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Research Brief

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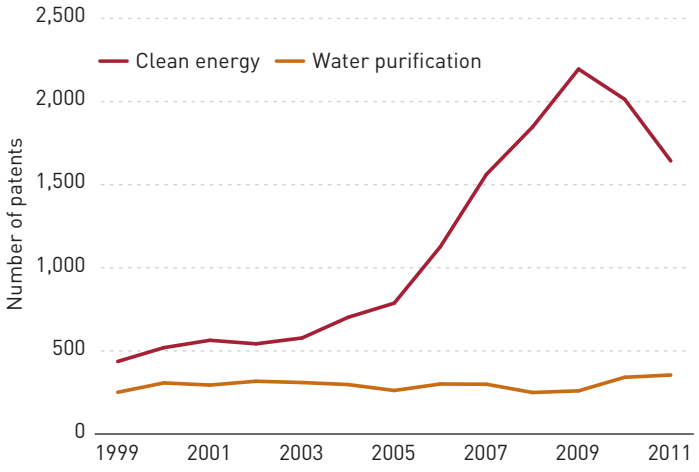
The Path to Water Innovation

Background

Over the past century, our nation has invested heavily in its water sector to enhance water supply reliability, manage flood-water, and control wastewater effluent, creating the largest water sector in the world. These investments have significantly enhanced our nation's social, economic, and environmental wellbeing. Although our current water resource management system has been effective to date, it is facing mounting challenges that it is ill prepared to meet. Despite significant gains from conservation, pressures on water supply are intensifying as the population grows; and water infrastructure, including dams, reservoirs, aqueducts, and urban distribution pipes, is aging with nearly half of it at the end of its designed lifespan and in need of replacement. Climate change will further threaten water supplies while at the same time increasing demand in certain parts of the United States.

While the future scenarios for the environment in which our water distribution systems must function and the demands it must now meet have shifted dramatically, the system itself has been slow to respond, evolve and innovate. This brief is based on the paper The Path to Water Innovation, a 2014 report published by the Hamilton Project and the Stanford Woods Institute for the Environment. It takes a fresh look at the some of the barriers to innovation inherent to the water sector, drawing insightful comparisons from the clean energy sector. It examines indicators for innovation; looks at challenges and opportunities in pricing, regulation, and

Comparison of U.S. Patents Filed under the Patent Cooperation Treaty for Clean Energy and Water Purification, 1999–2011



Source: Organisation for Economic Co-operation and Development (OECD) 2014.

Note: Clean energy = biomass generation + energy efficiency + energy storage + geothermal + hydro & marine power + solar + wind; and water purification is the primary contributor to patent filings in the water sector.

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access to capital; and provides recommendations and proposals to promote innovative technologies, strategies and governance approaches.

Investment Trends and Patents — Indicators of Innovation

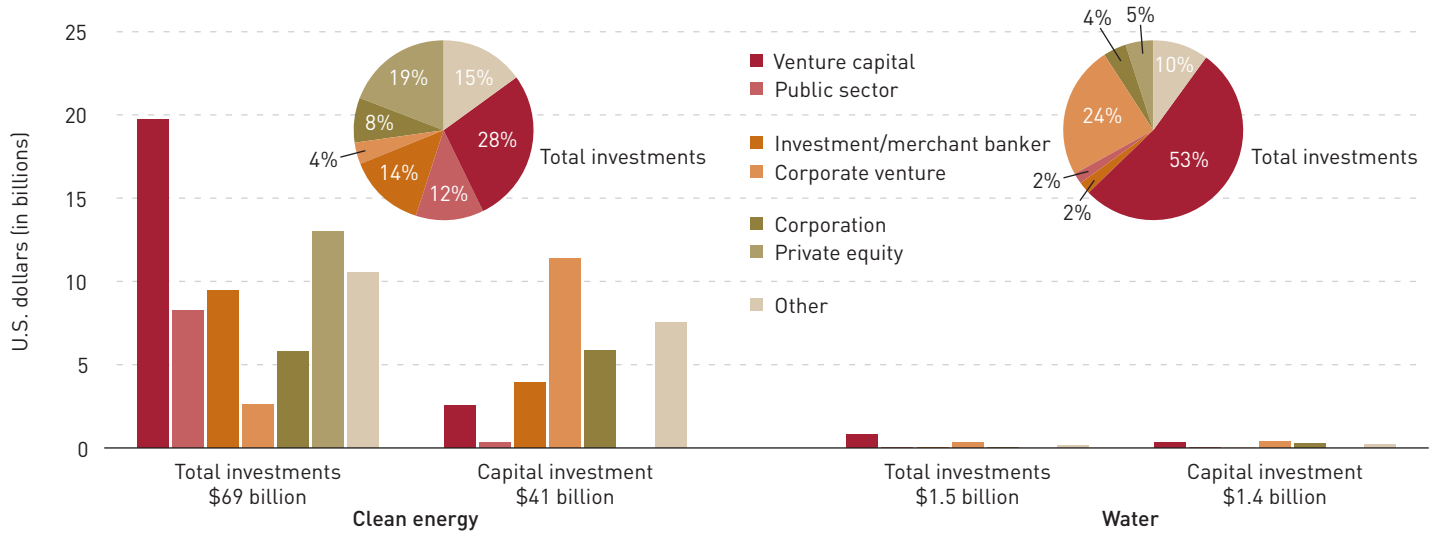
The water sector is suffering from an innovation deficit. Conventional water resource management placed a priority on meeting increased demand with increased supply; preferred centralized infrastructure for its economies of scale and operational flexibility; and assumed that ground and surface water conditions would not change much over the long-term. Recognizing that these assumptions do not hold true, the water sector has to rethink its water management and governance strategies and focus more on embracing innovative solutions that place increasing emphasis on demand management and on alternative water supplies such as recycling and stormwater capture. For the water sector to move to 21st century the sector has to reinvent itself.

Target markets and end-user demand have driven some technological advances in the water sector. For example, the food and beverage, pharmaceutical, and petroleum industries have helped drive two of the most rapidly growing technological frontiers in the water industry – desalination and water purification. However, the rate of innovation and dissemination has been slow.

The amount and type of investments in the water sector, as well as the number of patents issued, provides insights into the state of and capacity for innovation in the water sector, particularly in comparison to the clean energy sector. For example:

- New patent filings during the 2000s, both globally and domestically, saw a remarkable uptick in the clean energy sector while remaining static in the water sector. While overall patent activity has not increased in the water sector, filings for water purification technologies dominates among the types of patent applications mostly due to industry/end user pull and target markets.
- Over the past decade, investments in clean energy (including biomass generation, energy efficiency, energy storage, geothermal, hydro & marine power, solar, and wind) have exceeded those in water by

Sources and Level of Investment Dollars for U.S. Innovation in the Clean Energy and Water Sectors, 2000–13



Source: Cleantech Group 2014.
Note: Clean energy = biomass generation + energy efficiency + energy storage + solar + wind + geothermal + nuclear + hydro & marine + smart grid; and water = water + wastewater.

an order of magnitude, both globally and within the United States

- In the United States, significant clean energy investment come from all investor types, while corporate ventures and venture capital account for over three quarters of all water investments
- U.S. public funding in the water sector has been considerably less than that in the clean energy sector which has benefited from about $8 billion in public investment compared to $28 million in public funding for water

Innovation Challenges and Opportunities — Pricing, Regulation, and Access to Capital

Many factors can help explain the lack of innovation in the water sector. The sector as a whole is risk-averse given the potential dire consequences for human health should technology fail. Water infrastructure tends to be large-scale (dams, reservoirs, pipes) with long lifetimes, resulting in fewer opportunities to replace infrastructure. Water systems are fragmented by geography and function posing further obstacles to the adoption of new technologies. These challenges to innovation are not easily addressed by policy reform. New policies, however, may well be able to address three other areas that have profound impacts in inhibiting innovation: current water pricing practices, regulations, and access to affordable capital.

- **Water Pricing:** Water in the United States is generally underpriced and does not reflect the true economic cost of water to society. Pricing affects innovation in several ways – by reducing the revenue available to water suppliers to invest in innovation (the ratio of capital investment to collected revenue for water supplies is two to three times higher than for other utilities); by biasing the decisions of water managers against investment in new technologies because the externalities of existing water supplies and technologies are not fully reflected in costs; and by undercutting incentives that water users would otherwise have to conserve water and invest in new water-efficient technologies.
- **Regulation:** Regulation can both help and hinder technological innovation. The Clean Water Act has helped to drive the development and adoption of new water-quality technology. Regulation also has been a driver of new technology in other settings – for example, where states have required wastewater districts to look for recycling opportunities or required agencies to serve as early adopters. Governments, however, have used regulation to encourage new technology less in the water sector than in the energy sector. Examples of regulatory barriers, by contrast, are multiple, including jurisdictions that have banned recycling or required complicated permitting of inspection processes without legitimate concerns.
- **Access to Capital:** Aging infrastructure has led to rising operational and maintenance costs in the water sector. Meanwhile, revenue is declining in response to reduced demand from conservation and efficiency efforts and due to leaks and inefficiencies in the water delivery system. These factors in addition to inadequate pricing have led to financial instability in the industry, jeopardizing its credit quality and affecting its access to affordable capital. The large role that the public sector plays in the water industry also inhibits the raising of capital due to their reliance on high-quality, low-yield bond funding. The accrued bond-related debt plus interest must be paid back out of generated revenue or from a locality's general fund. Rising costs and declining revenue have jeopardized the market's evaluation of public water systems as low-risk investment, which occasionally has affected their access to cheap capital and financing options.

Recommendations for Infusing Innovation into the Water Sector

Three sets of reforms are particularly important in order to overcome some of the barriers to water innovation and equip the sector with solutions that are fit to meet our nation's 21st century water challenges. While many of the recommendations are targeted to the state and local authorities with the ultimate power to act on them, the federal government has an important and significant role to play by ensuring that funding across federal agencies is aligned to support innovation at the local level; investing

in further R&D; and serving as a clearing house of information to disseminate and promote best practices in the water sector.

I. Pricing

- Prices for urban, industrial, and agricultural water should reflect the full costs of delivering water to the end user, ensure the financial health of water suppliers, and ideally include the costs of environmental and other impacts;
- Water suppliers should adopt tiered (or block-rate) pricing structure that confront water consumers with the marginal cost of the water they use and encourage the adoption of efficient technologies;
- Water utilities should "decouple" revenues from the quantity of water sold and establish a guaranteed target revenue based on expected sales and costs. Decoupling promotes innovation by allowing utilities to promote demand-side management, increasing financial reliability that allows for investment in new technologies, and enhancing long-term access to capital

II. Regulation

- The federal government, as well as each state, should conduct a systematic review of their regulatory practices to avoid both unnecessary obstacles to new technologies and geographic and cross-sectoral inconsistency in regulations;
- Governments should consider ways in which they might be able to use regulations to encourage the adoption of new technologies;
- Where appropriate, the federal and state governments should develop a vision for technological and managerial innovation and encourage their agencies to promote that vision through their regulatory and funding authority

III. Access to Capital

- State and local authorities should consider instituting a surcharge on water usage (such as public benefit charge) to create a pool of monies that would be dedicated to promoting water efficiency and conservation as well as development and investment in innovative solution. The funds could be used to invest in R&D, reduce the cost of new technologies, and attract private capital
- Federal grants should prioritize states that have adopted policies promoting the development and adoption of new technologies to address their water availability or quality challenges.

Conclusion

The water sector is suffering from lack of innovation. Historically, the water sector has largely taken a reactive and conservative approach to innovation. Multiple factors have driven the low level of innovation, including unrealistically low water rates, regulatory limitations, lack of access to affordable capital and the conservative culture of the industry. The critical role of public-sector funding, combined with the limited private-sector funding for innovation in the water sector is one of the major factors behind the sluggish technological development in the sector.

Our analysis shows that most of the barriers to innovation in the water sector are related to the way we govern water. The three sets of core recommendations set out above – reform pricing policies, regulatory frameworks, and financing and funding mechanisms – are key to spurring innovation in the water sector.

This Research Brief is based on "The Path to Water Innovation," by Newsha K. Ajami, Barton H. Thompson Jr., and David G. Victor, a discussion paper presented in October 2014 at "New Directions in U.S. Water Policy," a conference hosted by The Hamilton Project and Stanford Woods Institute for the Environment.

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