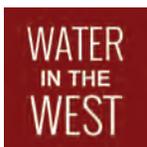


TAPPING INTO ALTERNATIVE WAYS TO FUND INNOVATIVE AND MULTI-PURPOSE WATER PROJECTS: A Financing Framework from the Electricity Sector





February 2016

Authors

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About Water in the West

Water in the West is a partnership of the faculty, staff and students of the Stanford Woods Institute for the Environment and the Bill Lane Center for the American West. The mission of Water in the West is to design, articulate, and advance sustainable water management for the people and environment of the American West. Linking ideas to action, we accomplish our mission by engaging in cutting-edge research, creative problem solving, active collaboration with decision-makers and opinion leaders, effective public communications and hands-on education of students. To learn more visit: waterinthewest.stanford.edu.

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ACRONYMS

ABS	Asset-Backed Securities	NEM	Net Energy Metering
ACEEE	American Council for an Energy Efficient Economy	OBR	On-Bill Repayment
AWWA	American Water Works Association	OBF	On-Bill Financing
CEC	California Energy Commission	PACE	Property Assessed Clean Energy
CPUC	California Public Utilities Commission	POU	Publicly-Owned Utility
DSM	Demand Side Management	PPA	Purchase Power Agreement
DOE	U.S. Department of Energy	PWD	Philadelphia Water Department
DSIRE	Database of State Incentives for Renewables and Efficiency	REIT	Real Estate Investment Trust
ECAA	Energy Conservation Assistance Act	RES-BCT	Renewable Energy Self-Generation – Bill Credit Transfer
EECBG	Energy Efficiency and Conservation Block Grant	RPS	Renewables Portfolio Standard
EIB	Environmental Impact Bond	SB	Senate Bill
EPA	U.S. Environmental Protection Agency	SEIA	Solar Energy Industries Association
ESCO	Energy Service Company	SFPUC	San Francisco Public Utilities Commission
GHG	Greenhouse Gas	SMIP	Stormwater Management Incentives Program
IOU	Investor-Owned Utility	VNM	Virtual Net Metering
ITC	Investment Tax Credit	WEF	Water Environment Federation
LID	Low Impact Development	WERF	Water Environment Research Foundation
MLP	Master Limited Partnership	WIFIA	Water Infrastructure Finance and Innovation Act
NAESCO	National Association of Energy Service Companies		

EXECUTIVE SUMMARY

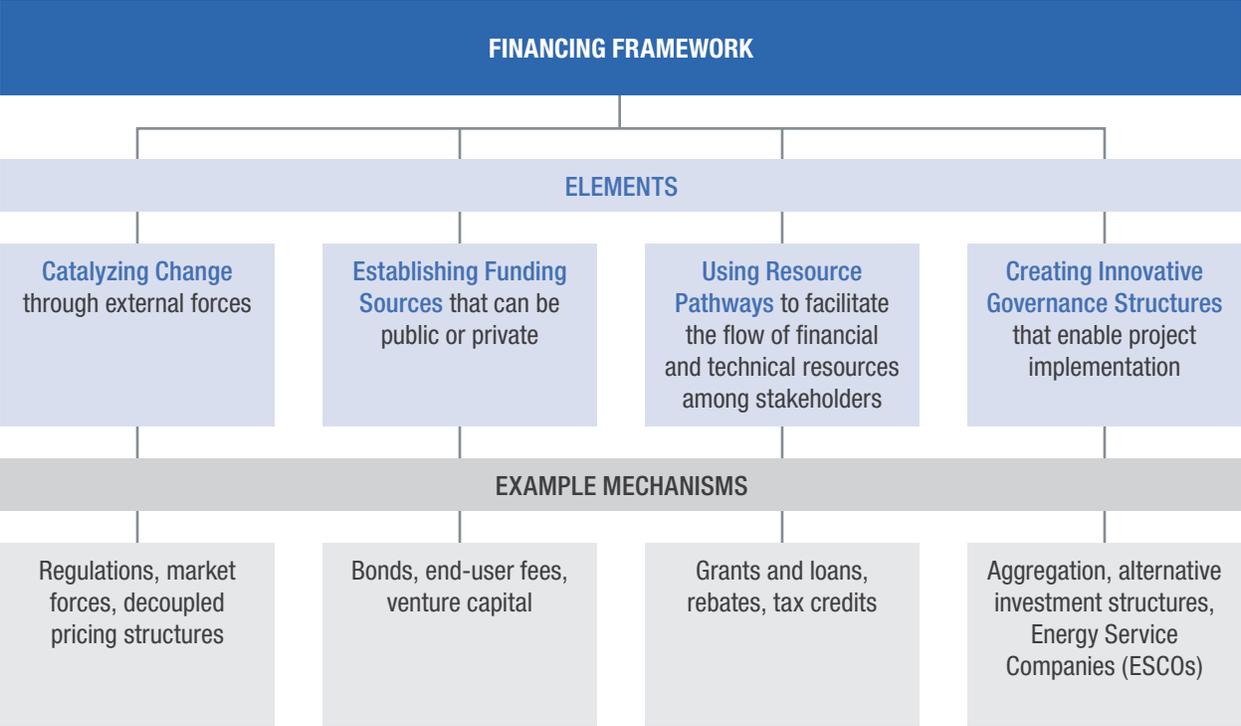
Over the past century, the United States has developed one of the largest water sectors in the world. Our water and wastewater network is a widespread, centralized infrastructure system designed to improve water reliability, manage stormwater, and control wastewater effluent. This network of dams, aqueducts, levees, treatment facilities, and millions of miles of pipelines has enhanced our nation's social, economic, and environmental well-being by ensuring dependable access to clean water. Federal and state governments have played a vital role in making this possible through direct investment in the form of grants, subsidies, and tax exemptions for municipal bonds.

Yet, our sophisticated water system is in need of renewed investment due to population growth, urbanization, climate change impacts, environmental degradation, aging infrastructure, and ever-increasing operation and maintenance costs. Tackling these modern challenges calls for new thinking and innovative, multi-purpose infrastructure solutions. There is an opportunity to reimagine conventional water management in the U.S. by taking a more holistic, integrated, and contemporary approach. However, the financial landscape in the water and wastewater sector is changing, and securing funding for new projects can be difficult. Traditional federal and state government funds are limited, and local utilities and municipalities are often too cash-strapped to meet existing operations and maintenance obligations, let alone finance new projects. Additionally, private investors sometimes shy away from certain water projects because of their potentially high risks due to limited track records and slow or small rates of return.

This absence of available and appropriate funding resources has created a financial barrier and played a key role in slowing the widespread integration of new technological solutions into America's water infrastructure. One of these solutions is the incorporation of innovative and multi-purpose water projects, such as distributed solutions that are designed to manage water more locally and closely mimicking the natural hydrologic cycle. Examples of these small- to medium-scale innovative projects include green infrastructure designed to manage stormwater, demand-side management (DSM) measures that protect potable source water from waste, and decentralized wastewater treatment systems. Incorporating these solutions has the potential to offer increased flexibility in responding to a changing climate and meeting future water quality and quantity needs.

The objective of this paper is to identify and explore innovative funding and governance mechanisms that can be used to support the integration of new distributed water infrastructure, practices, and technologies. To accomplish this, we looked outside of the water sector to explore financing tools and techniques that have been used by the electricity sector to implement distributed solutions. Distributed energy resources encompass a wide range of technologies and practices at various scales. Here, we investigate two: renewable generation and electricity DSM practices.

In this research, we first reviewed case studies of successfully implemented distributed energy projects to determine what tools have been used to develop, finance, and implement these solutions. We also examined the challenges stakeholders faced during implementation, and how they overcame the series of risks that preclude innovation. We then used our findings to develop a financing framework that could help the water sector transition to include more distributed solutions. We propose that this framework has four central elements critical for project financing: catalyzing change, establishing funding sources, using resource pathways, and creating innovative governance structures. We evaluated many mechanisms within each element. Those discussed in this report are most appropriate for the water sector.



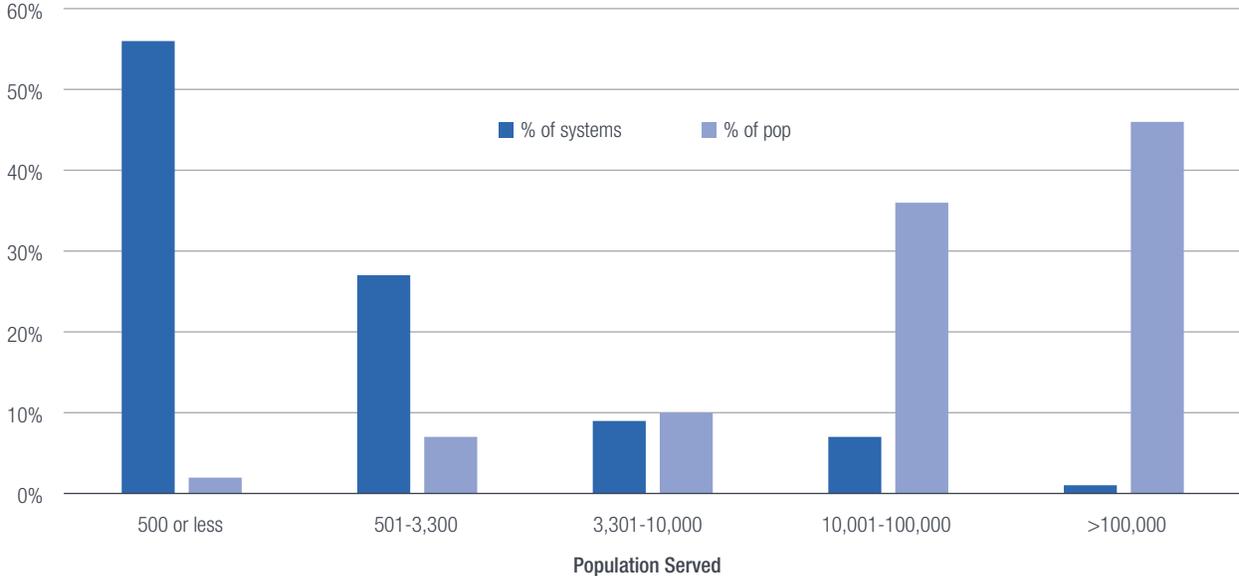
The water sector can learn many lessons from distributed project implementation in the electricity sector. Through this investigation, we determined that the water sector should utilize tools that promote cost sharing with end users, look beyond traditional water-specific funding resources, develop diverse financing portfolios, and encourage collaboration among all stakeholders. By evaluating how the electricity sector has financed innovative distributed energy solutions, we elucidate ways that the water sector could fund innovative and multi-purpose projects in the future. Many of these financing tools and governance structures could be used not only for distributed solutions, but by the water sector as a whole to help revamp our nation’s urban water systems. All infrastructure transitions require extensive capital, and the water sector must secure adequate funding if it is to move into a more sustainable and resilient future.

1. INTRODUCTION

Throughout the 20th century, the United States has invested heavily to create one of the largest water infrastructure systems in the world (Hering et al., 2013). This network of dams, aqueducts, levees, treatment facilities, and millions of miles of pipelines has enhanced our nation’s social, economic, and environmental well-being by improving water supply reliability, preventing flooding, and managing wastewater effluent (The Johnson Foundation, 2014). Federal and state governments have played a vital role in making this possible through direct investment in the form of grants, subsidies, and tax exemptions for municipal bonds (Hanak et al., 2014).

Nevertheless, modern challenges including environmental degradation, a changing climate, urbanization, aging infrastructure, and ever increasing operation and maintenance costs are testing the reliability and resiliency of our nation’s water system (Hering et al., 2013). The disjointed and antiquated governance structures that currently overlay our centralized network are too rigid and politically complex to handle these issues (Ajami et al., 2014). Our water system is extremely fragmented as thousands of small utilities serve the majority of the population (Figure 1), many different government agencies are responsible for oversight, and different water types such as stormwater, drinking water, and wastewater are managed separately (Mukheibir et al., 2014).

Figure 1. Community Water Systems in the United States: System Size by Population Served



Source: Source: U.S. EPA, 2009

To modernize our systems, we must take a holistic, integrated, and innovative approach to water resource management. Significant capital is required for this reinvention, however, and the financial landscape in the water sector is laden with problems that make financing new projects difficult (Hanak et al., 2014). Consequently, the water sector has been slow to evolve and to incorporate new technological solutions into existing infrastructure systems (Kiparsky et al., 2013). One of these solutions is the integration of innovative and multi-purpose distributed water projects. Distributed water solutions include infrastructure, systems, technologies, and practices that manage water more locally than traditional infrastructure and more closely mimicking the natural hydrologic cycle (Leurig and Brown, 2014). Incorporating these solutions is a practice that some communities have already found to be more

economically, socially, and environmentally efficient than using centralized water systems alone (Water Environment Research Foundation [WERF], 2006).

While there are few examples of distributed solutions that have been successfully financed and constructed in the U.S. water sector (Leurig and Brown, 2014), there are many more in the electricity sector. Energy innovation in the U.S. has advanced at a much faster rate than it has in the water sector (Ajami et al., 2014). Like America's water sector, in modern history our energy infrastructure has been dominated by centralized systems (U.S. Environmental Protection Agency [EPA], 2015). However, in recent years the electricity sector has evolved to include more distributed solutions, such as renewable energy technologies and demand side management (DSM) devices and services (Owens, 2014). Regulations and public policy have played an important role in this evolution (Johnstone et al., 2009), and energy service providers have utilized innovative financing and governance mechanisms to meet these new policies (Kim et al., 2012).

Our research investigates how the electricity sector has progressed to include more distributed solutions through a case study methodology. In this report, we uncover specific tools that have been used to fund and implement distributed energy projects, and through this exploration we create a financing and governance framework, highlighting mechanisms within the framework that could be applicable to the water sector. It is important for the water sector to find new and innovative financing and governance techniques for the future, and this research highlights some tools that could help modernize America's water infrastructure.

2. RETHINKING AMERICA'S WATER INFRASTRUCTURE

2.1 The Need for Water Innovation: Integrating Distributed Water Solutions

As modern challenges mandate reinvention, some communities are exploring the potential of incorporating alternative water systems, such as distributed and multi-purpose water solutions, into existing infrastructure as a way to increase the resilience and flexibility of their networks (WERF, 2006). Distributed water solutions include a wide variety of practices, technologies, and infrastructure that are used to manage water more locally than traditional techniques (Table 1). In this research, we focus on three that we see as having a high potential for changing the landscape of the water sector in the future: green infrastructure, DSM measures, and decentralized water treatment facilities. Distributed water projects are often implemented at the community- or customer-level, although they can also be realized at a utility-scale, and often incorporate innovative technologies. Many cities have already discovered that integrating distributed solutions into existing water networks can be economically and environmentally competitive (Leurig and Brown, 2014; The Johnson Foundation, 2014). These solutions can eliminate transportation costs, decrease energy requirements, and protect source water through conservation and reuse. Distributed water projects can also provide cost sharing opportunities among various levels of government, utilities, private investors, and end-use customers.

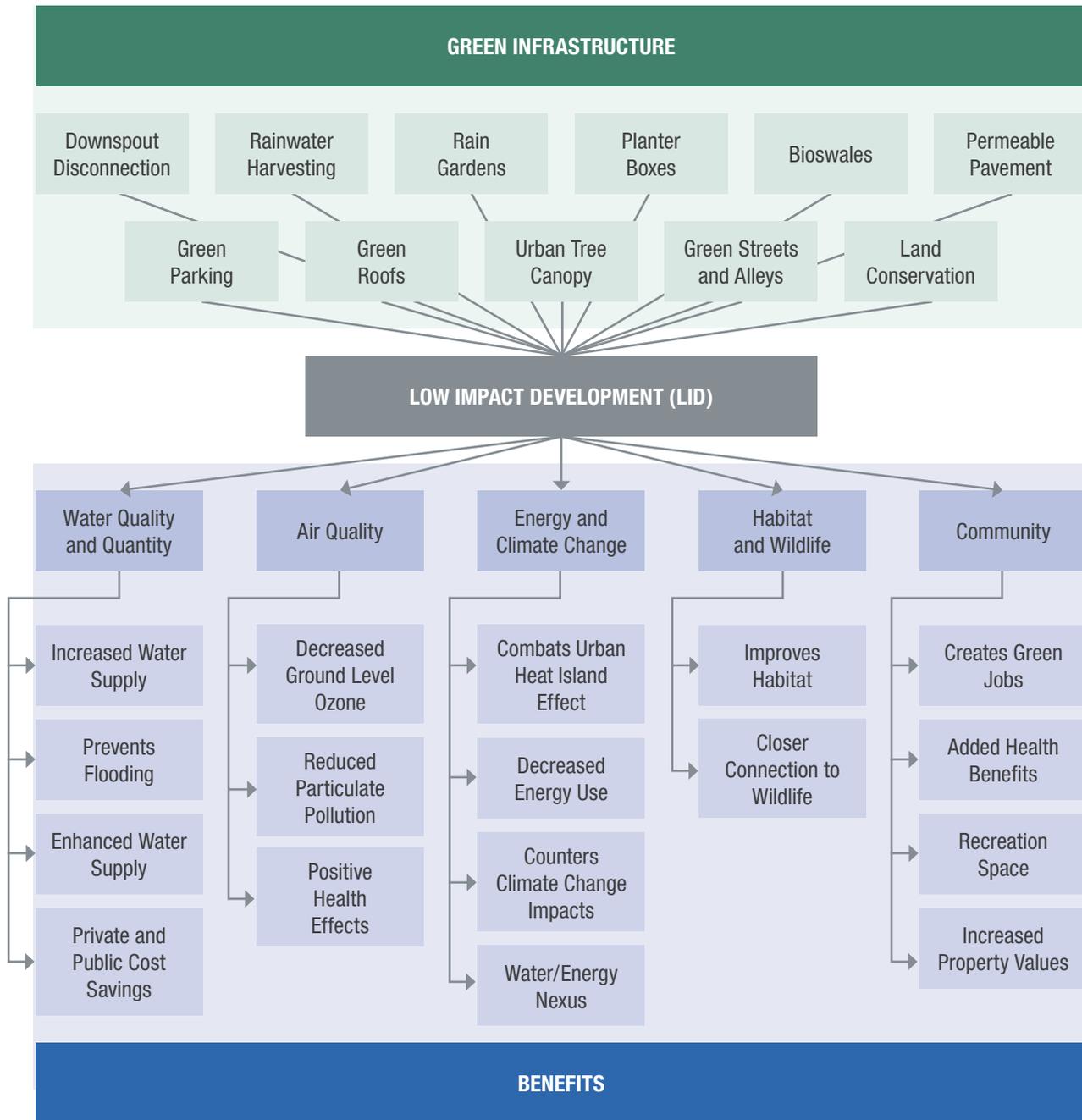
Table 1: Traditional vs. Distributed Water Management Strategies

	Traditional Management	Distributed Solutions
Stormwater	Runs off impervious surfaces and into storm drains or sent to detention ponds for treatment before discharge	Captured by green infrastructure and infiltrated to the subsurface
Potable Water	Supply-side management through expanded water resources	Demand side management (DSM) through conservation and efficiency
Wastewater	Sent to large, centralized treatment facilities and discharged to the environment	Sent to smaller, more local decentralized treatment facilities ; recycled for beneficial use

2.1.1 Green Infrastructure

Most urban stormwater flows over impervious surfaces, such as buildings or roads, and is sent directly into nearby surface water bodies or is captured for treatment at detention ponds before it is discharged (National Research Council, 2008). This not only degrades the natural environment as stormwater picks up pollutants and debris during overland flow but also wastes water that could potentially be captured for treatment and reuse or for recharging groundwater (Thurston et al., 2003). One way to more sustainably handle stormwater is to use green infrastructure. Green infrastructure uses natural processes such as infiltration or evapotranspiration to reuse stormwater or runoff onsite (U.S. EPA, 2014a). For example, instead of rain water flowing into storm drains, precipitation infiltrates the ground through permeable pavement or is captured in barrels for reuse. Green infrastructure can be used at the household- to watershed-scale and aids in the principles of low-impact development (LID) (U.S. EPA, 2014b). LID aims to more closely mimic pre-development hydrologic conditions than traditional infrastructure. These technologies and practices can also offer cross-sectorial benefits such as reducing greenhouse gas (GHG) emissions and providing green space for communities (Figure 2) (The Johnson Foundation, 2012).

Figure 2. Types of Green Infrastructure and Benefits



2.1.2 Demand Side Management (DSM)

DSM techniques, including conservation and water-use efficiency measures, can greatly benefit any water system and can be a simple way to improve water system reliability (Natural Resources Canada, 2014). Decreasing demand through conservation and efficiency practices can be more economically and environmentally sustainable than augmenting supply through new infrastructure or increased source capacity. Therefore, DSM strategies are typically the first line of action for cities and water utilities trying to

manage water consumption (Gleick et al., 2003). By decreasing consumption, these practices are also important in protecting source water from waste or contamination. Water conservation and efficiency programs are prevalent in many U.S. cities and have helped some water utilities in decreasing per-capita water demand in recent years (Gleick et al., 2003).

2.1.3 Decentralized Wastewater Treatment and Greywater Systems

Traditionally, wastewater is sent to large, centralized facilities for treatment and discharge. However, these centralized systems can be too energy-intensive and expensive for small utilities or municipalities to build and maintain. Consequently, some communities and utilities are investing in small-scale recycling or treatment facilities that manage wastewater more locally and complement existing infrastructure (Leflaive, 2009). In these systems, wastewater is piped to more local and smaller facilities where it is treated for reuse or discharged to the natural environment (Chalmers et al., 2011). While decentralized water treatment networks can introduce some potential risks and regulatory challenges, these systems can be appropriate solutions for apartment complexes, businesses or other public buildings that want a more resilient water supply (Decentralized Water Resources Collaborative, 2015). Additionally, some households are exploring the possibility of installing individual greywater capture systems that collect sink and laundry water from household devices for outdoor watering reuse (Friedler, 2004). Greywater systems are not currently being installed at a widespread scale, however, as there are some potential risks, public health concerns, and varying regulatory requirements associated with these novel solutions that do not have established or proven performance measures (Friedler, 2004).

2.2 Barriers to Adaption of Distributed Water Projects

Although distributed solutions can offer many benefits when integrated into existing centralized infrastructure, a series of barriers can prevent implementation (The Johnson Foundation, 2014). Here we discuss major barriers that directly and indirectly effect financial and governance challenges:

- Currently, many water utilities have **limited access to federal and state public funding sources**. Government grants are decreasing in number and often do not account for operations and maintenance needs (Musick and Petz, 2015). Federal and state assistance programs can also have large project size requirements. For example, projects funded through the federal government's Water Infrastructure Finance and Innovation Act (WIFIA) program must cost at least \$20 million to be eligible for assistance, with the exception of projects in rural areas that can be a minimum of \$5 million (Copeland, 2015), a threshold still higher than the cost of many distributed water projects.
- There is a **financial gap between the needs of water service providers and their abilities to generate funds** at the local level (American Water Works Association [AWWA], 2015). This is partly due to inefficient water pricing policies that link revenue to customer consumption, resulting in unstable revenue streams that directly and indirectly contribute to a lack of funding for new projects. Water services are the most expensive utilities to operate in terms of capital required per dollar of revenue (Alemi et al., 2009), yet water is typically the least expensive of Americans' monthly utility bills (Duffy, 2011). Because many water utilities in the U.S. are public entities with locally elected boards, board members can be unwilling to raise rates due to fear of public backlash (Donnelly et al., 2013).
- With limited public funding, financing for water projects can sometimes be sought from private investors. However, due to uncertainty in project cost recovery, **private funds for distributed infrastructure and technologies can be difficult to acquire** (Mukheibir et al., 2014). Financial backers can be reluctant to invest in water-related projects because the water sector is extremely capital-intensive, risk averse, fragmented, and heavily regulated (Leonard, 2015). It can be difficult for financiers to receive high or short-term returns on water infrastructure investment (Leonard, 2015).

- **Regulatory challenges can inhibit the development of new water projects**, especially those involving novel technologies, such as potable reuse, for which regulatory agencies have not articulated clear performance standards or which require long testing and review periods (Forer and Staub, 2013). Staying informed of, understanding, and complying with the many regulatory requirements associated with constructing and operating a new water project can be resource intensive. Furthermore, it can be difficult for service providers to understand complex water rights, even when aided by statewide organizations. Permitting and compliance can also add weeks, months, or even years to a project development timeline, increasing costs and in turn discouraging potential lenders.
- Regulators can be resistant to move away from the status quo when **public safety is perceived to be at risk** (The Johnson Foundation, 2014). This makes monitoring water quality and quantity parameters an important component of implementing novel distributed solutions. Demonstration sites and pilot projects can help garner support, but these too require additional capital. Additionally, measuring performance of these new solutions can be quite different from traditional infrastructure, making it difficult to evaluate their safety, impact, and cost effectiveness using traditional performance metrics.

Together, these challenges contribute to many different problems in the water sector, and here we focus on the financing and governance barriers that stem from these challenges. While these barriers can be seen throughout the entire water sector, the challenges are often amplified for distributed water projects. This has resulted in non-traditional and innovative water solutions not yet being adapted at a wide scale in the U.S (Kiparsky et al., 2013). The absence of innovation-encouraging regulations has further hindered the development of distributed solutions. Several municipalities and service providers throughout the U.S., including Philadelphia, Los Angeles, and Columbus, have successfully secured funding to integrate distributed solutions into their water networks (Leurig and Brown, 2014). These examples, however, are few and far between, relatively uncommon, and at a small scale and number. The water sector must find new and innovative governance and financing tools that can be used to develop and implement distributed solutions. In the search for appropriate funding mechanisms, this research studies and evaluates various innovative governance and financing mechanisms that have been used by electricity sector to promote distributed energy solutions.

2.3 Comparing Water and Energy

When looking for financing mechanisms that could be used to transform the water sector it is useful to look to the electricity sector. There are many similarities between the two industries as utilities in both sectors provide commodities to customers that are required for modern life. In turn, both sectors currently rely on extensive infrastructure networks and are highly regulated by many levels of government. Fiscally, the two sectors rely on revenue streams for most of their funding, and the financial health of their institutions plays a key role in accessing capital to fund supplementary projects.

There are also many differences between the water and electricity sectors, including the extensive public health requirements for water, approaches to efficiency, ownership structure (publicly-owned utilities [POUs] vs. investor-owned utilities [IOUs]), commodity pricing, and specific regulatory requirements (Table 2). Utility ownership is one of the most important differences between the two sectors when considering financing (Donnelly et al., 2013). As many electric utilities are IOUs, private companies play a greater role in utility financing, and there is no analogue for this governance in the water world. However, there are enough similarities between the two sectors that some of the financing and governance tools are transferable, and water utilities can learn many valuable lessons from electric service providers.

Table 2: Comparison of Water and Electricity

	Water	Electricity
Characteristic of the Good	Economic commodity, public good, human right	Economic commodity
Approach to Efficiency	Mostly voluntary	Mostly mandatory
Dominant Ownership and Rate Setting	Publicly-owned utilities (POUs): publicly-elected boards set rates	Investor-owned utilities (IOUs): rates set and regulated by state utilities commissions
Regulations	Quality and quantity at federal, state, and local levels	Rates, revenue, and generation sources at state levels

Source: Adapted from Donnelly et al., 2013

2.4 The Evolution of the Electricity Sector: Distributed Energy Solutions

Like America’s water sector, in recent decades our electricity sector has been dominated by large-scale centralized infrastructure networks. For electricity, this means using fossil fuels for generation at centralized facilities and building transmission lines to transport power, creating a vast network of distribution lines to customers (U.S. EPA, 2015). However, many factors have driven some states to incorporate more distributed solutions into their existing electricity networks (Massachusetts Institute of Technology, 2011). Distributed energy solutions encompass many different practices and technologies such as DSM, renewables, distributed generation, energy storage, and electric vehicle mandates. Distributed energy solutions can offer answers to many common energy-related problems such as energy security, power quality, strict environmental regulations, transmission bottlenecks, and reliance on unstable commodities (Office of Electricity Delivery & Energy Reliability, 2015). Similar to distributed water solutions, these technologies can be integrated into existing infrastructure to meet growing needs or can replace systems that are no longer functional.

As the electricity sector has integrated more distributed solutions into existing networks, stakeholders have had to overcome some of the same barriers faced by the water sector:

- Electric service providers have secured funding resources by developing innovative financing mechanisms and governance structures and by **utilizing a diverse pool of funding sources** (Kim et al., 2012).
- **Restructured electricity pricing schemes and revenue decoupling** have also been a major factor leading to more sustainable practices, allowing utilities to fully recover their fixed costs, increase their revenue stability while promoting conservation and efficiency, and invest in new distributed projects (Ajami et al., 2014).
- In recent years, there has been **increased private investment** in the electricity sector (Cleantech Group, 2014) due to innovation encouraging regulations, increased proven performance and decreased risk associated with novel technologies, and the prevalence of new governance and financing mechanisms that are well suited for public-private partnerships (Owens, 2014).
- While water law and policy remains convoluted, electric regulations can be much more clear and concrete, and in recent years, **electric regulations have promoted the uptake of distributed solutions**, catalyzing the widespread implementation of these new technologies and practices (Kim et al., 2012).
- While both electricity and water are vital parts of modern society, **regulators in the electricity sector can be more open to new and innovative projects, practices, and technologies** than those in the water sector. This means that governmental support for novel technologies can be easier to secure for distributed electricity practices such as solar or wind energy than for distributed water projects such as greywater reuse.

As regulations have mandated change and as the electricity sector has utilized innovative financing structures and government mechanisms within the past few decades, there has been growth in distributed electricity solutions. In this research, we focus on two categories of distributed energy solutions that can be most likened to the water sector: renewable energy generation and DSM.

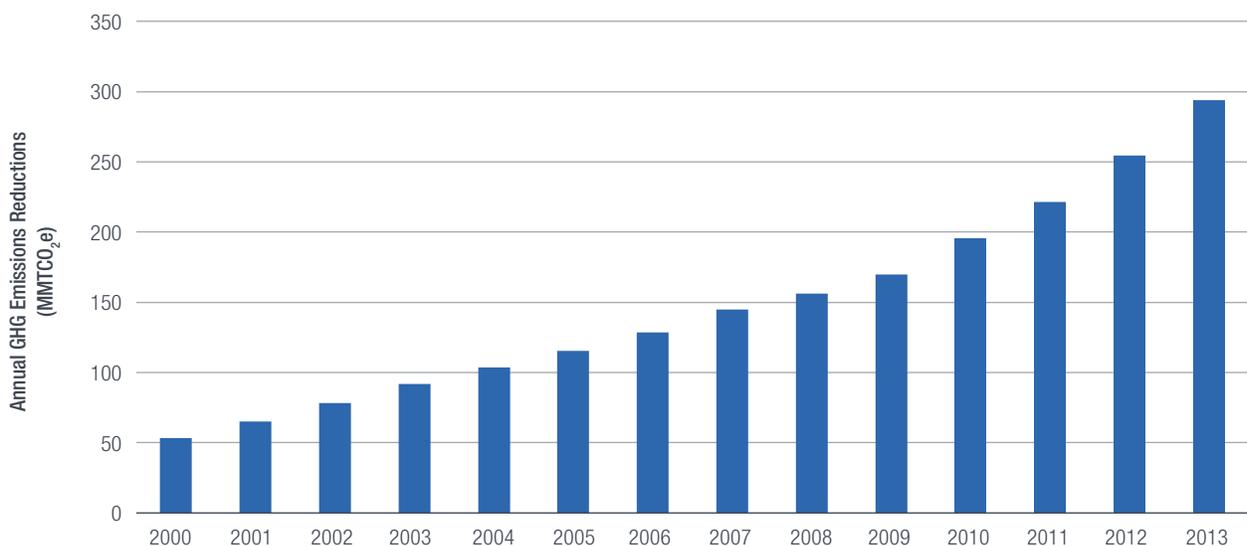
2.4.1 Renewable Energy

Renewable energy technologies are those that use naturally replenished resources to generate power. Renewable systems can be implemented at the customer-, community-, or utility-scale and include technologies such as hydropower, wind, solar, bioenergy, geothermal, and marine energy. Renewable solutions have become increasingly popular in recent years as various environmental regulations have become more stringent and as government mandates have been enacted to reduce technology costs and increase market saturation (Johnstone et al. 2009). The incorporation of these alternative generation technologies into the grid diversifies supply portfolios, reduces GHG emissions, and creates economic opportunities in the form of new jobs, manufacturing, and businesses (Goldemberg et al., 2003). Renewable generation at the utility-scale currently dominates the field, however looking ahead, residential and commercial on-site generation is projected to grow most rapidly (Solar Energy Industries Association [SEIA], 2015a).

2.4.2 Demand Side Management (DSM)

To deliver cleaner electricity in the least expensive and least environmentally disruptive way, providers often first focus on DSM (Datta and Gulati, 2014). By decreasing consumption through efficient devices and practices, less electricity needs to be generated, transmitted, and used, leading to source protection. DSM usually means installing energy saving devices at the customer-level, although efficient solutions can be implemented at the community- or utility-scale as well. These devices include appliances, building upgrades, heating and air conditioning systems, industrial equipment, lighting, and other technologies. The main energy efficiency agenda in the U.S. is the EPA's Energy Star program, a voluntary program that aims to "help businesses and individuals save money and protect our climate through superior energy efficiency" by creating energy-use standards for devices, typically certifying appliances that use 20-40% less energy than is required by federal standards (Energy Star, 2015). Energy Star is responsible for more than 2.1 billion metric tons of GHG emissions being saved since its inception (Figure 3), resulting in over \$295 billion dollars saved on customer utility bills (Energy Star, 2015).

Figure 3: Annual Energy Star Greenhouse Gas Reductions Since 2000



Source: <http://www.energystar.gov/about>

3 FINANCING AND GOVERNANCE FRAMEWORK

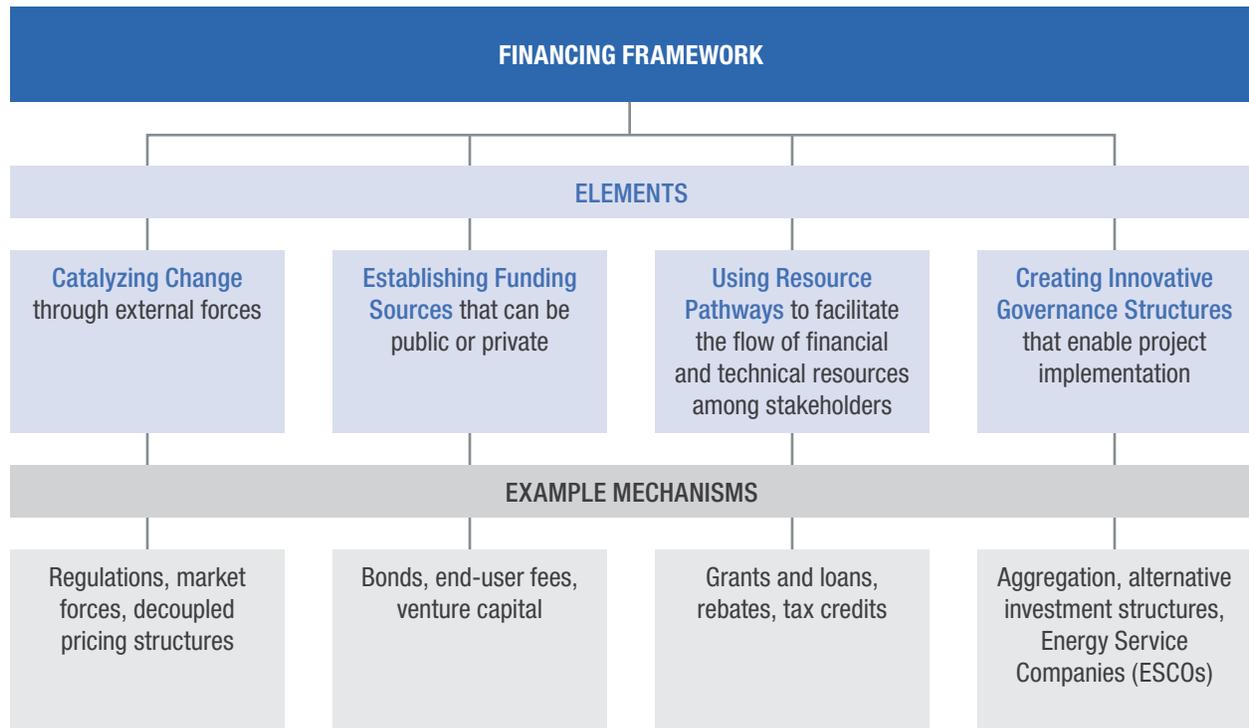
3.1 Methodology and Framework

In recent years, renewable and DSM technologies in the energy sector have become more widely available, less technologically risky, more efficient, and less expensive than some traditional centralized electricity systems (Owens, 2014). This evolution is largely due to regulations that have mandated change in the electricity sector and motivated states, utilities, and others to pursue a host of different funding and governance strategies to comply with these new policies (Kim et al., 2012). This success is despite the fact that funding for distributed projects is often difficult to secure, especially when projects are small, include new technologies, or are related to public good commodities. Many different components are involved in financing distributed projects, and we propose that together these elements make up a financing and governance framework.

The objective of our research was to develop this framework to provide distributed project financing guidance for stakeholders in the water sector. Our methodology was to first evaluate case studies of successfully implemented distributed electricity projects, establishing the various financing mechanisms used for project development across the sector. We then investigated and dissected those projects to identify the elements common to each case study. We looked at what motivated project implementation, who implemented the project, how capital was secured to fund the project, how monies were distributed to the implementer, and what creative management tools were used to facilitate transactions.

Through this analysis, we were able to classify the main financing and governance mechanisms that have enabled the incorporation of distributed electricity solutions into existing infrastructure. We identified four key elements that together establish a comprehensive financing framework (Figure 4). First, an external factor must catalyze change. An outside force must motivate the switch from traditional to non-traditional solutions. Second, a reliable funding source must be present that provides capital for project implementation, operations, and maintenance. Large, small, public, or private entities can provide this capital, and the funds can come in many different forms. Third, there must be a pathway that facilitates the flow of financial and technical resources among stakeholders. Fourth, there must be innovative governance structures that enable project implementation. We found that all four components play a role in successfully financing distributed solutions.

Figure 4: Financing and Governance Framework



In the following sections, we evaluate the four elements of our financing framework to further understand how stakeholders in the electricity sector have managed to fund projects and thereby spur energy innovation. While there are many different mechanisms and methods that could exist within each element, we highlight some of the more prominent ones and those that could be most appropriate for the water sector.

3.2 Catalyzing Change

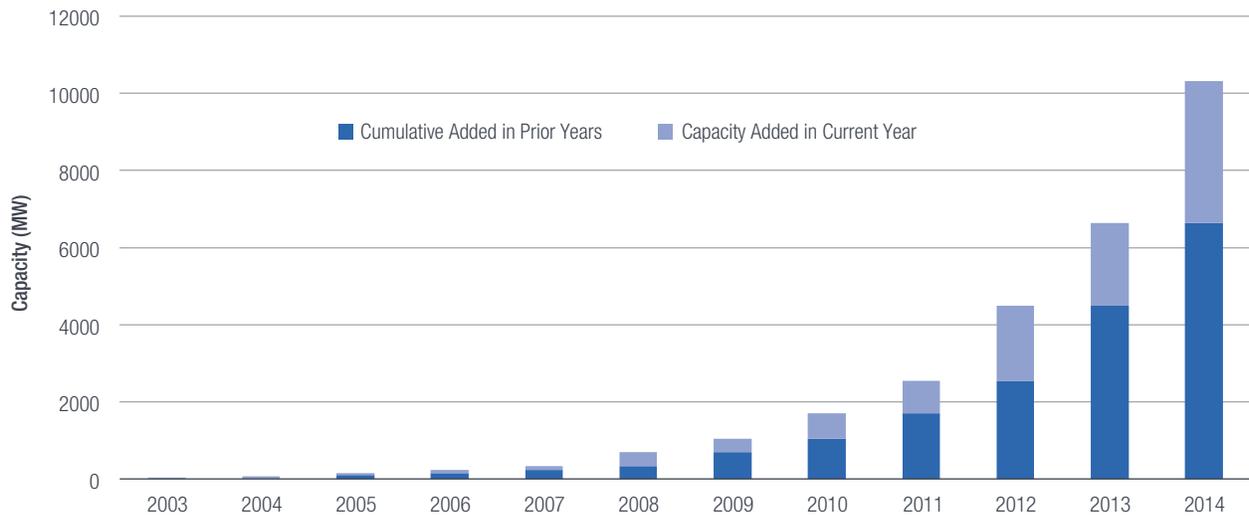
While distributed water solutions are gaining acceptance as being important to the future of water infrastructure (The Johnson Foundation, 2014), stakeholders are not intrinsically motivated to construct new systems. Thus, an external stimulus must promote adaptation of these innovative and non-traditional solutions. In the electricity sector, regulations have been critical in promoting change through direct enforcement, market forces and economic incentives, and innovative pricing structures.

3.2.1 Direct Regulations

Regulatory policies can directly stimulate change by providing guiding principles, fiscally incentivizing sustainable or innovative practices, or by penalizing pollution. Public policy has an important influence in the development of new energy technologies (Johnstone et al., 2009). Regulations can be imposed by federal, state, or local agencies, and all are important in catalyzing change (Doris et al, 2009). In general, each lower level of government can impose its own restrictions as long as they are no less strict than the rules imposed by higher-level regulators and policy-makers. For example, a state can enforce more stringent pollution prevention laws than those enacted by the federal government.

California is a state that has enacted particularly rigorous energy and environmental policy initiatives. These laws and initiatives are supported by all of California’s state agencies and include direct mandates on both IOUs and POUs. One regulation that has made a particularly big impact across the state is California’s Renewables Portfolio Standard (RPS), a program that was established in 2002 under Senate Bill (SB) 1078 (Sher), modified in 2006 under SB 107 (Simitian), and accelerated in 2011 under SB 2 (1x) (Simitian) (California Energy Commission [CEC], 2015a). The RPS program requires that California’s electric service providers increase electric procurement from eligible renewable sources to 33 percent by 2020 (California Public Utilities Commission [CPUC], 2015a). In 2013, 22.7 percent of the IOUs’ retail electric load was served by renewables (CPUC, 2015a), and the RPS mandate has significantly increased the amount of renewable supply capacity in the state (Figure 5).

Figure 5: Renewables Portfolio Standards (RPS) capacity installed in California since 2003

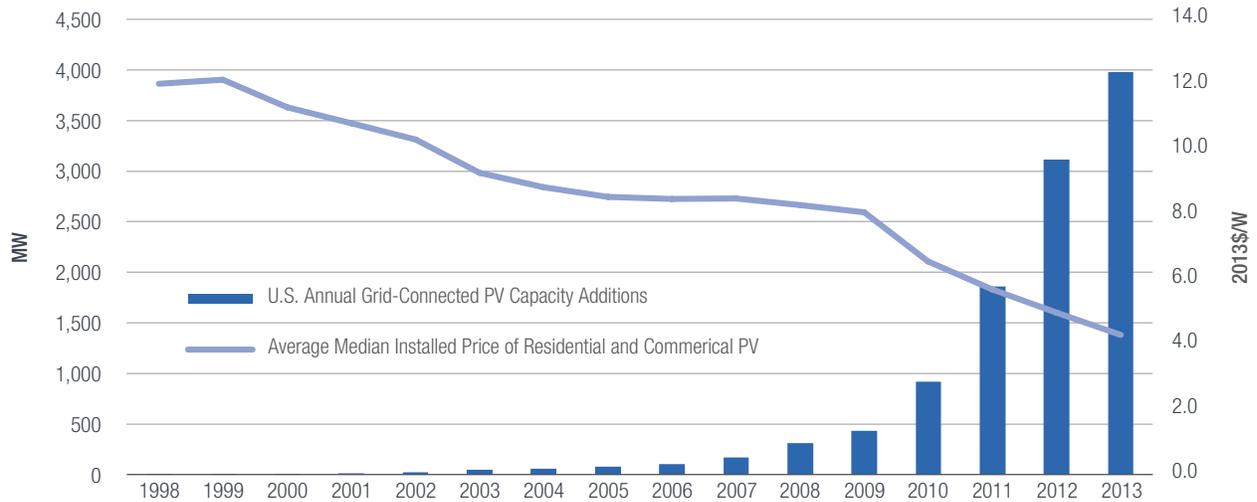


Source: California Public Utilities Commission 2015a

3.2.2 Market Forces and Economic Incentives

Regulations can fiscally change behavior by transforming the market or through economic incentives. Markets evolve when a new technology, practice, or device standard becomes commonplace and customers unintentionally purchase innovative devices or systems. These subtle market forces have played an important role in the uptake of energy efficient technologies as regulations have mandated more stringent building and appliance standards and as clean-energy devices have become less expensive. In the U.S., the EPA’s Energy Star program has been key in changing the appliance market (Dutta and Gulati, 2014) as the program’s standards have influenced most modern appliances to become much more energy and cost efficient than they were historically. For example, because of the Energy Star program, dishwashers made after 1994 are significantly more energy efficient and save customers an average of \$35/year on electricity bills (Energy Star, 2015). Advanced energy technologies, including renewables, have also become more prevalent in recent years as they have become more affordable and accessible. Solar energy technology costs have decreased substantially in recent decades, (Timilsina et al., 2011), and as these costs have declined the number of systems installed has increased (Figure 6).

Figure 6: Total Installed PV Prices, Global Average System Price

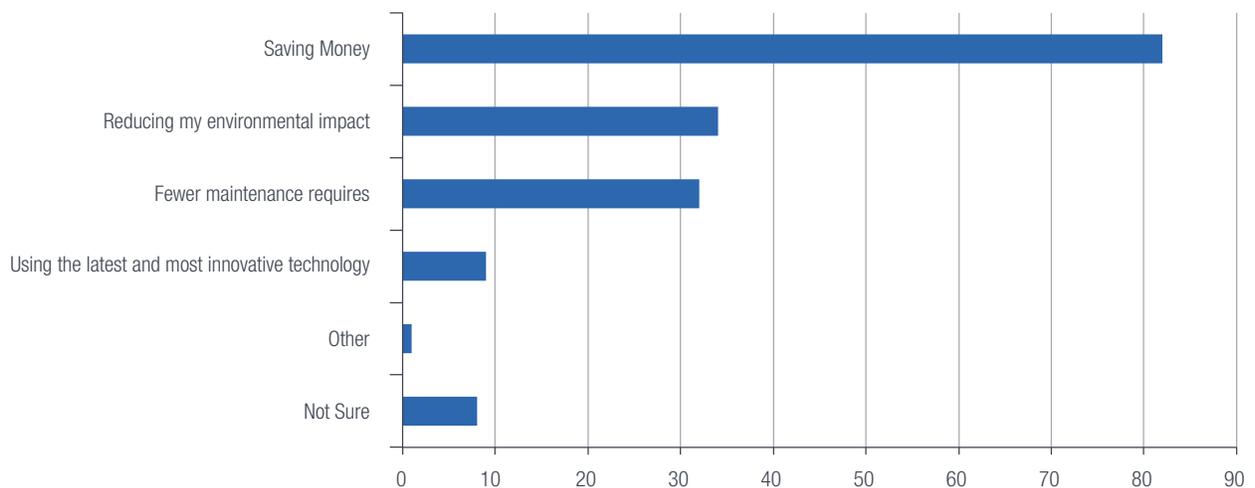


Source: Barbose et al., 2014

Note: Price is average of median of all sizes (<10, 10-100, >100 MW) and from a sample of data.

Active economic forces spark change when implementers, including municipalities, utilities, or end users, are financially motivated to embrace a new solution. While some customers may be intrinsically or environmentally motivated to change their electricity use habits, saving money is the primary motivator influencing most homeowners' decisions to purchase and install clean-energy devices and services (Figure 7). Commercial and industrial end users, utilities, and municipalities are also often motivated to construct more efficient, less resource-intensive systems to decrease electricity purchasing costs.

Figure 7: Reasons that Customers Purchase Clean Energy Devices and Appliances



Source: Solar City and Clean Edge, 2015

Note: Survey respondents were asked the following question: "When making decisions around purchasing clean-energy products and services, which of the following are your primary motivators? (Choose up to two)"

3.2.3 Price Structuring and Revenue Decoupling

In a traditional rate-setting structure, a utility's profits are directly linked to the quantity of the good sold—the more a customer consumes, the more the service provider profits. However, when profits are connected to sales, utility revenue streams are unstable and utilities are discouraged from implementing DSM strategies that could result in decreased consumption (Kushler et al., 2013). To address this issue, some state electric public utility commissions have introduced revenue decoupling mechanisms. One approach to decoupling is that private or investor-owned utilities earn revenue based on sales forecasts instead of actual sales. They are reimbursed for net revenue losses if they do not reach sales forecasts and must repay excess revenues if they sell more than predicted (Donnelly et al., 2013). Decoupling promotes innovation by allowing utilities to encourage DSM, increase financial stability and investment in new technologies, and enhance long-term access to capital (Ajami et al., 2014).

Revenue decoupling was introduced in the mid 1980s, and as of 2014, 14 states had electric decoupling mechanisms in place (The Edison Foundation, 2014). California has been using electric revenue decoupling strategies since 1982, with a more recent “decoupling-plus” policy implemented in 2007 which combines decoupling with energy efficiency performance-based incentives (The Edison Foundation, 2014). These policies have incentivized California's IOU's to support utility investments in energy efficiency, even as these improvements can cause a decline in per-capita electricity sales.

3.3 Establishing Funding Sources

Once regulations directly or indirectly motivate stakeholders to implement distributed solutions, there must be a source of capital available to construct, operate, and maintain these projects. However, utilities often have trouble finding capital for projects outside of basic operations and maintenance, let alone for new projects (AWWA, 2015). Therefore, distributed clean-energy projects often rely on a diverse set of public and private funding sources.

3.3.1 Public Investment

All levels of government generate revenue that can be used to back distributed infrastructure projects. Some common examples of mechanisms used are taxes, bonds, revolving funds, and end-user fees:

- **Taxes** are imposed by governments on income, sales, or property and provide a reliable and steady stream of income. Tax revenue has been used to fund many distributed projects in the electricity sector, often through grants and loans.
- **Bonds** are debt mechanisms that are often sold for specific uses and to specific audiences. In the electricity sector, bond monies have been used to support both renewable and DSM projects at federal, state, and local levels. Examples include qualified energy conservation bonds which enable state, tribal, and local governments to borrow money at subsidized rates to support energy conservation projects (Office of Energy Efficiency and Renewable Energy, 2015a) or clean renewable energy bonds which can be used by public entities to back renewable energy projects (Kreycik and Coughlin, 2009).
- **Revolving Funds** are special accounts in which money can be used without regard for fiscal year limitations as resources circulate between the fund and its users. State revolving funds have been utilized in the electricity sector as clean energy funds. As of 2012, clean energy funds were operating in 22 states and together had invested over \$2.7 billion in state dollars with an additional \$9.7 billion in federal and private capital for investment in renewable energy technologies (Puentes and Thompson, 2012).

- **End-user fees**, either flat or per-usage, can be imposed by utilities on ratepayers as a way to efficiently gather funds for projects that extend beyond normal operating procedures and might not otherwise be financed. Like taxes, fees provide a steady and reliable income stream instead of a one-time lump sum, allowing for long-term strategic planning. This funding mechanism works well for implementing small projects or for supporting ongoing operations and maintenance costs, but sometimes does not provide large upfront sums of money that are required for large improvement projects. Sometimes called a public benefits fee, this fundraising technique is popular for financing renewable energy and DSM projects (Box 1).

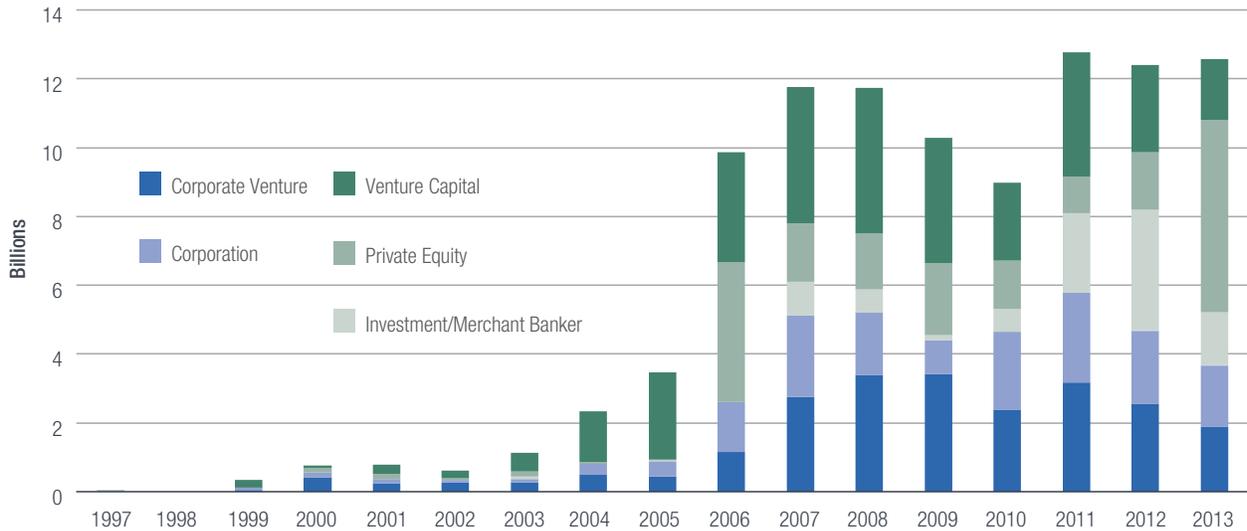
Box 1: Public Benefits Fee

One popular way for utilities to generate income for renewable energy and DSM projects is by collecting a per-usage fee from customers on their electricity bills. This end-user fee, sometimes called a public benefits fee, can be governed at the state-level, local-level, or both. Currently, over 23 states collect some sort of energy-related public benefits fund charge (Database for Energy Efficiency and Renewable Energy [DSIRE], 2015). Some states implement multiple fees for different causes. Connecticut has both a Connecticut Clean Energy Fund used to increase renewable saturation and an Energy Efficiency Fund used for efficiency programs (DSIRE, 2015). California has implemented both state-wide and local fees. From 1998-2012, California's three major IOUs collected a public benefits fund fee called the public goods charge (Quesnel and Ajami, 2015). Most funds were funneled through governmental programs in the state's capital while some were administered at the utility level. At the same time and through today, the state's smaller POUs also collect fees, but have less strict spending guidelines. This gives the POUs more flexibility in allocating collected monies and allows them to spend funds on programs and projects that most benefit their communities (Quesnel and Ajami, 2015).

3.3.2 Private Capital

It can be fruitful for private organizations to get involved with distributed energy projects. Many institutional investors are well suited to own and finance renewable energy or DSM projects given their management experience and large financial resources (Nelson, 2014). Private involvement, which has become increasingly popular in recent years, can include a wide variety of sources including corporate venture, corporations, crowdfunding, investment/merchant bankers, private equity, venture capital (Figure 8). Private investors can be interested in energy projects to diversify their portfolios, because of favorable tax policies, and as renewable and efficiency technologies and companies become increasingly profitable (Nelson, 2014).

Figure 8: U.S. Private Investment in Clean Energy



Source: Cleantech Group, 2014

Note: Clean energy = biomass generation + energy efficiency + energy storage + solar + wind + geothermal + nuclear + hydro & marine + smart grid. Non-private categories of investment not shown here are debt funds, public sector funding, and other. Crowdfunding is a small percentage of the total investments and therefore is not shown on this chart.

There are three main challenges in involving private investors in distributed energy projects—the size of the financing institution needs to be relatively large, the investor needs liquidity, and the investment portfolios must be diverse to reduce risk (Nelson, 2014). Project developers and financiers in the electricity sector have been able to overcome these barriers by using innovative governance structures such as project aggregation or green banks (Box 2) to successfully attract and utilize private capital for distributed projects. However, as mentioned in the previous section, regulations and government programs are also responsible for incentivizing private investment, for example through existing congressional tax breaks or recovery act funding.

Box 2: Green Banks

A green bank is an institution that provides financial support to clean energy projects by leveraging and recycling public funds through various financial mechanisms to attract private investment (Green Bank Academy, 2014). These mechanisms can be used to facilitate the flow of capital through intermediaries such as energy service companies (ESCOs), developers, owner/operators, or equipment manufacturers as these banks take on the risk associated with relatively new technologies (Green Bank Academy, 2014). The banks agree to pay for a percentage of any potential loss, such as borrowers not repaying loans, with private investors backing the rest (Booz and Co., 2013).

One example of an active green bank is the New York Green Bank, “a state-sponsored investment fund dedicated to overcoming current obstacles in clean energy financing markets and increasing overall capital availability through various forms of financial support such as credit enhancement, project aggregation, and securitization” (New York Green Bank, 2015). The goal of the New York Green Bank is to leverage its funds with private capital to help transition the state’s energy sector into a more sustainable future. The entity has raised over \$218.5 million in assets, including \$165.6 million raised through clean energy surcharges on the state’s IOU customers, and an additional \$52.9 million raised in auction proceeds from the Regional Greenhouse Gas Initiative (New York Green Bank, 2015). The New York Green Bank focuses on third parties, does not accept deposits and does not offer loans or financing directly to consumers (Booz and Co., 2013). A few other states have similar systems including Connecticut, Vermont, and Hawaii (Millett, 2014).

3.4 Using Resource Pathways

Once a funding source has been established, monies must be transferred among stakeholders through resource pathways. Many of these pathways engage customers by incentivizing them through cost sharing opportunities or by eliminating up-front costs. There is no single best pathway, and instead various models have been developed that address the particular needs of different users in different customer markets (Kim et al., 2012). Some popular pathway mechanisms used in the electricity sector are loans and grants, rebates, tax credits, and on-bill initiatives.

3.4.1 Government Grants and Loans

Federal, state, and local governments often provide resource pathways to facilitate the transfer of funds to project implementers. The public sector has historically acted in this role as it can often provide more affordable financing options than those offered by private companies (Wiser and Pickle, 1997). Funds funneled through public agencies usually come in the form of grants or loans:

- **Grants** are sums of money received by a grantee that do not have to be repaid to the grantor. Project implementers, either private or public, are eligible to apply for most government grants, which are usually generated from tax dollars. One example of a federal grant program aimed at increasing energy conservation and efficiency is the U.S. Department of Energy’s (DOE’s) Energy Efficiency and Conservation Block Grant (EECBG) program. This program aims to help “cities, communities, states, U.S. territories, and Indian tribes to develop, promote, implement, and manage energy efficiency and conservation projects that ultimately create jobs.” (Office of Energy Efficiency and Renewable Energy, 2015b). To date, the EECBG Program is the largest direct federal investment in community-level distributed clean energy technologies and systems (Office of Energy Efficiency and Renewable Energy, 2015b).

- **Loans** are similar to grants except that the third party receiving the funds must repay the funder back in the future, often with interest. Government loans are unique in that they can be partially or fully subsidized, resulting in low or no interest borrowing. These loans can be particularly helpful for small-scale or novel projects that may be ineligible for traditional bank loans given uncertain, small, or long-term returns (Wiser and Pickle, 1997). A typical government loan program can offer interest rates between zero to six percent with a repayment period between 15 and 20 years, and the cost savings associated with these loans can be significant when compared to traditional bank loans (Wiser and Pickle, 1997). One example of a state-level clean energy loan program is California's Energy Conservation Assistance Act (ECAA) Program (Box 3).

Box 3: California Energy Conservation Assistance Act (ECAA) Program

In California, the ECAA program has played an important role in funding public sector distributed energy projects. The program provides low-interest financing and technical assistance for public entities to increase their energy efficiency (Padilla, 2011). ECAA has been used to support a variety of energy-related projects including lighting system upgrades, streetlights and LED traffic signals, building heating systems, energy generation, and many others (Padilla, 2011). Reasons for the success of ECAA are its simple loan requirements and straightforward repayment process which is based on, and cannot exceed, estimated savings from the funded project (CEC, 2015b).

Through the ECAA program, specialty education groups are eligible for zero percent interest loans and other public institutions are eligible for one percent interest loans (CEC, 2015b). The majority of the total loan funds have gone to support local jurisdictions, but a significant sum has also assisted K-12 schools and colleges (CEC, 2015b). During the first 11 years of the program, an estimated \$25,650,100 in total annual energy cost savings were achieved through the \$196,810,765 of approved loans (Padilla, 2011). One case study from the program is Contra Costa County, which used two ECAA loans combined with their own funds to update and retrofit the heating and cooling systems of eight government buildings, effectively reducing the annual energy use of those buildings by an average of 28 percent (CEC, 2006). The ECAA low-interest loans allowed Contra Costa County to complete these energy-saving projects with excellent economic payback.

3.4.2 Rebates

Rebates use cost sharing to promote change. In a rebate scheme, a customer purchases a device or service using his or her own money, and is later partially reimbursed by a local government, utility, or other entity. Many rebate programs have been successful in promoting electricity DSM around the country. According to the Database for Energy Efficiency and Renewable Energy (DSIRE), there are more than 13,000 federal or state-level rebate programs across the U.S., making rebates the most prevalent tool used in the energy sector to encourage clean energy and energy efficiency upgrades (DSIRE, 2015). One study found that for a utility, implementing a rebate program for Energy Star energy-efficient clothes washing machines to reduce demand is more cost effective than building additional energy generation facilities to increase supply (Datta and Gulati, 2014).

3.4.3 Tax Credits

In the electricity sector, tax credits help end users buy or install DSM or renewable energy solutions by lowering their federal, state, or local taxes once the upgrade has been made. Like rebates, the consumer is required to make the initial purchase using their own money. The credit is claimed by the customer when they file taxes for the previous year, and the credit amount is subtracted from the taxes that they owe to the government, thereby saving them money. For example, the Solar Investment Tax Credit (ITC) program

promotes solar panel installation by providing federal tax credits for those that invest in residential or commercial solar energy systems (Box 4). Federal tax credits and other tax benefits are the U.S. government’s main mechanism for driving household or small-scale clean energy technologies (Fisher et al., 2011). Tax credits are investment-based (SEIA, 2015b) and not dependent on the actual performance of the system, service, or upgrade. Tax credits can be and are often used in tandem with other mechanisms (Office of the Comptroller of the Currency, 2014).

Box 4: Solar Investment Tax Credit (ITC)

The Solar Investment Tax Credit (ITC) was created in 2006 through the Energy Policy Act of 2005 as a way to incentivize residential and commercial customers to purchase and install distributed solar systems. Through this nationwide program, customers receive a 30 percent federal income tax credit for installing systems on their property (Fisher et al., 2011). The credit is calculated based on the total cost of the system, including the equipment, such as panels, mounts and wiring, and the installation labor, but not including the building or structural components on which the equipment is placed (Office of the Comptroller of the Currency, 2014). The Solar ITC has dramatically boosted residential and commercial solar system saturation (SEIA, 2015b) (Figure 6). During the first year the program was active, 2006 to 2007, the amount of installed electric solar capacity doubled, and since its inception annual solar installation has grown by over 1,600 percent, a compound annual growth rate of 76 percent (SEIA, 2015b).

3.4.4 On-Bill Initiatives

Upfront costs can be a significant barrier for residents or businesses wanting to install customer-level distributed projects (American Council for an Energy-Efficient Economy [ACEEE], 2012). One way to address this obstacle is by using on-bill initiatives (Zimring et al., 2014). Through these mechanisms, service providers pay for device installation and customers later repay the utility for the costs through a reoccurring fee (ACEEE, 2012). There are three main types of on-bill initiatives: on-bill repayment (OBR), on-bill financing (OBF), or property assessed clean energy (PACE) (Table 3). In both OBR and OBF structures, customers pay for their upgrades through their utility bills. With OBR, the utility receives capital to construct the projects from private investors, and in an OBF system the capital comes from utility shareholders, utility ratepayers, or public funds (Zimring et al., 2014). With PACE, money is collected from customers through property tax bills and assessments and the financial backing can come from public sources such as local bonds or from private lenders that have been selected by the government or are from an open pool (Bingaman et al., 2014) (Box 5).

Table 3: On-Bill Initiatives

Mechanism	Financial Backer	Repayment Mechanism
On-Bill Financing (OBF)	Utility shareholders, utility ratepayers, public funds	Utility bills
On-Bill Repayment (OBR)	Private investors	Utility bills
Property Assessed Clean Energy (PACE)	Public funds, private investors	Property tax bills and assessments

Box 5: Property Assessed Clean Energy (PACE)

PACE is a state-by-state financing program that helps end users install clean energy improvements in and on buildings by providing upfront project costs. There are three steps that a state must take to implement a PACE program. First, state legislature must pass laws permitting local agencies to offer PACE funding. Second, contractors and service providers become certified to facilitate projects through special programs. Finally, PACE administrators process applications, approve projects, and establish financing. Once funding is secured and improvements are installed, a charge is added to the customer's property tax bill. PACE can be used for both DSM and renewable energy solutions, and most sectors including commercial, industrial, residential and agriculture customers are eligible to participate (PACE Now, 2013).

One reason for the success of the PACE program is that it uses a wide variety of public and private funding sources to back property owners who want to voluntarily retrofit their properties. Some drawbacks are that the program cannot fund portable items, and that it requires high legal, administrative, governmental staff and expenses, increasing minimum investment. Additionally, because of a regulation enacted in 2010 by the Federal Housing Finance Agency that prohibits mortgage loan companies from buying mortgages using PACE (Bingaman et al., 2014), the program is more aimed at helping customers in the nonresidential sector. PACE programs have become more popular in recent years, with 31 states and the District of Columbia now authorizing the program (PACE Now, 2013).

3.5 Creating Innovative Governance Structures

Given the large number of diverse stakeholders and complex transactions involved in implementing distributed solutions, novel management methods are sometimes useful to enable project development. Using innovative governance structures can help facilitate transactions, catalyze collaborations, and enable project construction that might not be possible in a traditional project management scheme. Examples of these mechanisms are project or financial aggregation, alternative investment structures, end-to-end service companies, and net metering.

3.5.1 Project and Financial Aggregation

Aggregation involves grouping many projects or financial resources together to make one larger consortium. Scale can play a critical role in determining if aggregation is required. When projects are large in size, the implementer and funding source are often directly connected. However, for many smaller distributed projects, pooling is required to facilitate transactions and overcome risk. Similarly, sometimes financial institutions are too small to be able to fund a project alone, but are able to invest given collaboration with other entities. Both of these pooling methods, project aggregation and financial aggregation, have been used in the electricity sector.

Since small projects frequently have similar transaction costs to large projects, project aggregation makes construction more economical by creating one larger and marketable group (Valderrama et al., 2013). This decreases overall project costs¹ by diversifying project risks and reducing transaction expenses (Wiser and Pickle, 1997). Pooling projects can also attract private investors who may not otherwise be aware of the retrofit plans of individual customers. An example of municipal electric aggregation is when a city or a suburban community negotiates a long-term purchase power agreement (PPA) with a supplier on behalf of all of its citizens (Chadbourne, 2013).

¹ costs: legal fees, permits, application fees

Alternatively, aggregators can pool financial resources to create a more comprehensive and stable source of money, allowing for more capital-intensive projects and also bigger returns. Financial aggregation can be useful for smaller investors wanting to get involved in distributed electricity projects but that may not have enough resources or knowledge to fund a project themselves. The risk for each financier is decreased, as the middleman aggregator often assumes some project risk (Climate Investment Funds and The World Bank, 2013), and risk for project developers is also lowered as they are not reliant on a single source of income. One financial aggregation mechanism used in the electricity sector is Asset-Backed Securities (ABS) (Box 6). Project aggregation and financial aggregation can also be used in tandem. For example, a municipality could first pool many small distributed projects to create one large marketable project and that project could then be funded by an ABS.

Box 6: Asset-Backed Securities (ABS)

One model of a financial aggregation mechanism is Asset-Backed Securities (ABSs). In an ABS scheme, the asset originator first pools assets to form a reference portfolio and then sells the portfolio to an issuer as a special purpose vehicle (Jobst, 2008). The originator issues tradable, interest-bearing securities to investors who receive payments that are generated by the assets in the portfolio (Jobst, 2008). ABSs are generally used for refinancing projects that have a positive cash flow and can also be a good tool for expanding capital (Climate Investment Funds and The World Bank, 2013). While corporate bonds are backed by a single corporation or company, ABSs are backed by a pool of companies with similar interests, such as solar loans (True Sale International, 2008). In the electricity sector, solar ABSs have become a popular option of financing—the funding pool is often residential or commercial power purchase agreements (PPAs) or leases which creates a large and stable backing (Hegedus, 2013).

3.5.2 Alternative Investment Structures

Similar to aggregation, alternative investment vehicles can be used to help individual and institutional investors gain access to the distributed electricity sector. Unlike traditional investment mechanisms, these structures have tax advantages that make them preferable for many private investors (Porter et. al, 2013). Alternative investment mechanisms can be applicable to larger-scale projects that produce more substantial returns on investment; however, these tools can also be used for customer-level applications, for example providing the debt for companies that offer residential solar leasing programs (Freeman, 2014). Mechanisms that are used or could potentially be used in the future to fund renewable energy projects include real estate investment trusts (REITs), YieldCos, and master limited partnerships (MLPs):

- **Real Estate Investment Trusts (REITs)** are companies that own or finance income-producing real estate. Similar to mutual funds, REITs provide investors with a diverse portfolio of income streams and long-term capital appreciation by allowing investors to invest in real estate without purchasing properties themselves (Freeman, 2014). These investment structures have been used in the electricity sector to invest in both DSM and renewable energy projects (Arnold, 2015).
- **YieldCos** are publicly-traded companies created by a parent company that distribute dividends to their shareholders by generating low-risk and steady cash flows, usually through long-term contracts (Freeman, 2014; Urdanick, 2014). YieldCos have been appropriate mechanisms for financing many renewable energy projects that face some risk during development, but that have proven long-term returns (Urdanick, 2014).
- **Master Limited Partnerships (MLPs)** are tax-advantaged, publicly-traded, limited partnerships between companies that must earn 90% of their revenue from qualified sources (Arnold, 2015). Federal law currently limits MLPs to certain industries, such as energy and mineral extraction and transportation (Arnold, 2015). While solar and wind technologies are currently not open to MLPs, the governance structure could be serve as a template for renewable projects in the future.

3.5.3 End-to-End Service Companies

Comprehensive end-to-end service companies are intermediary businesses that facilitate the flow of resources, both financial and technological, between financing and implementing institutions. These companies integrate a system's design, financing, installation, and operational elements and have been beneficial for the distributed electricity sector in many ways (Kim et al., 2012). One model of an intermediary company in the electricity sector is Energy Service Companies (ESCOs) (Box 7). ESCOs are also considered a model for potential environmental impact (EIB) bond structures (Nicola, 2013). EIBs are "pay-for-performance" contracts that form a partnership in which a financier pays a project implementer for their services based on defined criteria and previously agreed-upon goals (Nicola, 2013).

Box 7: Energy Service Companies (ESCOs)

The ESCO model is redefining the concept of a public-private partnership by creating an entire governance framework instead of just focusing on financial services. ESCOs are businesses that act as intermediaries between energy suppliers and energy consumers, and these companies work on projects from inception to completion, similar to a design-build structure (National Association of Energy Service Companies [NAESCO], 2015). ESCOs develop, install, and arrange financing for projects that are designed to improve the energy efficiency and maintenance costs for facilities (NAESCO, 2015). First, customers consult with experts to evaluate potential energy savings. Then, the service company helps to analyze, prepare, and secure adequate funds for the project. Once plans are settled, the service company helps to supervise the installation and maintenance management required for the equipment (NAESCO, 2015). By bundling their services, ESCOs minimize transaction costs and achieve economies of scale (Valderrama et al., 2013). ESCOs are financed through loans, private sources, large manufacturers, or energy companies (Valderrama et al., 2013). One report by Lawrence National Lab showed that 15 percent of small ESCOs and 30 percent of large ones rely on federal programs and 80 percent use public benefit-funded incentives (Stuart et al., 2013). ESCOs use performance-based contracting so that the company's compensation and the project's financing are directly linked to the amount of energy that is actually saved (NAESCO, 2015), incentivizing the service companies to install efficient systems.

3.5.4 Lease and Purchase Power Agreements (PPA) Programs

While many residential and commercial customers like the idea of having distributed solutions on their property, many do not want the hassle of installing, operating, and maintaining the systems themselves. Additionally, many customers do not have the up-front capital required to purchase new devices (ACEEE, 2012). In the solar industry, many companies have started offering lease and/or purchase power agreement (PPA) programs as solutions to these problems. In these schemes, developers install solar panels, which they continue to own and operate, on customers' properties. Once the panels are installed, the solar company sells the power generated from the system to the host customer at a fixed rate that is usually lower than the local retail price (Thumann and Woodroof, 2009). Since the solar company remains responsible for the devices, they are eligible for any rebates, tax credits or other incentives.

In leasing programs, customers pay a fixed monthly charge based on the amount of electricity that is projected to be produced. About 70% of residential solar systems are leased from third party owners, although given the sometimes higher costs of leasing compared to owning, it is estimated that customer ownership is likely to become more popular than leasing in the next several years (Tsuchida et al., 2015). In PPA programs, which primarily operate at the utility-scale or for commercial properties, customers agree

to purchase the power generated at a set per-usage price. Often PPA programs give customers the option of purchasing the panels after a certain number of years of operation or renewing their contract (Thumann and Woodroof, 2009).

3.5.5 Net Metering

Other times, customers want to install and own distributed solutions themselves instead of leasing them or purchasing alternative energy from an outside source. In the electricity sector, net metering allows customers to have control over their own systems while simultaneously saving money. In a net metering scheme, customers generate electricity from solar panels or other distributed solutions and then sell a certain amount of the power that they don't use back to the grid, thereby lowering their electricity bills (Barnes et al., 2014). Net metering has been instrumental in the growth of household solar systems as it is now the most common distributed generation billing mechanism in the U.S. (Solar Electric Power Association, 2013). Currently, 43 states and Washington D.C. have net metering laws, with some states also having voluntary net metering programs that operate through utilities (DSIRE, 2015). California has the largest net metering program in the U.S. and it is estimated that through this mechanism, public agencies and schools will save \$2.5 billion in electricity costs over the next 30 years (SEIA, 2015b). There are three main pricing options in a net metering scheme:

- **Net Energy Metering (NEM)** allows customers to pay the difference between the electricity they generate and the electricity they consume.
- **Virtual Net Metering (VNM)** is a scheme in which a single solar installation on a multifamily building is credited to all tenants of the building.
- **Renewable Energy Self-Generation – Bill Credit Transfer (RES-BCT)** is similar to NEM but exclusively for local governments, as it allows small public entities to transfer the monetary value of any excess bill credits to another account owned by the same local government (Go Solar California 2014 and CPUC, 2015b).

4 CASE STUDIES IN THE WATER SECTOR

While distributed solutions have been much more widely implemented in the electricity sector, there are also a few case studies of distributed solutions being realized in the water sector. In the following section, we demonstrate how three cities have used innovative financing methods and mechanisms to successfully implement distributed water systems. In all three case studies, the financing framework used in the electricity sector can be seen in project development (Table 4).

Table 4: Financing Framework in the Water Sector

	Catalyzing Change	Funding Source	Resource Pathways	Innovative Governance Structures
<u>Stormwater management:</u> Philadelphia, Pennsylvania	Regulations	Stormwater fees, utility operating budget, third parties, cost sharing with end-users	Grant programs	Project aggregation, stormwater credits
<u>Low impact development:</u> Cincinnati, Ohio	Regulations	Utility operating budget, end user fees		Market-based, auction-type permit program
<u>Water reuse:</u> San Francisco, California	Regulations (Regulatory Framework)	Utility operating budget	Technical assistance programs for implementers Grants	Streamlined permitting process with four San Francisco City Departments

4.1 Stormwater Management in Philadelphia, Pennsylvania

In recent decades, the Philadelphia Water Department (PWD) has faced growing concerns related to the overflow of the city's combined sewer system. During heavy rains, stormwater is diverted to the sewer system, causing combined sewer overflow problems as untreated household sewage and stormwater mix (Philadelphia Water Department, 2011). The PWD's solution to this problem was to create the Green City, Clean Waters program, a 25-year plan to transform Philadelphia into a green urban environment that properly manages and captures stormwater, thereby protecting and enhancing the watershed (Ando and Netusil, 2013). The PWD estimates that turning impervious land into green infrastructure prevents 80-90 percent of pollutants that would normally flow into the sewer system from doing so (Philadelphia Water Department, 2011). It was also calculated that a \$1.2 billion investment in green infrastructure would achieve the same pollution control benefits as a \$6 billion investment in traditional grey infrastructure, such as pipes and sewers (Leurig and Brown, 2014).

The PWD is using multiple mechanisms to fund Green City, Clean Waters, including a stormwater fee program, a grant program, and a project aggregation program. In 2009, a stormwater fee was implemented that charges non-residential properties based on the ratio of impervious surface to total property area instead of charging them solely on their water meter (Ando and Netusil, 2013). Those with a higher ratio are charged more, but those who implement green infrastructure, like porous pavements, rain gardens, or green roofs, are rewarded with stormwater credits that effectively reduce their fee (Valderrama et al., 2013).

To increase visibility and interest in the parcel-based billing structure, in 2011 PWD introduced a grant program under their Stormwater Management Incentives Program (SMIP). The SMIP grants help owners fund the design and construction of their stormwater retrofits, aiding in their onsite stormwater management (Water Environment Federation [WEF], 2014). Through the grant program, grantees agree to maintain their new green infrastructure and retrofits for a minimum of 45 years, and the grants are paid for by the stormwater fee (WEF, 2014). In 2014, Greened Acre Retrofit Program (GARP) was created as a spin-off of SMIP. GARP encourages project aggregation by allowing property owners or private companies to pool multiple properties together and apply for stormwater retrofit grants (WEF, 2014).

4.2 LID Trading in Cincinnati, Ohio

Allowance trading as a method for limiting pollution discharges has been demonstrated at the community-scale in Cincinnati, OH. In the Shepherd Creek watershed near Cincinnati, polluted runoff prompted water managers to implement a trading program aimed at encouraging landholders to install green infrastructure on their property without legal mandate (Thurston et al., 2008). This market-based, auction-type tradable runoff permit program, also known as LID trading, has been a practical and cost-effective method to manage stormwater runoff in urban areas (Thurston et al., 2003).

To determine the most efficient permit system structure, citizens were first surveyed about their preferences, including compensation, for installing green infrastructure solutions on their property (Thurston et al., 2008). Then, after the city designed the best permit system using the results of the survey, residents could either pay a fee (purchase an allowance) or install a green infrastructure improvement on their property to capture stormwater runoff (Thurston, 2006). The number of permits issued was equal to the ideal runoff for the total land area, and landowners were responsible for ensuring that their properties did not produce more stormwater runoff than allowed by their permit. Landowners with low abatement costs had an incentive to reduce runoff in order to sell their extra permits to landowners with high abatement costs (Ando and Netusil, 2013).

4.3 Water Reuse in San Francisco, California

In many U.S. cities, urban water reinvention is driven by the necessity to improve water quality. However, in the arid west, water scarcity often motivates water infrastructure improvement. A few cities in California are beginning to implement small-scale water recycling or reuse facilities as a way to address water security by increasing reliable supply. San Francisco is one such city that has embraced reuse and decentralized systems. The San Francisco Public Utilities Commission's (SFPUC) Non-Potable Water Program first began in September 2012 as a way to increase water savings and diversity in the water supply (SFPUC, 2015). These alternative water sources are used and funded in a variety of different ways (Table 5). The SFPUC also offers multiple forms of technical assistance to developers including tools that calculate potable and non-potable water use quantities for a project, a manual on the permitting process, and a program that provides grants up to \$500,000 (SFPUC, 2015).

Table 5: Water Reuse Incentives

Types of Alternative Water Sources	Types of Non-potable End Uses	Types of Incentives
Rainwater	Toilet and urinal flushing	Grants
Stormwater	Irrigation	Technical assistance programs
Greywater	Cooling applications	
Blackwater	Priming drain traps	
Foundation drainage	Decorative fountains and impoundments	
	Dust control	
	Clothes washing (rainwater only)	
	Other uses of Non-Potable Water may be allowed under variance procedures	

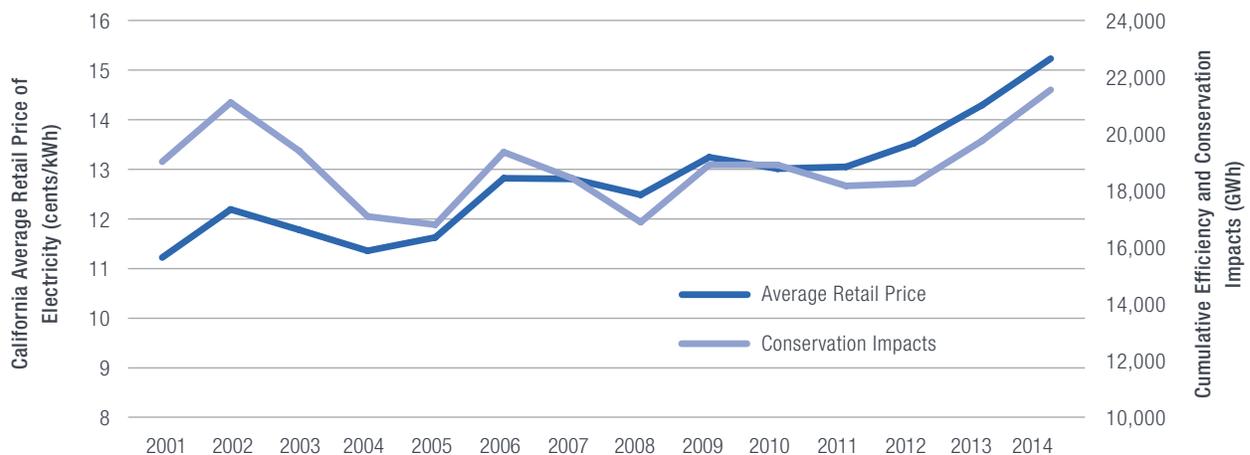
Source: SFPUC, 2015

5 FINDINGS

5.1 Policies and Economic Forces Drive Change

Through this investigation, we found that regulations and economic forces have played a central role in the widespread integration of distributed energy solutions into existing infrastructure. For example, solar energy has evolved in recent years because of regulatory mandates such as RPS requirements coupled with economic incentives like the Solar ITC (Timilsina et al., 2011). Incentivizing end users has also been a key factor in the integration of distributed systems. At the customer-level, end users are most likely to change their behavior and install new devices if they are financially motivated (Figure 7). At a larger scale, communities, utilities, and municipalities are motivated to modify their practices both to comply with regulations and for financial benefits. Fiscal motivation can be amplified when commodity prices increase as customers respond to higher prices by adopting more energy-efficient devices and practices (Gillingham, 2009). This applies both customers to looking to save money on their utility bills as well as to utilities that purchase power from a larger grid system. This correlation can be seen as the price of electricity in California has fluctuated over the past decade and as conservation and efficiency impacts have mimicked those changes (Figure 9). The low cost of water compared to electricity lessens this relationship in the water sector, but events such as drought can help boost conservation and efficiency efforts.

Figure 9: Electricity Pricing and Conservation in California



Source: U.S. Energy Information Administration 2014 and CEC 2013

5.2 Cost Sharing is an Enabler

In many case studies we evaluated, project cost sharing played a central role in making distributed solutions more financially accessible to a wide audience. Instead of a government entity, utility, end user, investor, or developer being solely responsible for project development costs, expenses are spread among many different stakeholders. Cost sharing is especially important for end-use customers. For example, OBR schemes in the electricity sector provide a cost sharing opportunity between a private investor, utility, and end user (Zimring et al., 2014). It is unlikely that without this governance structure, any one of the entities would be able to pay for project costs alone. Cost sharing could be used in the water sector to make distributed solutions more accessible. If utilities are able to offset the (sometimes high) costs associated with implementing innovative systems by allocating them to other project stakeholders, they may be more likely to implement new distributed projects.

5.3 Look Beyond Traditional Funding Sources

Innovation in the electricity sector has increased in recent years as implementers have been creative in finding funding resources for new distributed projects. In addition to conventional, sector-specific mechanisms, implementers have explored and utilized many non-traditional funding sources, both from financing programs primarily intended for projects in other sectors and by using fundraising methods not typically used in the commodity sector.

Infrastructure improvements and distributed solutions often have multiple co-benefits in other sectors, making many projects suitable for cross-sector funding. In the electricity sector, this can be seen in the intersection of DSM with the built environment, as almost half of all energy consumption in the U.S. is used in buildings (Bingaman et al., 2014). Consequently, many energy efficiency projects have simultaneously been funded by construction or building development companies. For distributed water solutions, municipal development, construction, housing, parking, and transportation projects can include green infrastructure components, effectively integrating distributed solutions into already funded projects (Hughes, 2014). One financing mechanism currently available for both water and energy projects is PACE, which can be used for DSM in both sectors (PACE Now, 2013).

Additionally, stakeholders in the electricity sector have used nontraditional funding mechanisms to finance projects. One example is crowdfunding, which has been successfully used in the electricity sector to fund many solar projects (Box 8). Another example of an innovative financing mechanism is labeled green bonds. Labeled green bonds operate like traditional bonds, except that all of the proceeds are earmarked for green projects or assets. Green bonds are becoming increasingly popular, as the amount issued tripled from \$11 billion to \$36.6 billion from 2013 to 2014 (Climate Bonds Initiative, 2015). The water sector can also use similar methods to fund distributed projects, looking outside of the traditional resources and mechanisms that have been used in the past.

Box 8: Crowdfunding

One unique way that some distributed electricity projects have been funded is through equity-based crowdfunding. In this form of crowdfunding, individuals who fund a project become owners or shareholders in the project and consequently have the potential for financial gains (Freeman, 2014). Benefits of crowdfunding include decreased risk, enhanced local community decision making and involvement, and diversified financing opportunities. However, equity-based crowdfunding is relatively new in the electricity sector, and therefore the long-term effectiveness of this type of crowdfunding is unknown (Gilpin, 2014).

One equity-based crowdfunding company, Mosaic, has raised over \$7 million for projects around the world (Mosaic Inc., 2015). Approximately \$3.4 million of their start up funding was seed money from venture capitalists with an additional \$2 million from the U.S. Department of Energy Sunshot Initiative (Gilpin, 2014). Individual community-level investors, who donated as little as \$25, raised the rest of the funding (Gilpin, 2014). Mosaic currently only operates in California, but the company plans to partner with Sungage Financial in Connecticut and the Connecticut Green Bank (Freeman, 2014).

5.4 Utilize a Diverse Financing Portfolio

Distributed projects are usually not financed by one source alone, but are instead supported through a variety of resources and mechanisms. Various funding mechanisms can be appropriate for certain sectors, for projects of different sizes, and at a variety of scales. Utilities must therefore have a diverse portfolio of financing mechanisms that fit each project. One case study in the electricity sector that exemplifies this is renewable energy generation in the town of Columbia, Missouri. The city has transformed into a clean energy leader by using a mix of policies and programs such as a local RPS, PPA program, solar rebate program, and solar loan program to increase the saturation of renewables in the city (North Carolina Clean Technology Energy Center, 2013). In the water sector, some cities and utilities have taken a similar path to achieve their sustainability goals (Leurig and Brown, 2014), and should continue to do so for the future.

5.5 Everyone Benefits from Collaboration

Infrastructure projects usually involve numerous stakeholders including government agencies, utilities and service providers, end users, investors and financiers, construction firms, and product developers (Kim et al., 2012). Therefore, both top-down and bottom-up collaboration can significantly aid in the development of distributed solutions. Top-down collaboration involves regulatory agencies across federal, state, and local levels of government coordinating efforts. This collaboration is increasingly important for the evolution of distributed solutions, as being unified can improve policy performance (Doris et al. 2009). Collaboration between regulatory agencies when establishing performance metrics and measures and streamlining permitting processes can also help in the dissemination of novel technologies and practices. For example, some states, such as Colorado, Hawaii, and Vermont have created programs designed to streamline the permitting process and speed up construction for renewable systems (National Association of State Energy Officials, 2013).

Bottom-up collaboration can aid in better allocation of resources. For example, local and regional trading can create pathways for more efficient allotment of financial resources. Regions can be defined based on the resources available and capacity requirements for a project, and trading can be used in a variety of ways. One example is to use trading to limit pollution discharges. This has been done in California where the cap and trade system is used to mitigate GHG emissions, and in Cincinnati where the trading of stormwater permits has been used to mitigate polluted discharge (Thurston et al., 2003). Another way that bottom-up collaboration can enhance project implementation is through multi-benefit water projects. In this scheme, projects are developed using an integrated approach—many water agencies work together to implement solutions that have a wide range of water-related benefits such as flood protection, wastewater treatment, and increased green space for recreation (Dawson and Cornwall, 2007).

6 CONCLUSION

Given the many challenges facing America's water and wastewater systems, it is clear that we must transform and modernize our current urban water management practices, technologies, and infrastructure. One way to increase the economic and environmental sustainability of our existing network is to integrate more innovative and multi-purpose projects, including distributed solutions. Examples of distributed solutions include using green infrastructure to capture stormwater, DSM to reduce potable water consumption, and decentralized wastewater treatment systems to decrease energy requirements and protect source water. However, this infrastructure transition requires extensive capital, and currently there are limited public and private funds for distributed water projects. Consequently, water infrastructure innovation and modernization has advanced slowly.

In this paper, we looked beyond the water sector to the electricity sector in order to discover new financing and governance tools. In recent years, regulations have been the driving force behind the widespread implementation of distributed electricity solutions. To comply with these regulations, states, utilities and others have been pursuing a host of funding and governance strategies. This review examined case studies of successfully implemented distributed energy resource projects, such as DSM and renewable energy solutions, to discover potential mechanisms that could be used by the water sector. While our research explored many different tools, the mechanisms presented in this report are those that could be most useful for the water sector.

Through this analysis, we proposed a financing and governance framework that can be used to usher the water sector into a more resilient and sustainable future. The key elements of this framework include external factors driving change, reliable funding sources backing projects, resource pathways connecting funding sources to implementers, and innovative governance structures facilitating transactions. First, regulations must promote change either directly, through market forces and economic incentives, or by utilizing revenue decoupling schemes. Then, to comply with policies, project implementers must establish funding sources. Capital can come from public sources, such as such taxes, bonds, revolving funds, or end user fees, or from private investment. Once a funding source has been established, resource pathways can be used to connect the financier to the implementer. Examples of pathway mechanisms are loans and grants, rebates, tax credits, and on-bill initiatives. Finally, innovative governance such as project or financial aggregation, alternative investment structures, end to end service companies, and net metering can enable project development.

In addition to utilizing and following this framework, we also discuss lessons that the water sector can learn from existing practices in the electricity sector. Most importantly, regulations in the water sector must change to include, and more importantly encourage, the integration of distributed solutions. If implementers are mandated to upgrade their facilities and practices, they will also find ways to overcome the many barriers precluding the integration of these innovative technologies and practices. Additionally, states, utilities, and municipalities should use cost sharing mechanisms. Stakeholders should look beyond traditional water-specific funding sources to finance projects and these stakeholders should also develop a diverse financing portfolio to match projects of varying scales. Utilities, governments, and end users must also collaborate with each other to achieve success through top-down and bottom-up partnerships. As we look towards the future of water resources management in the U.S., the water sector can use many financing and governance strategies from the electricity sector to integrate more distributed solutions into our existing water networks.

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