September 27, 2012

ECO-ENGINEERING: ADDRESSING WATER CHALLENGES

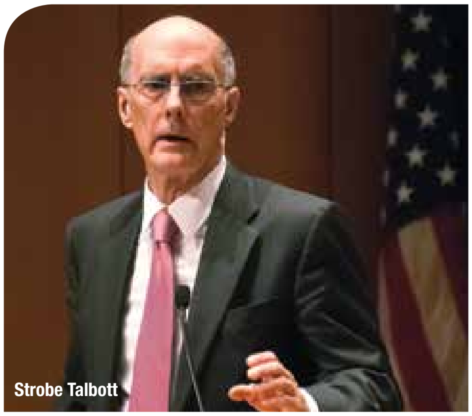
On September 27, 2012, Hitachi, Ltd., with the Brookings Institution and the American Association for the Advancement of Science (AAAS), presented the fourth in a series of annual forums focusing on Eco-Engineering: Addressing Water Challenges. The Forum was held at AAAS headquarters in Washington, DC and featured a keynote presentation from the Deputy Assistant Secretary for Water and Science at the Department of the Interior and two panel discussions, one focused on water use in shale gas production and the other on urban water challenges.

Opening Remarks

Alan I. Leshner, Chief Executive Officer, AAAS and Executive Publisher, *Science*
A safe and reliable supply of water has great public health and economic implications for the world. Agricultural and industrial users are competing with the need for adequate drinking water, and so science and technology solutions for ensuring adequate resources will be increasingly important. Hitachi is committed to educating the world to science and technology issues and how they can improve society, making this an important forum and partnership.

Strobe Talbott, President, The Brookings Institution
Most of the human body is water and most of the surface of the earth is water. The human enterprise relies on water for health, sanitation, and generating energy. But we face several challenges in making sure that we have the water we need to sustain this enterprise—the planet's population is growing by 80 million people a year, 60 million of whom live in urban areas where water demand is particularly high and supply is scarce, especially for clean drinking water. Climate change and global warming are exacerbating some of the challenges associated with water; through its commitment to safe and reliable nuclear power, Hitachi is helping advance technologies that can mitigate climate change.

Takashi Hatchoji, Chairman of the Board, Hitachi America, Ltd.
This forum is the result of sustained partnership between Japan and the U.S. Hitachi, Brookings, and AAAS have created a successful platform for sharing knowledge and exchanging ideas that impact how society functions and sustains itself. Hitachi's sponsorship of these forums is a reflection of the company's philosophy of contributing to humanity with technology, developing solutions that respond to society's needs for advanced infrastructure. In this case, that means infusing water processes with energy savings and information technology.


Strobe Talbott


Takashi Hatchoji


Alan I. Leshner

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AGENDA

WELCOME

Master of Ceremonies
Edward Derrick
Chief Program Director, Center of Science, Policy, and Society Programs
American Association for the Advancement of Science (AAAS)

OPENING REMARKS

Alan I. Leshner
Chief Executive Officer, AAAS
Executive Publisher, *Science*

Strobe Talbott
President, The Brookings Institution

Takashi Hatchoji
Chairman of the Board, Hitachi America, Ltd.

KEYNOTE PRESENTATION

John Tubbs
Deputy Assistant Secretary, Water and Science
Department of the Interior

PANEL 1: IMPROVING WATER USE IN SHALE GAS PRODUCTION

Moderator
Charles Ebinger
Senior Fellow and Director, Energy Security Initiative
The Brookings Institution

Panelists
Bruce Baizel
Interim Director, Oil and Gas Accountability Project
Earthworks

Julio Friedmann
Chief Energy Technologist
Lawrence Livermore National Laboratory

James Richenderfer
Director of Technical Programs
Susquehanna River Basin Commission

James Slutz
President and Managing Director
Global Energy Strategies

PANEL 2: CONFRONTING WATER ISSUES IN CITIES AND URBAN AREAS

Moderator
Katherine Bliss
Director, Project on Global Water Policy
Center for Strategic and International Studies (CSIS)

Panelists
Matthew Diserio
Co-Founder and President
Water Asset Management, LLC.

Richard Meeusen
Co-Chair, Milwaukee Water Council
Chairman, President, and CEO
Badger Meter, Inc.

Dave Norris
Mayor, West Monroe, LA

Shinjiro Ueda
Executive Technology Adviser
Hitachi Plant Technologies, Ltd.

…the effects of climate change on timing and amount of water available mean that old approaches will not help us plan for the future and a successor system needs to be found.

Keynote Address

John Tubbs, Deputy Assistant Secretary for Water and Science
Department of the Interior

Understanding the challenges associated with water relies to a great extent on the work of applied scientists who are out in the field gathering data that research scientists can use. Stream gauges, which take a range of measurements from waterways around the country, provide essential information that leads to solutions that serve citizens and the environment.

In urban areas, the greatest concerns revolve around water cleanliness and safety, but the day-to-day provision of water to consumers is a distinct challenge on its own. In most cases, water is safe and reliably delivered, and wastewater is treated effectively, but that is not uniformly true everywhere in the U.S. For example, the Navajo Nation just received a large grant to build a pipeline to bring water to its reservation in the arid southwestern U.S. Prior to that, water was mostly trucked in and delivered to households that lack running water. This was a labor-intensive and expensive method for transporting water, and the safety of the water was difficult to ensure.

Risk and uncertainty underlie many of the water challenges we face. It became clear several years ago that we could no longer rely on historical averages of stream flows and water volumes to accurately predict future supplies. There has been too much change to waterways; diversion, dams, and pumping now affect 90% of U.S. streams. Beyond these physical interventions, the effects of climate change on timing and amount of water available mean that old approaches will not help us plan for the future and a successor system needs to be found.

In the Colorado River Basin—where water allocation is managed by the Secretary of the Interior—records go back 400 years, so there is a pretty good understanding of historic flows, which helps with understanding risks and uncertainty. However, even with that relatively extensive record to look at, management systems have not changed to keep pace with decreasing availability and lower quality, despite a new study to forecast demand in the Basin over the next 50-75 years.


John Tubbs

Indeed, understanding and managing demand is critical to adapting to changing conditions. Higher temperatures mean that manufacturing plants and crops are both using more water. Likewise, energy production demands significant water and moving water requires significant energy. As a nation, we have not always done a good job of recognizing water rights that exist. This is not much of a problem in the eastern U.S., where water is relatively abundant, but in the west where scarcity is a real issue, we have had to move water from streams to accommodate people, agriculture, and energy.

One of the challenges in the U.S. is that we divide our water better than anyone else, breaking it up by type, location, use, and utility. This makes for a complex tapestry to manage and makes thinking about water as a whole seem a bit overwhelming. The Department of the Interior is trying to bring all of these divisions back together and think of water as a single resource, with both demand and supply as local issues.

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Keynote Address *(continued)*

In California and Texas, for example, surface water is subject to a permitting process; although there has been resistance to permitting, it provides a stable environment for businesses to grow. Even in drought, senior water users get their supply, even if junior users do not. With groundwater, however, the owner of the surface land owns the rights to the water below, so in places like Texas, speculators are buying acreage for the groundwater access. But surface water and groundwater are connected, and drilling wells affects flows beyond what the landowner controls. In short, the legal paradigm that distinguishes between the two types of water is a disaster.

Edward Derrick

An experience in Montana is a case in point. Trout Unlimited sued the state over some permits it had issued for the Upper Smith River, a renowned fishery. Local landowners had been using flood irrigation to grow alfalfa, which was inefficient from a water usage standpoint but allowed the stream flows to recharge quickly. When a more efficient watering system was introduced, the flows deteriorated markedly in mid-summer, because less water was being returned to the ground. In response to the lawsuit, the Montana Supreme Court ruled that surface and groundwater are the same resource and so now landowners have to buy permits or otherwise provide offsets for what they draw from the stream to make sure it recharges the flows.

Recharging stream flows is also an issue where coal seam aquifers are being drained to release natural gas. The process takes an aquifer down many feet but, where there are only 10 inches of rain a year, like in southeast Montana, the aquifer recharges too slowly to be sustainable. Also, the water that is produced in this process is highly saline, and so dealing with the wastewater becomes a challenge. Some can be discharged into streams, but some of it has to be treated before it can be released. With the huge volumes of water that are being taken out of these seams, and the long time horizon for natural recharging of aquifers, care must be taken to ensure that there is not a sudden gap in water availability 50 years down the road.

Secretary Ken Salazar has always considered water a priority. The Department of the Interior is the largest wholesaler of water in the country and is the second largest source of hydropower. The Department oversees mineral development on federal lands and, through the U.S. Geological Survey, is an essential source of information. With water so closely tied to health and prosperity, the Department has a responsibility to find a balance between the water we have, the water we need, and the water we use. The WaterSmart program is focused on sustainability; it directs federal agencies to examine ways to improve water use, with a goal of saving 700,000 acre-feet per year through efficiency gains in transmission, treating wastewater, and building desalination plants.

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Price signals in water are not as strong as they should be, so there is little incentive to conserve. In many places, the water itself is free but the costs are in transportation and pumping. In the eastern U.S., where water is more abundant, a permitting system would make pricing more efficient, whereas in the west where water is scarcer, the price signals are stronger. Businesses and the economy would do better with a regulatory regime where price drove conservation more effectively.

From left: James Richenderfer, Julio Friedmann, Charles Ebinger, Bruce Baizel, James Slutz

The concern with water demand is not as much in total quantity, but rather in the timing and location of the demand.

PANEL ONE:

Improving Water Use in Shale Gas Production

Moderator:
Charles Ebinger, Senior Fellow and Director, Energy Security Initiative
The Brookings Institution

Panelists:
Bruce Baizel, Interim Director, Oil and Gas Accountability Project
Earthworks
Julio Friedmann, Chief Energy Technologist
Lawrence Livermore Laboratory
James Richenderfer, Director of Technical Programs
Susquehanna River Basin Commission
James Slutz, President and Managing Director
Global Energy Strategies

Water is an essential ingredient in shale gas production by hydraulic fracturing—"fracking"—and so the expanding use of the technique to recover previously inaccessible or uneconomical gas resources raises important questions about supply and safety. The first panel brought together a range of experts to examine the implications and propose solutions to minimize the environmental impact of this increasingly important method for producing energy.

The costs of water in shale gas development are huge, particularly in transporting the water to drilling sites. In Colorado, for example, oil and gas companies are paying $1,000 per acre-foot compared to the $30 paid by farmers. The concern with water demand is not as much in total quantity, but rather in the timing and location of the demand. Since the water used in fracking does not return to the system—it's 100% consumed in the process—its impact on the local environment can be huge. Because of the higher cost of fresh water, use of recycled alternatives like treated wastewater or acid mine drainage is increasing, but it has not yet been incorporated into the policy framework.

Technological innovations are having a major impact on water use in fracking, but it is important to think both about the system as a whole and the most critical considerations (volume, water quality, and the environment), more so than just total use. On the first point, one example is that Indiana, Illinois, and Kentucky have started discussing a basin-wide utility for the Illinois River. In Pennsylvania, using deep saline wells for 85% of fracking needs has greatly reduced the amount of fresh water being used. Likewise, improved disposal methods, including recycling and treatment, can reduce environmental impacts at the local level. Other technologies related to transporting water, including a rollable pipeline (akin to a giant firehose) eliminates the expensive need to truck water long distances and allows wastewater to be pumped the other direction when the operation is complete. "Waterless" fracking using propane or CO2 can use much less water, but other complications like increased production of radon may limit widespread deployment.

The Susquehanna River Basin is 27,510 square miles, and shale formations cover 84% of its footprint. The Marcellus Formation is located near the pristine headwaters of the river, and so developing the gas reserves safely is an important priority. The Basin is still feeling the environmental effects of coal mining, and so all stakeholders have experience with managing impact on water quality and supply.

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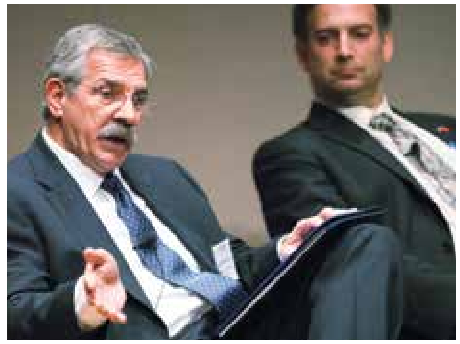

Panel One *(continued)*

Because of the way that fracking operations move from one deposit to another, water demands are migratory in a way that those of ordinary residential, industrial, and agricultural users are not. These operations only need water during the actual fracking, not all the time, so demand varies for that reason as well. To put the total water demand on the Susquehanna River into perspective, since 2008, the Marcellus Shale has used a total of 8.8 billion gallons, compared to 27 billion gallons per day that flow from the Susquehanna into the Chesapeake Bay.

Seasonal variations in the Susquehanna's flow—high during winter and spring and low in the summer and fall—mean that industry cannot extract water 365 days a year. The Susquehanna River Basin Commission has established a low flow protection policy that curtails water withdrawals if the level drops below a predetermined flow rate at any of the measuring points the Commission has established. Particular attention is paid to flow rates nearer the headwaters, with looser regulations downstream.

Natural gas producers have a variety of ways to deal with wastewater from shale gas development. Disposal means injecting it back into formations after it has been recovered; reuse means cleaning up the wastewater, although one still ends up with slightly saline water; and recycling means getting a portion of the water back to fresh with a concentrated brine stream left over that still needs to be addressed. Companies must balance a number of considerations in deciding how to proceed—public safety, community relationships, regulatory climate, environmental risk and liability, access to water and disposal options, fracking fluid quality, and long-term well performance. Water management costs can vary greatly, depending on the chemistry of the flow-back water, costs of source water, disposal, storage, transportation, and available treatment technologies.

A few years ago, shale formations contributed 2% of natural gas production, a percentage that has since risen to the upper 30s and could reach 60% in the near future. The Environmental Protection Agency is conducting a study of the safety of hydraulic fracturing which, depending on the results and recommendations, could have a dramatic effect on whether the share of natural gas produced that way continues on that trajectory. Given that the U.S. has been regulating fluid injections since the passage of the Safe Drinking Water Act in 1974, primarily by working with the states, it is unlikely that fracking will be banned. Most companies are cleaning up their operations on their own. The Institute for Gas Drilling Excellence in Pennsylvania is working to set the industry standards, consulting with companies, environmental groups, and experts. Clearly, the environmental risks are not trivial, but they must be weighed against the immense benefits in jobs, competitiveness, energy security, and greenhouse gas emissions—and against the environmental risks of other forms of energy production. While the major international energy companies

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maintain rigorous standards throughout their operations, three of the largest companies are in China, where the environmental track record has not been robust.

Shrinking budgets at the federal and state levels are threatening the ability of regulators to closely monitor industry. In Wyoming, inspectors are being asked to review cement casing logs to ensure proper procedures are being followed, but the few inspectors there do not have experience with cement casings. It is the gas companies that have the experience, so it is important to work closely with them to achieve real oversight. Getting agencies to work together is also important, especially since responsibility for oil and gas is in a natural resources department while air and water quality are monitored by an environmental department. The Susquehanna River Basin Commission joins with local environmental groups to monitor the entire Basin and has enlisted the public's help in reporting unauthorized withdrawals of water. Information technology—such as remote sensors that report statistics like flow rate, water quality, pH, temperature, dissolved oxygen, and turbidity every 15 minutes—allows anomalies to be quickly recognized and investigated.

Technological innovations to the water circulation cycle include advanced water treatment systems for purification, sewage and industrial wastewater treatment, and desalination that can reduce reliance on fresh water to meet increasing needs.

Left to right: Katherine Bliss, Dave Norris, Matthew Diserio, Richard Meeusen, Shinjiro Ueda

PANEL TWO:

Confronting Water Issues in Cities and Urban Areas

Moderator:
Katherine Bliss, Director, Project on Global Water Policy
Center for Strategic and International Studies (CSIS)

Panelists:
Matthew Diserio, Co-Founder and President
Water Asset Management, LLC
Richard Meeusen, Co-Chair, Milwaukee Water Council
Chairman, President and CEO, Badger Meter, Inc.
Dave Norris, Mayor
West Monroe, Louisiana
Shinjero Ueda, Executive Technology Advisor
Hitachi Plant Technologies, Ltd.

The second panel brought together public and private sector leaders to examine the issues of providing water for residential and industrial users in urban areas, which are becoming more challenging as a larger share of the world's population moves to cities. Growing food, water, and energy demands of a larger, more urbanized population, especially in the developing world, require new technologies and improved infrastructure.

The global water market, which is affected by relative scarcity or abundance in particular regions, varies across the advanced countries, emerging countries, and the developing world. In advanced countries like the U.S., Japan, and European nations, demand for water is fairly stable and the infrastructure is well developed; although it is aging and replacement is a concern, privatization is a viable option for financing. In emerging countries (such as China, India, and Brazil), demand for both fresh water and wastewater treatment capacity is increasing rapidly due to population growth and urbanization; public-private partnerships provide much of the funding for improvements since government funding is often inadequate. In the developing world, water infrastructure is inadequate and countries must rely on official development assistance to undertake necessary water projects.

Technological innovations to the water circulation cycle include advanced water treatment systems for purification, sewage and industrial wastewater treatment, and desalination that can reduce reliance on fresh water to meet increasing needs. Energy saving and generating systems, such as producing natural gas from sludge, increasing solar generation, and more eco-friendly cooling methods for desalination plants also contribute to reduced demand for water. Information technology also has an important role to play, as advanced supervision, control, and distribution systems can increase the efficiency of water infrastructure.

(continued on page 8)

FIGURE 1

Panel Two *(continued)*

West Monroe, Louisiana is a prime example of a community that was running out of water and had to take action. A major study of the aquifer that feeds this town (and the surrounding counties and parishes in Louisiana and Arkansas) found it is being drained rapidly. West Monroe sits on an inverted cone and the aquifer has been over-pumped for years, so the town had to find ways to reduce the draw on the aquifer. A paper mill in the town—an important source of jobs and income for the area—uses 10 million gallons per day, so finding a way for it get its water from another source, like treated wastewater, was imperative to the solution. Because the paper mill manufactures food-contact paper, it is required by law to use water that meets EPA drinking water standards in its processes. The city designed a treatment plant that produces the 10 million gallons per day that far exceeds the EPA's requirements at a cost of 75¢ per 1,000 gallons. Given that the town also sits near a shale formation, the prospect of having to deal with the wastewater from fracking also factored into constructing robust treatment capacity.

Private investment firms have identified significant opportunities around water, given scarcity and cleanliness issues around the world. Investors think about efficient allocation of capital and the potential for adequate returns when considering new projects, and local legal and regulatory frameworks in different parts of the world can have a big impact on whether an investment is worth pursuing. Dealing with wastewater is an important part of the industry since water can always be cleaned and purified if enough money is put into it and there is a market for buying and selling wastewater treatment credits. Returning treated wastewater into depleted aquifers returns the water to use and enables cities to grow.

Water is one of the most capital-intensive industries, and artificially cheap water leads to underinvestment in infrastructure…

Water availability and water pricing are not necessarily correlated. The relative age and stress on infrastructure in different places will have an enormous impact on the costs of water, so, for example, in Phoenix where the infrastructure is newer and is not subject to repeated freezing and thawing, the water is cheaper than in Pittsburgh where, despite being situated on three rivers, old pipes and environmental factors mean that operations and maintenance are far more expensive.

Water is one of the most capital-intensive industries, and artificially cheap water leads to underinvestment in infrastructure, as well as waste by consumers and through leakage during transportation. The 20 million people in the U.S. who have private wells are not influenced by costs, since their water is free once the well has been dug. Likewise, the pricing of municipally owned water systems (80% of the systems in the U.S.) tends to not reflect the true total costs of the water, capital investments, and operating expenses. Private investors who own water systems put up all the money for capital improvements and pay taxes on their income as well. U.S. culture, however, is predisposed against privatizing water utilities and so moving to a system of investor-owned utilities would require an attitude shift. Many U.S. communities were founded around water sources, so the idea of selling them off to investors brings strong reactions. The model of signing private operating and maintenance contracts is more popular that outright privatization, but it has shown different levels of success.

The long timeline for water to move underground and replenish an aquifer means that action must be taken now to ensure that problems with supply do not emerge only when it is too late to solve them quickly. More rational pricing of water and continually improving technology for dealing with wastewater and decreasing leakage in transportation will have a significant, positive impact on the global water picture. Finding ways to reduce demand can make an important contribution to ensuring an adequate supply of water, whether through altruistic, authoritative, or pricing methods. Residential water usage is fairly inelastic, but commercial and industrial users are much more price sensitive and will adapt their consumption behavior in the face of increased costs. The world is, in fact, not running out of water, but it is running out of cheap water.

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