Interior, the Chief Engineer of the Army Corps of Engineers, the Secretary of Commerce, the Secretary of Defense, and other Federal agencies as appropriate.
- (d) Facilities- The Secretary may utilize all existing facilities within the Department and may design and construct additional facilities as needed to carry out the purposes of this program.
- (e) Advisory Committee- The Secretary shall establish or utilize an advisory committee to provide independent advice and review of the program.
- (f) Reports- Not later than 2 years after the date of enactment of this Act, the Secretary shall submit to Congress a report on the assessment described in subsection (b) and recommendations for future actions.

Simon Act (Public Law 109-121)

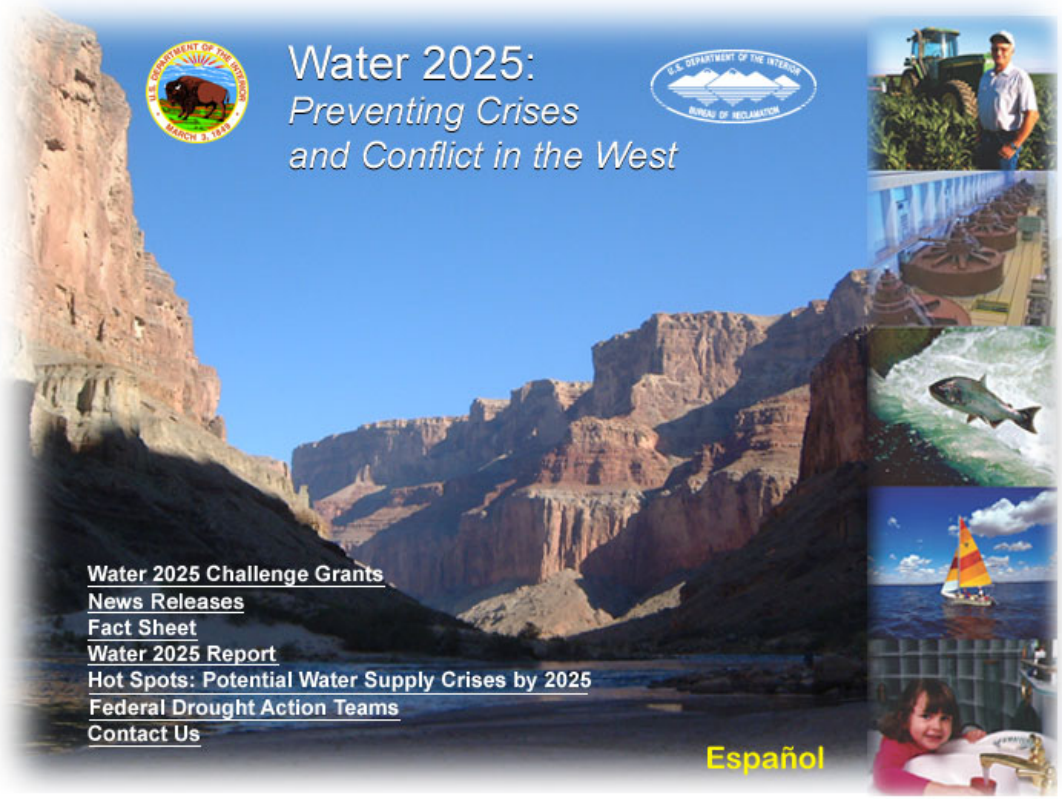
- "SEC. 6. SAFE WATER AND SANITATION STRATEGY

  (a) Strategy – The President, Acting through the Secretary of State, shall develop a strategy to further the United States foreign assistance objective to provide affordable and equitable access to safe water and sanitation in developing countries, …"

  (g) "Initial report --….Not later than 180 days after the date of the enactment of this Act, the Secretary of State shall submit to the appropriate congressional committees a report that describes the strategy required by subsection (a)."

- Report to Congress released June 2006 (Department of State Publication 11345)

Water 2025



- **Water 2025 will encourage voluntary water banks and other market-based measures, improve technology for water conservation and efficiency, and remove institutional barriers to increase cooperation and collaboration among federal, state, tribal, and private organizations (**http://www.doi.gov/water2025**)**

Research Needs Associated With Water-Energy Issues

- R&D to
  - reduce water use in agriculture
  - reduce energy costs of desalination
  - reduce power plant cooling requirements
  - develop improved technology for water treatment/reuse

Research Needs (continued)

- R&D to
  - develop improved technology for water decontamination (filters, UV)
  - understand the water requirements of emerging technologies:
    - biofuels
    - oil shales
    - tar sands
    - hydrogen economy
  - Understand the impact of global climate change on spatial and temporal variability of water resources

Concluding Remarks

- Energy security is closely linked to the state of water resources
  - no longer can water resources be taken for granted if the U.S. and other countries are to achieve energy security in the years and decades ahead

- No longer can water security be guaranteed without careful attention to related energy issues

- Achieving U.S. water and energy security will require a new partnership
  - between the federal government, which has primary responsibility for energy security, and
  - the states and local communities, where water issues have historically been addressed.

Contact Information

E-mail: allan.hoffman@ee.doe.gov

Telephone: 202-586-8302