

POLICY BRIEF 2014-06

The Path to Water Innovation

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The Path to Water Innovation

The U.S. economy depends on a well-functioning water infrastructure. America's water systems support 55 million acres of irrigated farmland, 315 million domestic users of water, and a \$16 trillion national economy. Commercial industries ranging from manufacturing to information technology to retail rely on readily available access to water; without it, the profitability of these companies and the livelihoods of their employees are threatened. In sum, our long-term prosperity depends on satisfying the U.S. economy's thirst for water while also protecting the environment.

The U.S. water infrastructure—including dams, reservoirs, aqueducts, and distribution pipes—is aging and is ill-equipped to efficiently handle current water needs. Almost 40 percent of the pipes in our water distribution systems are at least forty years old. Some key infrastructure predates World War I. In fact, about one fifth of the piped water in this country is lost to leaks and system inefficiencies, wasting about 7 billion gallons of treated water every day.

The continued deterioration of the nation's water systems is just one of many threats to the viability of America's water supply. The population is growing and is expected to reach 400 million by 2050. This will place pressure on the water infrastructure despite continued gains through water conservation. Climate change will further threaten water supplies in some parts of the country; it is likely to shift weather patterns and thin snow packs in the West. In coastal zones the impacts of climate change will be felt through stronger storms and coastal flooding that could put the reliability of urban water supply systems at risk. Higher temperatures will also raise evapotranspiration rates, further increasing agricultural water needs. Finally, rapid depletion of groundwater reservoirs has threatened, permanently in some locations, water users' ability to draw on long-standing water reserves. In the future, we will need to do more with less.

New technologies can help better allocate water in the face of scarce supply. Innovation can provide additional water, increase the productivity of existing water sources, and make conservation measures easier and cheaper. For example, advances in recycled water and desalination can provide additional sources of water that are better insulated from drought and from other supply-related pressures. Furthermore, new water technologies and improvements in the management of groundwater aquifers and complex river systems can further improve drinking water quality.

While there is great promise in new technologies, the potential for innovation in the water sector has barely been tapped. Investment in the water sector totaled only \$1.5 billion in 2012—a small amount when compared to other industries,

such as clean energy, where investment amounted to \$69 billion during the same year. Similarly, patent levels have remained relatively constant over the past decade in water subsectors such as purification, whereas the number of patents in the clean energy sector has increased rapidly.

The relatively low levels of innovation in the water sector are due to a host of barriers that drive down incentives to invest. Pricing policies fail to pass on the full cost of water to consumers, and limit water suppliers' revenue to invest in innovation. Outdated and inflexible regulations encourage the continued use of status quo technologies instead of new advances. For example, California requires that industrial plants using recycled water be inspected by the Department of Health Services, despite the remote chance for human contact with that water. In addition, limited mechanisms for raising capital hinder development of new technologies. Industry conservatism, the inherent long lifespan of water infrastructure, and system fragmentation also inhibit innovation.

In a new Hamilton Project discussion paper, Newsha K. Ajami and Barton H. Thompson Jr. of the Stanford Woods Institute for the Environment, and David G. Victor of the University of California, San Diego, propose three policies to overcome barriers to innovation in the water sector. First, the authors seek to reform water pricing policies to encourage conservation and unlock a steady revenue stream that can be used to fund new innovation. Second, they recommend that state and local governments conduct a systematic review of their regulatory practices, focusing on rewriting policies that conflict between levels of government or fail to incentivize innovation. As part of this government policy reform, they propose that select states establish water innovation offices to promote innovation-friendly policies and spur new research and development. Finally, the authors recommend instituting a surcharge on water use to raise revenue for capital investment.

The Challenge

The past two centuries witnessed a series of fundamental innovations in the water sector, generally driven by health or environmental concerns. In the early nineteenth century advances in water treatment enabled the delivery of safe, clean drinking water to growing U.S. cities, helping protect populations from contaminants causing contagious diseases. The invention of sewage treatment plants in the early twentieth century led to greater protection of rivers, lakes, and other aquatic ecosystems. Passage of the Clean Water Act of 1972 (and its 1977 amendments) and the Safe Drinking Water Act of 1974 required further improvements in wastewater treatment and water quality in the final quarter of the twentieth century, along with marginal changes in the technology used for drinking-water treatment. Since then, however, technological change in the sector has generally stagnated even as the

complexity of delivering clean water—especially during times of scarcity—has grown.

Sluggish innovation in the water sector exacerbates the challenges posed by scarce water supplies. Despite the need for more innovation, several factors hinder the development of new technologies. Ajami, Thompson, and Victor describe three sets of challenges to innovation in the water sector that can be mitigated by thoughtful policy interventions: (1) pricing issues, (2) regulatory hurdles, and (3) insufficient access to capital.

For several reasons, water pricing is often not reflective of the costs of obtaining and transporting water. First, many water users, particularly in the agricultural and industrial sectors, are either charged a constant price regardless of the amount of water they use or are charged a fixed rate per unit of water, and neither of these pricing schemes reflects the rising costs of delivering greater amounts of water. Second, the available revenue raised from water bills is often insufficient to cover the costs of infrastructure maintenance, such as keeping purification systems up to date and maintaining pipes. Third, the lack of sufficient revenue can make needed investments in new water-saving technologies unaffordable, with no dedicated revenue stream to repay development costs. Fourth, water prices seldom reflect the costs of environmental damage—what economists call a negative externality. For example, low stream flows due to overextraction of river water damage environmental habitats and deplete resources for water-dependent industries, such as fishing.

Current regulations can also serve as a barrier to innovation and lock organizations into existing technology. Even where regulations are justified, new technologies often face administrative costs stemming from the need for permits or other forms of regulatory approval that existing technologies do not face. However, in some cases regulations can directly promote the adoption of new technologies by discouraging the use of existing technologies. For example, the federal Clean Water Act requires that the U.S. Environmental Protection Agency set performance standards for industry to employ the best available technology or its equivalent, incentivizing water utilities to innovate by finding more cost-efficient ways to meet the standards, where possible.

The mostly public nature of the water industry is an initial barrier to available capital. Public entities such as cities or water districts commonly rely on bonds, issued at low interest rates, to fund new projects. These bonds are typically paid back using new revenue generated from the project or by tapping into the locality's general fund. However, rising operation and maintenance costs as well as declining revenue threaten these funding sources and can even affect bond ratings, further increasing the cost of new projects. This challenge is especially problematic for localities considering new technologies such as desalination that might already present riskier rates of return than established technologies.

The authors note that there are additional factors inherent to the water industry that contribute to its conservative approach to investment, but that cannot be readily addressed by policy reform. For example, the long lifespan and large scale of water infrastructure—e.g., dams and pipes that last for decades and are expensive to replace—bias the water industry toward incremental upgrades over more-innovative technologies. Water systems are also highly fragmented: there are more than 150,000 systems in the United States, most of them quite small. This decentralized landscape slows the diffusion of new technologies and leads to the classic public goods problem that arises when the entity that outlays the initial costs of an investment does not capture all the benefits. For example, if a local supplier adopts water recycling or desalination, it might benefit an entire region. However, the supplier who assumes the initial costs may not reap all, or perhaps even most, of the benefits. This leads to a situation where no individual actor has the proper incentives to invest to the level that would be socially beneficial. The result is that, absent effective coordination, the amount of investment is too low from a public perspective. An additional reason for conservatism in the industry is the potential for water impurities to cause great harm to individuals. Public health concerns often trump virtually any other consideration, leading water suppliers to be reluctant to employ and experiment with new technologies. Still, the authors contend that much progress can be made by addressing the barriers to innovation that result from inadequate pricing mechanisms, regulatory hurdles, and insufficient access to capital.

A New Approach

Innovation in the U.S. water industry is incremental and fragmented. Ajami, Thompson, and Victor propose increasing innovation in the water sector by addressing the challenges presented by inadequate water pricing, obstructive regulations, and the lack of public-sector financing to raise capital for new projects. Addressing these challenges would unlock new funding sources and opportunities for the water industry, while also establishing a regulatory environment more conducive to innovation, prerequisites for addressing the nation's water needs.

Water Pricing

To strengthen innovation in the water sector, the authors call for three targeted reforms. First, they advocate pricing schemes that capture the full price of delivering water to better support the financial health of water suppliers. In particular, they argue that rates should recover all the costs of utilities' services, including the costs of replacing infrastructure over time as well as needed research and development. Full-cost water pricing would help utilities recover the fixed costs of their infrastructures, granting them greater stability in funding innovative projects.

Second, they call for consumers to face the full marginal cost of each unit of water consumed, including costs to society in the form of environmental damages. For example, water utilities that charge flat fees for water, under which all users pay the same price no matter how much water they use, would move to a metered pricing structure; utilities that charge a uniform unit rate to all consumers would move to a pricing structure that charges more per unit as consumption rises. These pricing reforms would encourage greater conservation by end users and incentivize them to adopt water-conserving technologies.

Third, the authors propose decoupling utility revenue from the quantity of water sold by setting fixed revenue targets that do not vary with sales. Decoupling can be achieved by allowing utilities to issue a surcharge or a refund if the quantity of water sold lands below or above the target quantity, respectively. For example, the California Public Utility Commission ordered investor-owned utilities to decouple prices in 2006, using a water rate adjustment mechanism—the ability to issue a surcharge or refund—to lower utilities’ risk of falling revenue resulting from increased conservation, unexpected weather conditions, or an economic recession. Decoupling would remove the incentive from water utilities to maximize the amount of water sold, instead giving them a stake in the development of more-efficient technologies.

Regulations

Regulation in the water sector can both promote and inhibit innovation. To ease the negative impact of regulations, Ajami, Thompson, and Victor propose a two-pronged approach to regulatory reform. First, they propose that state legislators and regulators undertake a review of regulatory practices along several key criteria, such as minimizing variation across geographic jurisdictions and across related sectors (e.g., water and wastewater, water and energy) and providing sufficient flexibility to avoid blocking the timely adoption of new technologies. Second, they propose that certain states create water innovation offices to better coordinate and support innovation efforts across the industry and to recommend regulatory reforms to the respective state’s water sector.

The regulatory review would seek to:

- Reconcile regulations that are inconsistent between state and local government and among local governments, with state regulations always taking precedence.
- Coordinate regulations across sectors (e.g., water and wastewater, water and energy) to ensure consistent treatment of new technologies and to reduce obstacles to the development and adoption of new technologies.
- Shape regulations to encourage utilities to meet performance standards, rather than force them to adopt fixed technology mandates.
- Enact regulations that drive, rather than inhibit, the development of new technologies.

Roadmap

- Local water utilities would initiate three reforms to pricing. First, utilities would raise the price of water to capture its full cost, including environmental costs. Second, utilities would employ tiered pricing structures that charge users more per unit consumed as consumption increases; in some places, this reform would also require the addition of water meters where they are not already utilized. Third, utilities would decouple target revenue from the actual quantity of water sold, using surcharges or refunds to consumers to make up the difference. The exact method of instituting these reforms would vary by utility. As water utilities can be public or privately owned, the council or agency overseeing the water utilities’ pricing reforms would vary.
- Executive bodies and/or state legislators would authorize regulators of the principal water agency (or interagency team where no principal water agency exists) to conduct a review of regulatory practices.
- Certain states would establish innovation offices to develop a vision of water sector innovation. In some cases this would involve the legislature or governor first creating a commission or task force comprising policymakers, academic experts, and stakeholders to examine specific water challenges and opportunities in that state. The legislature or governor would then decide whether an independent innovation office or an existing office within a principal water agency would carry out the vision.
- Water authorities would impose a public benefit charge (PBC) in addition to normal water bills. In some cases the PBC would be collected and run by local water utilities, while in others it would be administered directly by a statewide entity such as the principal water agency. The size of the PBC would vary based on the funding objectives of the water utility in question.

The authors propose that select states establish offices of water resources innovation and development (called innovation offices) to develop a vision of water sector innovation. In some cases the legislature or governor would first create a commission or task force comprising policymakers, academic experts, and stakeholders to examine specific water challenges and opportunities in the state. The legislature or governor would then decide if an independent innovation office is necessary to carry out the vision, or if an existing office within the principal water agency can implement the plan.

Learn More about This Proposal

This policy brief is based on The Hamilton Project discussion paper, “The Path to Water Innovation,” which was authored by:

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Statewide water innovation offices would be well-positioned to support regulatory, as well as pricing and financial, reforms. Potential first adopters of water innovation offices include California, Florida, and Texas, which have the existing administrative capacity and most-pressing water supply challenges. These states may wish to employ their innovation offices to carry out or assist in the systematic review of water regulations. The innovation offices would also be positioned to support water pricing and utility financing reform and to promote research and development to a level seen in the energy industry.

The authors also suggest that the federal government play a supportive role to the first innovation offices, especially for states that lack the expertise or funding to promote innovation on their own. Utilizing the resources of the U.S. Environmental Protection Agency, the federal government would supply expertise and enable information sharing of best practices among the states. It could reward best practices with race-to-the-top funds and a periodic innovation report card. It would also engage organizations such as the National Association of Regulatory Utility Commissioners to promote adoption of innovation-driving regulations.

Public-Sector Financing

Finally, Ajami, Thompson, and Victor propose that authorities—either local water utilities or a statewide entity such as a water innovation office—institute a surcharge on water usage, called a public benefit charge (PBC), to create a stable and sustainable source of funding to finance innovative projects. The surcharge would create a pool of monies that could be used to invest in research and development, to pay for adoption of new technologies, and to attract private capital. The authors also suggest that the federal government act as a catalyst to investment by continuing to provide low-interest loans and grants to pilot and implement innovative projects.

Experience already shows how the administration of the PBC can be tailored effectively to state and local circumstances. One example is the water stewardship rate levied by the Metropolitan Water District of Southern California, which added a fixed charge to water bills to fund conservation programs and support research. Another successful illustration of how PBCs can promote innovation includes the California Solar Initiative, which used the funds levied from California’s PBC on electricity usage to promote renewable clean energy, successfully bringing down the prohibitive cost of rooftop solar power through the use of subsidies. Implemented in stages, the subsidies started at a high level and then declined—broadly in line with improvements in technology.

The primary benefit of instituting a PBC is that it would confront the water sector’s fundamental public-sector challenge to raise sufficient capital to support innovation. For the 80 percent of the water market that is supplied through state-owned enterprises, a public surcharge on water users is perhaps the most economically efficient mechanism for raising new capital while tying the costs to users. The PBC would help reverse the long-standing trend of exceptionally low public investment in water innovation.

Conclusion

In order to prepare for the future and the nation’s anticipated increased vulnerability to water scarcity, the water sector must confront its historic lack of support for innovation. The authors stipulate that three factors in particular present barriers to greater innovation, and that these could be addressed with smart policy reforms. First, water is typically underpriced, meaning that consumers do not face the full cost of their consumption, and water systems struggle to fund infrastructure renewal projects, let alone research and development of new technologies. Water systems are also subject to regulations that vary by jurisdiction and often emphasize implementation and use of status quo—rather than next-generation—water technologies. Furthermore, water systems lack access to the capital needed for innovation due to a dearth of public funding and difficulty obtaining low-yield bonds. Taken together, these factors limit the innovation in an industry predisposed to utilizing existing technologies over pioneering, but possibly riskier, alternatives.

The policy reforms called for by Ajami, Thompson, and Victor can help to break down some of these barriers to innovation. Price reforms would incentivize both utilities and consumers to conserve water and increase funding for innovation. Conducting systematic reviews of water regulations at the state and local levels would make regulations consistent and help drive the water industry to reach new performance standards through innovation and adoption of new technologies. Finally, instituting a PBC would provide utilities with a dedicated revenue stream and increase their access to capital to fund research for new technologies.

Questions and Concerns

1. Would states need to build additional capacity or provide additional funding for these reforms?

Most of the reforms presented in this paper, including reforms to pricing, regulations, and public financing, do not require significant new capacity or funding from state governments. The only reform that could require additional capacity or funding is the establishment of an innovation office. A task force or commission in each state would initially evaluate the steps needed to promote innovation, including the potential value of an innovation office. As part of this evaluation, the task force would examine the capacity needs of such an office and how the office might be financed. The exact needs of an office would depend on its mandate and activities. In some cases, a state might be able to create the office without a significant investment of new resources by reallocating resources within an existing state agency.

If the innovation office would need new resources, the state may be able to fund the office and its activities either by allocating a portion of the funds collected from the public benefit charge or through contributions from the local water agencies who would benefit from the office. States could require local agencies to fund the office, or they could institute a membership model in which local agencies could voluntarily decide whether to provide funding. In the energy sector, the Electric Power Research Institute (EPRI) successfully relies on voluntary subscriptions to support its activities. Like the Institute, a state innovation office could open its membership not only to local water agencies, but also to businesses and other governmental agencies interested in promoting innovative water technologies. EPRI estimates that, by pooling the resources of its members, it provides them with ten dollars in research and development for every one dollar received in contributions. Under this model, members would presumably receive benefits, such as the ability to formulate research goals and access research results, that are not available to nonmembers. However, other activities, such as regulatory reform, would benefit all water agencies.

2. Should there be a mandate for these pricing reforms?

In many cases, state or federal mandates may not be necessary. Water suppliers will often want to develop larger and more-reliable revenue streams in order to respond to the multiple water challenges facing them. Moreover, some reforms, such as decoupling revenue from the quantity of water sales, may not increase water consumers' rates and therefore not engender significant political opposition. Other reforms, such as full-cost pricing and tiered pricing schemes, may threaten consumers' budgets and therefore attract political opposition. Many water suppliers, nonetheless, have successfully raised rates or reformed their pricing structures. Education of customers has often been the key to success in these cases. Consumers are much more likely to accept higher rates if they understand the necessity of the rate increase or the benefits of reform.

Both the federal government and state governments, moreover, can help encourage pricing reforms without resorting to mandates. First, these governments can provide information and programs designed to help water suppliers explain the necessity of the reforms to their customers. Second, where state governments require water suppliers to adopt efficiency or conservation policies, the states can make pricing reforms such as those recommended above meet those requirements. The pricing reforms not only would help promote innovation, but would also encourage conservation and more-efficient water use.

Where pricing reforms prove impossible, water suppliers or states might be able to adopt other policies that mimic the effect of the reforms but with less political opposition. For example, if a water supplier is unable to raise its rates because of consumer opposition, the supplier might use a shadow price (i.e., a price equal to the full cost of the supplier's water, including environmental and other costs) to determine what investments to make in new technology. Innovation opportunities that may be cost-ineffective when based on actual water rates could actually be cost-effective when shadow prices are used instead.

Highlights

Newsha K. Ajami and Barton H. Thompson Jr. of the Stanford Woods Institute for the Environment, and David G. Victor of the University of California, San Diego, propose a set of forward-looking policies to promote innovation in the water sector. They call for fundamental reforms in utilities' pricing of water, systematic reviews of regulatory practices, and a new mechanism for utilities to raise revenue to finance new infrastructure investment.

The Proposal

Adjust the price of water charged by utilities so that it captures the full cost of delivery; implement tiered pricing so that consumers face the full marginal cost of consumption; and decouple revenue from the quantity of water sold. These changes would promote conservation measures by giving users better incentives to curtail water use, while also enhancing the financial stability of water utilities.

Conduct a systematic statewide review of regulatory practices and create water innovation offices to better coordinate the research and development of new technologies across the industry. The statewide review of regulatory practices would seek to minimize variation of rules across jurisdictions and related sectors, and provide flexibility to avoid blocking the timely adoption of new technologies. Statewide innovation offices can be shaped to drive any of the reforms and to support other endeavors such as information-sharing with water utilities and distributing funds for research and development.

Institute a surcharge on water usage, called a public benefit charge, to create a stable and sustainable source of funding for infrastructure investment. The surcharge would create a pool of monies that could be used to invest in research and development, to pay for adoption of new technologies, and to attract private capital.

Benefits

These reforms confront the most pressing challenges to innovation in the water sector. The authors emphasize that improving the financial sustainability of utilities through better pricing strategies and enhanced access to capital would help to unlock funding opportunities for innovative new technologies. In addition, the authors contend that regulatory reform would break down the legal protections for status quo technologies. Evidence from both the water sector, where these reforms have thus far been implemented only on a small scale, and the clean energy sector demonstrate the benefits of the proposal.



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