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RESOURCE
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PROTECTING THE WEST'S LAND, AIR, AND WATER



TAPPING THE POWER OF THE MARKET

Energy Savings, Water Conservation, and
New Revenue Streams Through Performance
Contracting in the Colorado River Basin States



This market study is a collaborative effort by McKinstry, Inc. and Western Resource Advocates (WRA). The lead author of the report is Rachel Brombaugh (McKinstry). Jorge Figueroa (WRA) is a chapter author. Joan Clayburgh (WRA), Leslie Larocque (McKinstry), and Jorge Figueroa are the review editors.

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Western Resource Advocates shapes a clean energy future that reduces pollution, protects our unique Western lands, and addresses climate change. The organization also restores degraded rivers and champions solutions to ensure a reliable water future. With offices in six Western states, Western Resource Advocates' team of lawyers, scientists, and economists craft innovative solutions for the most complex natural resource challenges in the region.

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Acronyms, Abbreviations, Definitions, and Units

acre-foot	325,851 gallons (about the amount of water 10 people use in 1 year)
AF.	acre-foot or acre-feet
AF/yr	acre-feet per year
AMR	automated meter reading
AMI.	advanced metering infrastructure
AWWA	American Water Works Association
Basin states.	Colorado River Basin states
Cu. Ft..	cubic foot or cubic feet
Colorado River Basin states . . .	Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming
EIA	U.S. Energy Information Administration
ESCO	energy service company
ESPC	energy service performance contract
HVAC.	heating, ventilating, and air conditioning system
kWh.	kilowatt-hour (1 thousand watt hours)
LED.	light-emitting diode (light)
MCF	million cubic feet (of natural gas)
MGD	million gallons per day
MWh	megawatt-hour (1 million watt hours)
M&V	monitoring and verification (protocol and process used to verify whether or not the guaranteed savings in a performance contract are realized)
NOO	Notice of Opportunity
PNNL.	Pacific Northwest National Laboratory
public entity	water treatment plant, wastewater treatment plant, water utility, and the owners of a public facility
public facility.	a facility owned and operated by state agencies, including institutes of higher education, counties, municipalities, K–12 school districts, and special districts
RFP	Request for Proposal
Sun Corridor.	the Central Arizona urban region that includes Phoenix and Tucson
USGS	U.S. Geological Survey

Executive Summary

Our society has placed a high value on conserving energy and water, which are both finite and essential. Developing events emphasize the need to adopt the best energy and water conservation actions even faster than we are currently doing. The federal government has emphasized and set in place new programs to address these issues, such as the Clean Power Plan, calling for strong actions to curb carbon pollution. The Colorado River, which supplies water to almost 40 million people in seven states (Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming), has long-term insufficient water flows to supply the river's allocations. Limited water supplies, drought, and a warming climate are exacerbating this situation throughout the West. Providing reliable clean water and reducing energy use are “top of mind” for everyone these days.

The market can catapult energy and water savings, providing one important solution to this challenge. The performance contracting model is a smart approach for cities, counties, school districts, and wastewater and water utilities to quickly implement energy and water efficiency improvements in their facilities using a qualified, private energy services company. Financial savings on water and electric bills resulting from the installation of energy and water conservation measures are guaranteed by the contracted energy services company to exceed project and financing costs necessary to implement the energy and water saving upgrades. If the realized savings do not exceed the project and financing costs, the contracted energy services company makes up the difference, not the public entity. At the end of the performance contract, all subsequent savings, year after year, accrue directly to the public entity. Because savings over the life of the contract must cover the costs of the project, public entities with budget constraints can eliminate the need to tap into capital budgets with performance contract projects. As a result, performance contracting has been used for more than two decades by innovative governments, schools, and other public entities to save energy and promote renewable sources of energy.



In this study, McKinstry and Western Resource Advocates evaluated the revenue-generation potential and the water, electricity, and natural gas savings that public entities can realize using performance contracting in the Colorado River Basin states. For purposes of this report, “public entity” includes water treatment plants, wastewater treatment plants, water utilities, and the owners of public facilities. The term “public facility” refers to buildings owned by state agencies (including higher education), counties, municipalities, K–12 school districts, and special districts.

Key Findings

\$859 million in total annual savings are possible for public entities in the seven Colorado River Basin states by using performance contracts. These energy and water efficiency projects would be guaranteed to pay for themselves. Specific components of the savings include the following:

- ◆ Public facilities can save \$750 million every year in water and energy bills through efficiency retrofit projects.
- ◆ Water utilities and water treatment plants can save \$74 million per year in energy bills.
- ◆ Wastewater treatment plants can save \$35 million per year in energy bills.
- ◆ Within ten years, public facilities can save 40,000 acre-feet of water per year, with an additional reduction of 24,000 acre-feet by consumers in the utility service area, providing a total potential water savings of 64,000 acre-feet per year.

In addition, performance contracts can deliver new revenue streams totaling \$593 million per year to water utilities in the Basin states by improving water metering and reducing apparent water loss (from customer meter inaccuracies) by 461,000 acre-feet per year. These metering improvements can lay the foundation for municipal drought management and water conservation efforts in the Basin states.

Figure ES1 Potential electricity, natural gas, and water savings that can be achieved with performance contracts in the Colorado River Basin states

Savings to public entities through performance contracting

	\$ (Million)	Electricity (MWh)	Natural Gas (MCF)	Water (AF)
Savings In Public Facilities	\$750	5,100,000	4,200	40,000
Savings In Public Water Systems	\$74	950,000		
Savings In Public Wastewater Systems	\$35	350,000		
<i>Total annual savings</i>	\$859	6,400,000	4,200	40,000

Total water savings

	Water (AF)
Consumer Savings by Reduced Demand	24,000
Savings in Public Facilities	40,000
<i>Total annual savings</i>	64,000

Benefits to public entities by water meter replacement projects

	\$ (Million)	Water (AF)
Gross Revenue and Reductions in Apparent Water Loss	\$624	485,000
Consumer Savings by Reduced Demand	\$(31)	(24,000)
<i>Net Revenue and Total Reductions in Apparent Water Loss</i>	\$593	461,000

Top Recommendations

Performance contracting is a well-proven, market-driven, procurement, financing, and project delivery approach that provides significant economic development and return on investment — in terms of money, clean air, and conserved water — to public entities and local communities. We urge public officials and decision-makers to carefully consider this report and its recommendations to help realize the tremendous resource savings and revenue opportunities that performance contracts can offer public facilities and communities in the Colorado River Basin states.

- ◆ All schools (from K–12 to higher education), state agencies, counties, municipalities, and special districts in the water-scarce West should evaluate whether performance contracting could save operational costs while conserving water and energy.
- ◆ Governors and state legislators should find ways to spur full market penetration of performance contracts to drive economic development in order to attain clean air and water conservation goals.
- ◆ States should invest in robust state performance contract programs that use established best practices for performance contracting, including those for qualification of energy service companies, measurement and verification standards, and ongoing reporting.
- ◆ All Basin states should ensure their performance-contracting-enabling legislation allows the upgrading of water meters using performance contracts to enhance water utility revenues from more accurate measurements, advance water conservation, and promote drought preparedness.
- ◆ The Basin states need to provide strong technical support and best practices guidance for water meter replacement projects implemented through performance contracting.
- ◆ Federal and state funding measures and programs that support the replacement of aging infrastructure should incentivize the use of budget-neutral tools like performance contracting.
- ◆ Energy and water utilities should consult with federal, regional, and state regulatory bodies to develop collaborative efficiency programs, and coordinate with and use ESCOs for large-scale deployment of joint incentives and synergistic programs.



Chapter 1: Colorado River Water Supply and Drought: A Call for Action

The Colorado River is an economic fulcrum for the seven Colorado River Basin statesⁱ (see Figure 1), providing water to nearly 40 million people and 4.5 million acres of farmland, as well as servicing hydropower facilities and thermoelectric power plants that provide more than 19,200 megawatts of power annually. The asset value of the Colorado River Basin's ecosystems has been estimated between \$7.0 trillion and \$50 trillion dollars.¹

Performance contracting, an integrated efficiency project procurement and delivery mechanism that uses utility and operations savings to fund projects, has been used successfully for more than two decades in the Colorado River Basin to save energy and promote renewable sources of energy. While the energy efficiency and clean energy market is well developed and profitable, much less attention has been paid to the water efficiency market. Municipal water supplies — because of drought, over-allocation of our freshwater resources, and population growth — are projected to be in short supply for the foreseeable future. Water scarcity, together with a significant water infrastructure investment gap (which will result in rising costs of potable water), presents an enormous opportunity to tap the power of the marketplace through performance contracting to make big gains in water conservation and help build drought-resilient cities.

This market study finds that performance contracts can provide \$859 million in energy and water savings every year to communities in the Colorado River Basin states, and nearly \$600 million in additional annual revenue to water utilities that are facing substantial budget constraints and infrastructure investment challenges.

Figure 1

Map of the Colorado River

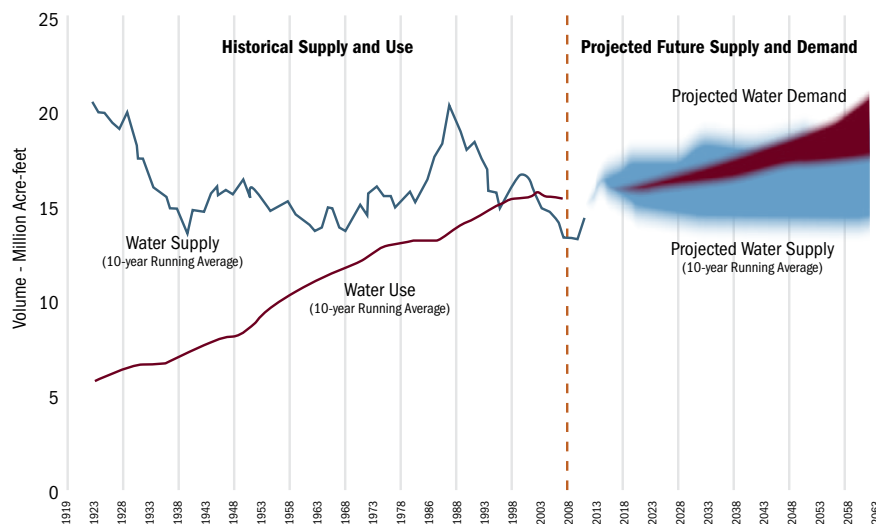


ⁱ The Colorado River Basin states are Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming.

Colorado River Water Supply and Demand Imbalance

The U.S. Bureau of Reclamation has estimated that the long-term average annual runoff in the Colorado River Basin is not enough to meet the Basin's water allocations. The water levels in Lake Mead, which is located on the Colorado River and is the largest reservoir in the U.S., reached a historic low in May of 2015, falling to levels not seen since the reservoir began filling in the 1930s.² Southern Nevada, which gets nearly 90% of its water supply from the lake, is in a race against time to build one of the most complex engineering projects in the world to install an intake pipe at the bottom of Lake Mead before the lake's water level falls below its two existing intakes and the Las Vegas Valley is left without water. Looking into the future, the U.S. Bureau of Reclamation's latest Colorado River study estimates within 50 years an average gap between the river's supply and demand of 1 trillion gallons of water (see Figure 2).³

Figure 2 Colorado River water supply imbalance



Drought In The Colorado River Basin States: Past, Present, and Future

Severe drought is considered the greatest recurring natural disaster in North America.⁴ Many studies conducted in the past decades using tree ring data have found that multi-decadal “megadroughts” of unprecedented severity and duration, which have never been experienced in modern times, occurred relatively frequently in the Western U.S. during the medieval period from about A.D. 900–1300.^{5,6,7,8} A recent 2015 study published by the National Aeronautics and Space Administration and Columbia University found

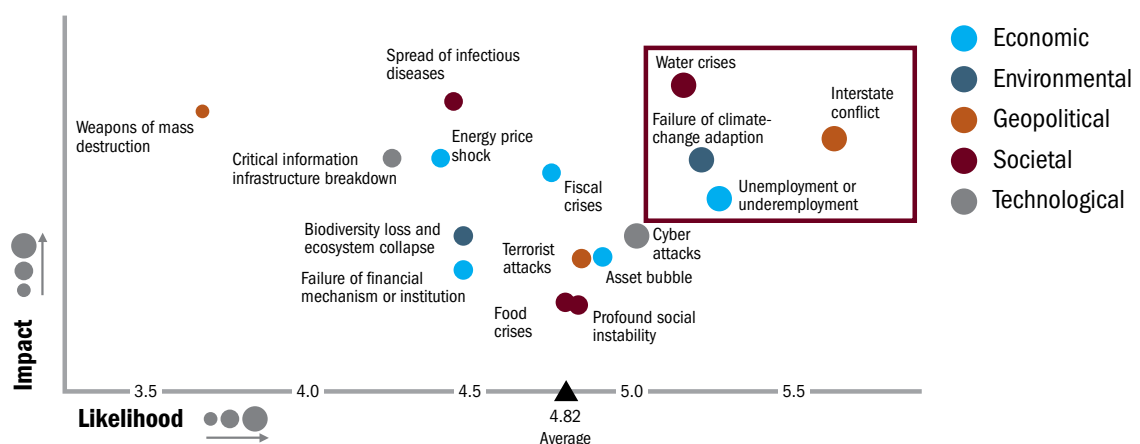
that, even under a future scenario with relatively ambitious greenhouse gas emission reductions, the drought frequency and intensity in the Colorado River Basin region during the late 21st century will likely exceed even the most severe megadrought periods of the medieval era.⁹ Currently, California is facing one of the most severe droughts on record. Making matters worse, California's groundwater, which has historically served as the key strategic reserve during periods of drought, is being depleted by 800 billion gallons a year — enough to supply every resident of California with water for seven months.¹⁰ On April 1, 2015, for the first time in state history, the governor of California directed the State Water Resources Control Board to implement mandatory water reductions in cities and towns across California to reduce water usage by 25%.

Turning Significant Challenges Into Big Economic Benefits by Fully Realizing Performance Contracting Opportunities in the Colorado River Basin States

In its Global Risks 2015 report, the World Economic Forum identifies water crises, interstate conflict, failure of climate change adaptation, and unemployment as the events or conditions that have both the highest likelihood to occur in the next 10 years and the biggest negative impact on our communities and industries, above that caused by fiscal crises or weapons of mass destruction.¹¹

These four risks (inside the red box in Figure 3) happen to also be the four discrete reasons that inspired the production of this market study.

Figure 3 Global risks landscape¹²



Jobs and Long-Term Economic Development

The U.S. Chamber of Commerce estimates that full implementation of the federal government's performance contract program alone would create 35,000 jobs a year by saving energy and water and reducing government costs. The National Association of Energy Service Companies (NAESCO) has estimated that, since 1990, energy service companies (ESCOs) have designed and implemented performance contracts that have collectively resulted in:

- ◆ \$45 billion in efficiency projects
- ◆ \$50 billion in savings — guaranteed and verified
- ◆ 425,000 person-years of direct employment
- ◆ \$30 billion of infrastructure improvements
- ◆ 470 million tons of carbon dioxide savings at no additional cost

That said, as demonstrated in this market study, the market adoption rate of performance contracts needs to be increased significantly in order to realize the enormous energy and water savings potential that exists for public facilities and water utilities across the Colorado River Basin states.

Water Scarcity and Interstate Comity

In the current drought and water-scarce reality of the West, the Colorado River Basin states do not have to compete against each other in a zero-sum game. While there are many conflicting interests and controversial issues related to management of the Colorado River, water efficiency within the Basin states is one of the solutions where many stakeholders find common ground. We all benefit by ensuring that sufficient water remains available to sustain and enhance our economies, communities, and environment. Full realization of the performance contracting potential would be a no-regrets, win-win solution to fund large-scale water- and energy-efficiency projects that could provide powerful tools for communities to manage drought, generate significant water savings, and help protect the reliability of freshwater supplies.

The Bureau of Reclamation, in collaboration with the seven Colorado River Basin states and other stakeholders, published the Phase 1 report of its Moving Forward effort in May of 2015, which identifies actionable steps to address water shortages in the future in ways that have broad-based support and provide a wide range of benefits.¹³ **Performance contracts and ESCOs can help advance 80% of the Major Opportunities and almost half of the 51 specific actions identified for the municipal sector in the Moving Forward report** (see Appendix A).

This market study estimates that performance contracting can provide 64,000 acre-feet of water savings in the Colorado River Basin states while providing almost \$859 million in energy and water savings to public entities in the Basin states.

Building the Drought-Resilient Cities of the 21st Century

The Western U.S. will become the ground-zero of climate change impacts on the nation's freshwater resources. Climate change is expected to significantly increase the severity and frequency of drought, and there is a critical need for cities in the West to invest in long-term capital improvement projects that make communities and infrastructure much more resilient to severe drought events. Advanced water metering infrastructure can serve as the backbone of the drought-resilient city of the future. This technology can help eliminate water loss from the reservoir to the faucet and provide real-time information on who is using water, when, and how much — the foundation for implementing effective water conservation programs and incentives that are tailor-made for a service area.

Using performance contracts to install advanced water metering projects, water utilities in the Colorado River Basin states can reduce apparent water loss (resulting from customer meter inaccuracies) by 461,000 acre-feet per year, which would result in new revenue streams totaling \$593 million per year. This new revenue could make a big difference for water utilities that are nationally facing a \$1 trillion water infrastructure investment gap.¹⁴

A Powerful Free Market Approach to Fund Comprehensive Efficiency Projects

Performance contracting is a win-win tool that allows public entities to partner with private industry to invest in comprehensive energy and water retrofit projects that pay for themselves and are conveniently implemented through a turnkey service. Public entities with budget constraints can eliminate the up-front costs and financial risks of large-scale water- and energy-efficiency projects with guaranteed performance contracts — if the savings realized don't pay the full costs of the performance contract project, the ESCO, and not the public entity, covers the shortfall. At the end of the performance contract, all subsequent savings, year after year, accrue directly to the public entity.

Performance contracts in the Colorado River Basin states can provide \$859 million in energy and water savings a year to public entities, and increase water utilities' annual revenues by \$593 million.

CHAPTER HIGHLIGHTS

- ◆ Performance contracting is a well-tested, no-regrets economic development tool that has nationally resulted in \$45 billion worth of efficiency retrofit projects that have paid for themselves and generated more than \$50 billion in savings.
- ◆ Drought, water scarcity, and a significant water infrastructure investment gap in the West result in an enormous potential to tap the power of the marketplace through performance contracting to make big gains in conservation and help build drought-resilient cities.
- ◆ Performance contracts can lay the foundation of long-term municipal water conservation programs and municipal drought management in the Colorado River Basin states with water meter replacement projects that pay for themselves and generate \$593 million in new annual revenue.
- ◆ Performance contracts and ESCOs can help advance 80% of the Major Opportunities and almost half of the 51 specific actions identified in the Bureau of Reclamation's Moving Forward report to help solve the water scarcity challenges in the Colorado River Basin.



Chapter 2: Benefits of Performance Contracting for Public Entities

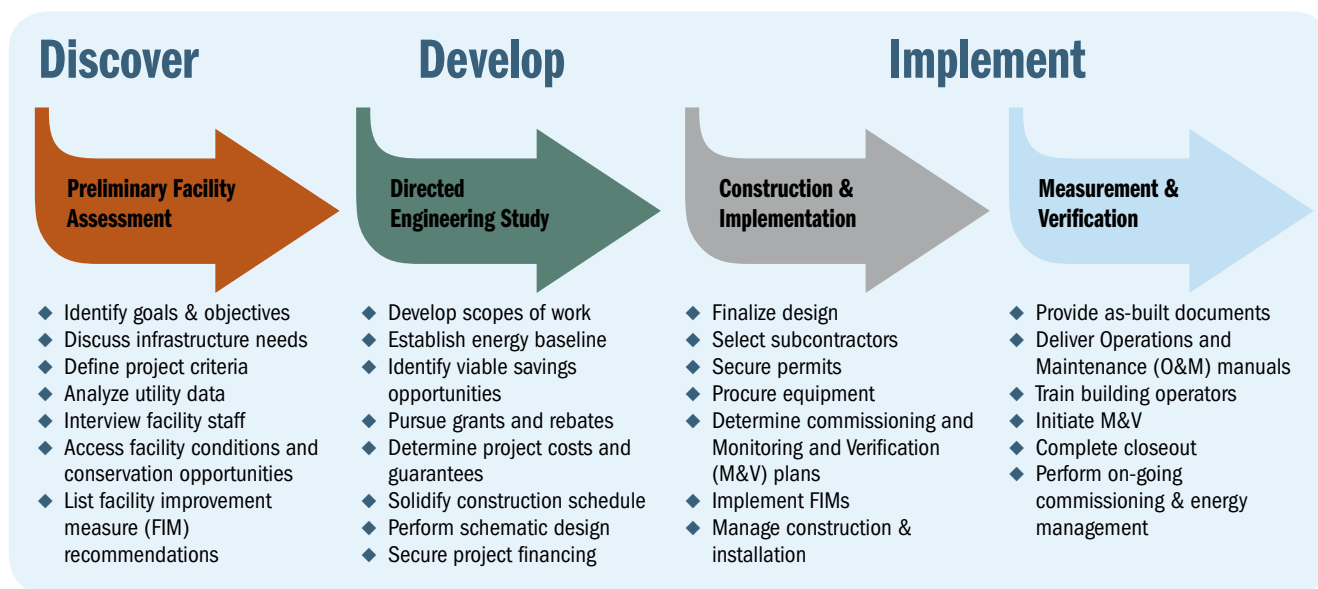
The performance contracting model is financially and operationally superior to the standard piecemeal contracting approach for energy and water efficiency improvements. It is based on a procurement and financing mechanism in which private companies design and implement comprehensive energy and water retrofit projects that are guaranteed to pay for themselves — or the service companies take the shortfall. This chapter reviews the performance contracting tool and the various benefits for public entities that choose this service.

Energy and Water Saving Projects That Pay for Themselves: Shifting the Risk of Comprehensive Efficiency Retrofits in Public Facilities to the Private Industry

A performance contract, also known as an energy service performance contract (ESPC), is a contract between a public entity, such as a school district or local government, and an ESCO to do comprehensive energy and water retrofit projects in public facilities. Financial savings on water or electric bills resulting from the installation of energy and water conservation measures are guaranteed by the private service company to exceed the financing costs necessary to implement the energy and water saving upgrades. If the realized savings do not exceed the financing costs, the service company makes up the difference, not the public entity. Performance contracts are thus referred to as “budget-neutral” because savings over the life of the contract cover the costs of the projects, eliminating the need to tap into capital budgets.

Performance contracts require service companies to conduct a series of audits on the public entity’s facilities to identify improvements that would provide significant energy, water, and money savings (see Figure 4). The last and most comprehensive audit is “investment grade,” which means that it provides a complete engineering study that justifies investing in the project by detailing, with a high level of confidence, the performance of the recommended technical measures, together with a projected annual cash-flow analysis of the project.

Figure 4 Major steps in a performance contracting project

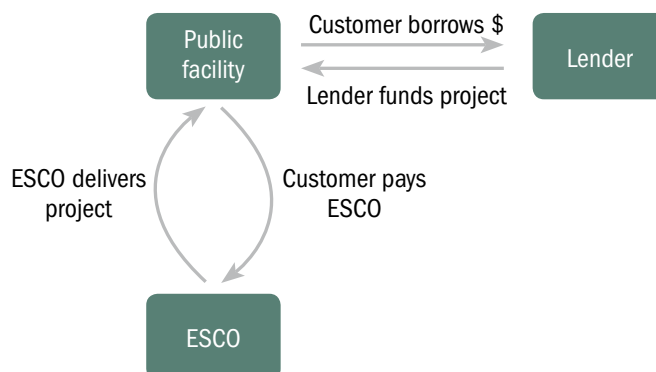


The investment grade audit, also called a Directed Engineering Study, combined with the performance contract, allows the public entity to secure low-interest financing for energy and water system upgrades whose payback falls within an established timeframe. The avoided future costs resulting from increased operational efficiencies plus the reduced monthly water and energy bills cover the costs of installing the upgrades and any financing costs over the life of the contract. After the contract ends, all additional and subsequent cost savings achieved through increased energy and water efficiencies accrue to the public entity.

Guaranteed performance is the hallmark of performance contracts. At all times, the savings are guaranteed by the ESCO to exceed the financing costs of the project (see Figure 5). In the state of Colorado and in federal government buildings, for example, the realized savings of a performance contract must pay for the project's respective debt service/financing costs in every year, starting in year one. If the savings do not exceed the financing costs, the service company is required to make up the difference. Because the service companies guarantee that the projects will pay for themselves (or they take the shortfall), performance contracting is a powerful business model that allocates the financial risks to private industry, while providing significant returns on investment — in terms of money, clean air, and conserved water — to public entity clients.

Figure 5 Financing and paying for performance contracting projects

Savings over term of financing pay debt service



How does the contract work? The public entity works with the ESCO to develop a project and with a lender to secure financing for the project. The ESCO guarantees that the savings from the project will repay the lender over time. If the full estimated savings don't materialize, the ESCO covers the shortfall.

Many Benefits of Using Performance Contracts

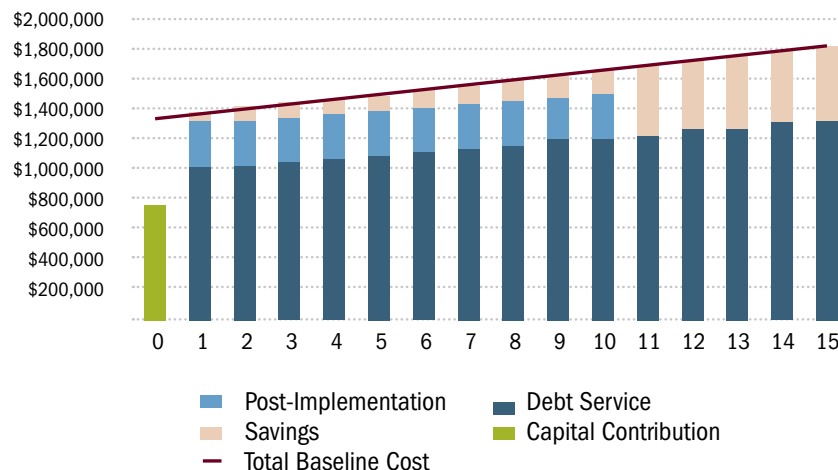
Performance contracts provide a number of benefits in addition to guaranteeing savings and eliminating up-front capital costs.

Lower Operating Costs, Greater Savings Over the Life of the Project

The traditional contracting process places a premium on the lowest bid and the first-cost (how much the project will cost initially), and does not consider advanced, comprehensive efficiency improvements and strategies that may initially cost more but may have much higher long-term energy and water savings plus lower operational and maintenance costs. Although the project designs of performance contracts have higher initial costs, they end up having lower operating costs over the life of the project than the cheapest first-cost design (see Figure 6).

Figure 6 Cash flow of a sample \$3 million performance contract project

In this project, the red line represents the utility bills under a business-as-usual scenario. From years 1 to 10, the energy and water savings generated by the project pay for the financing costs of the project. At the end of year 10, all subsequent savings accrue directly to the client.



When compared to other types of efficiency projects, the energy and water efficiency improvements implemented through performance contracts often work better, last longer, and enjoy stronger support from facility administrators, maintenance staff, and building users because the value is placed on comprehensive efficiency improvements and long-term operation rather than the piecemeal haphazard approach of investing in what is the lowest-cost improvement in the short-term.¹⁵

Projects Are implemented as a Turnkey Service

ESCOs provide performance contracts as a comprehensive “turnkey” service. One single contractor is in charge of providing a full spectrum of services from beginning to end in the project cycle, including an investment-grade audit, design engineering, construction management, commissioning, operations and maintenance (O&M), and monitoring and verification (M&V) of savings.¹⁶

Performance Contracts Provide a Single Point of Accountability

The conventional contracting process for installing energy- and water-efficient improvements in public facilities represents a cumbersome and scattered collection of solicitations and multiple contracts. There is legislation that enables performance contracts in all seven Colorado River Basin states, which allows a public entity to select an ESCO based on qualifications other than price for the desired improvements. For example, a public entity may have to solicit and award separate contracts with different contractors to (1) conduct an energy study; (2) complete the plan and specifications to install the energy study’s recommended improvements; (3) install the improvements; and (4) provide preventive maintenance services for any equipment the facility will not maintain with in-house staff.¹⁷

Performance contracts provide a single point of accountability across all the stages of the project. A single company is responsible for the design, construction, operation, and maintenance of all of the efficiency improvements of the project. This streamlined process results in projects that take less time and money to manage, have superior quality control, and ultimately result in better customer satisfaction.¹⁸

Financial and Operational Risks of the Efficiency Improvements Are Shifted From the Public Entity to the Service Company

An ESCO guarantees that all of the costs of the project will be paid for by the efficiency savings generated from the project or the company will cover the shortfall. It is very beneficial to public entities to be able to implement guaranteed, low-risk, large-scale efficiency projects. State-enabling legislation protects the public entity by requiring that the utility and operational savings over the term of the contract exceed the costs of the project, including any interest incurred for financing. Some states have less stringent statutes, while other states require that the savings exceed costs in every year of the contract.

Projects Are High Quality, Maintained, and Verified

Because the performance contract transfers the financial and operational risk of the efficiency project to the ESCO, the company has strong incentives for high-quality design and construction, optimal management and maintenance, and robust ongoing monitoring and verification through the duration of the contract.¹⁹ This financial model results in the service companies specializing in high performance and optimal quality control throughout the life of the contract.

Funds Saved From Lower Energy and Water Bills Can Be Reinvested in More Facility Improvements

Financial constraints in the public sector often results in the delay of much needed building maintenance and renovation. A performance contract gives the building owner the flexibility to combine facility improvement measures that have high levels of savings, such as lights, with measures that have low or no energy savings, such as boilers or roofs. The savings generated by the high-savings measures help pay for the other measures. As long as the project conforms to enabling legislation, the ESCO can provide a wide range of services at the facility.

Use of Local Subcontractors Results in Local Economic Development

Energy and water efficiency improvements through performance contracting promotes local economic growth and creates jobs from the use of local installation subcontractors. It has been estimated that one-third of the cost of every performance contract project is spent on labor.²² Accordingly, a \$3 million performance contract would provide approximately \$1 million in labor wages.

Maintenance Costs and Equipment Breakdowns Are Reduced

When efficiency savings in a performance contract are calculated, they compare the upgraded equipment to a “do-nothing” scenario in which the existing equipment in a facility would be left in place.²¹ This calculation assumes that the existing equipment will continue to have the same level of performance and maintenance costs over the life of the performance contract. Because the equipment suitable for replacement under a typical performance contract is old, performance contracts also reduce frequent repairs and high-maintenance costs due to inadequate, aging, or obsolete equipment.²²

A study conducted in 2013 by Oak Ridge National Laboratories developed cost models for a performance contract in a typical federal facility and for a similar facility that left its older equipment in place during the span of the performance contract. By comparing these two similar facilities, the study found that due to the reduced level of maintenance resulting from the performance contract retrofits, the facility with the performance contract site increased its net savings by an additional 44.5% of the guaranteed savings.

Projects Result in Improved Indoor Air Quality in Public Facilities

The savings from performance contracts can pay for new HVAC systems that meet recommended ventilation standards to improve indoor air quality and health.^{24,25} Studies have shown that by meeting ventilation standards in office buildings, the proportion of occupants that have frequent upper respiratory symptoms can be reduced by almost 10%. Reported asthmatic symptoms have also been found to be less common in schools that have new HVAC systems that meet indoor air quality standards, with the new system resulting in higher air exchange rates, lower concentrations of airborne pollutants, and lower relative humidity.²⁶

Clean Air and Water Conservation

Since the 1990s, service companies have delivered thousands of performance contracts, which have reduced carbon dioxide emissions by more than 470 million tons and which have been paid for by guaranteed reductions in energy bills totaling \$50 billion.²⁷ This market study estimates that, with projects that pay for themselves, performance contracts can help communities in the Colorado River Basin states save approximately 64,000 acre-feet of water annually and reduce apparent water losses by up to 461,000 acre-feet per year (see Chapter 3 for details). In sum, performance contracting is a well-proven tool that communities can use to save hundreds of millions of dollars by being good stewards of our future generations’ environment.

CHAPTER HIGHLIGHTS

- ◆ Performance contracting is a win-win tool that allows public entities to invest in comprehensive energy and water efficiency projects that pay for themselves and are conveniently implemented through a turnkey service.
- ◆ Public entities with budget constraints can eliminate the up-front costs and financial risks of large-scale water- and energy-efficiency projects through performance contracts — if the savings realized don't pay the full costs of the performance contract project, the service company, and not the public entity, covers the shortfall.
- ◆ At the end of the performance contract, all subsequent savings, year after year, accrue directly to the public entity.
- ◆ ESPC is a proven procurement and financing method that has been used by thousands of public agencies. Legislation exists in all seven Colorado River Basin states that enables ESPCs to improve public facilities.
- ◆ Risk is transferred to the ESCO in two ways: construction risk and performance guarantees. Legislation protects the public entity by requiring that savings exceed all costs, including financing costs. Some states require that the savings from the project are greater than costs each year, while others require that the savings from the project are greater than costs over the term of the performance contract.



Chapter 3: Maximizing Efficiency and Minimizing Costs in Public Facilities

The term “public facilities,” as used in this study, refers to buildings owned by state agencies (including higher education), counties, municipalities, K–12 schools, and special districts. School districts, cities, and counties in the Colorado River Basin states require significant amounts of energy and water to operate and maintain their facilities. A substantial amount of money can be saved by reducing energy and water use in public facilities through efficiency improvements that pay for themselves via performance contracts. Achieving these big money savings would also improve air quality, reduce greenhouse gas emissions, and conserve water resources. Local governments and school districts can thus demonstrate — through the guaranteed, low-risk approach of performance contracting — that fiscal responsibility and environmental stewardship can go hand in hand.

In this chapter, we review energy and water use in public facilities and the opportunity for performance contracting to save energy, water, and money. We estimate the following for public facilities in the seven Colorado River Basin states: current energy and water use; potential energy and water efficiency improvements that can be achieved through performance contracting; and the financial savings that these improvements can provide.

Performance contracting can provide \$750 million in energy and water savings every year in government and public education facilities in the Colorado River Basin states.

Electricity and Natural Gas Savings in Public Facilities

According to the U.S. Energy Information Administration (EIA), the built environment consumes 40% of all of the energy used in the United States and three-quarters of the country’s electricity.²⁸ Public facilities, therefore, represent a big opportunity to save money and energy through efficiency improvements.

Table

1

Summary of potential savings via performance contracts in public facilities in the Colorado River Basin states

Government and public education facilities in the Colorado River Basin states can save \$673 million per year in energy bills alone with guaranteed performance contracts.

	\$ (Million)	Electricity (MWh)	Natural Gas (MCF)	Water (AF)
Electrical conservation in public facilities	\$642	5,100,000	-	-
Natural gas conservation in public facilities	\$31	-	4,200	-
Water conservation in public facilities	\$77	-	-	40,000
<i>Total</i>	\$750	5,100,000	4,200	40,000

Energy Demand of Public Facilities

Public facilities need energy to keep their indoor and outdoor environments habitable and functional. Among other things, energy is needed to keep indoor space warm in the winter and cool in the summer, and to keep lighting fixtures, computers, refrigerators, and coffee makers running for building occupants. Electricity covers most of the energy used in public facilities, with natural gas generally used for the same purposes it is used in the residential sector (to warm or cool the indoor environment and to heat water).

One of the challenges with wholesale retrofitting of the national building stock is the diversity of facilities — one standard size or design does not exist for either office or educational facilities. For the purposes of this report, we break down energy use of office and education facilities based on data compiled by the U.S. Department of Energy's Commercial Reference Building Models of the National Building Stock (see Figure 7 and Figure 8).^{29,30}

Figure 7 Typical energy usage in large commercial facilities in the Colorado River Basin states

Interior lighting, interior equipment, and cooling consume three-fourths of the energy used by large commercial facilities in the Colorado River Basin states.

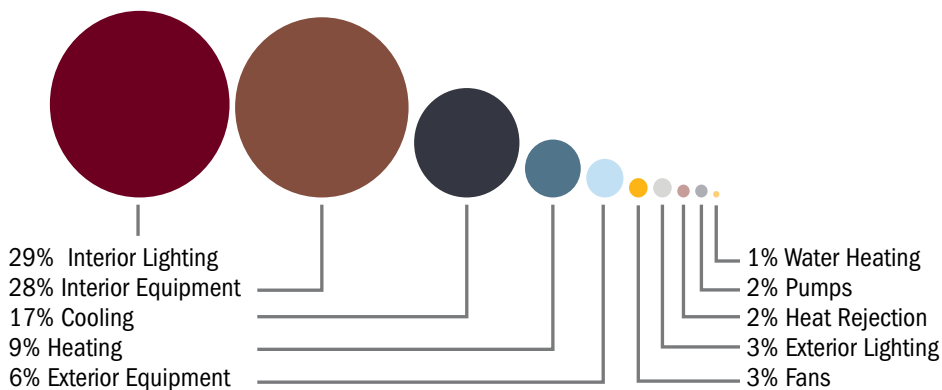
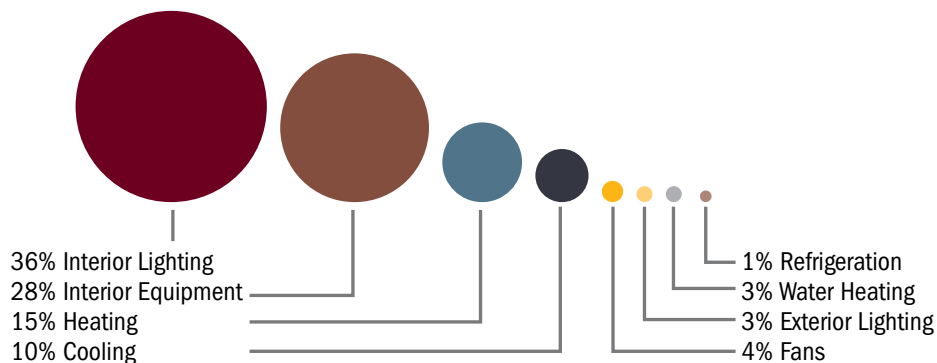


Figure 8 Typical energy use in K-12 education facilities in the Colorado River Basin states

Interior lighting alone consumes more energy in schools than heating and cooling.



Many Opportunities for Electricity Conservation

After evaluating how much energy governments currently use and the costs of that energy, potential energy savings were estimated by evaluating the implementation of different types of efficiency improvement projects. The energy retrofit project types and sample energy conservation measures fall into the following categories:³¹

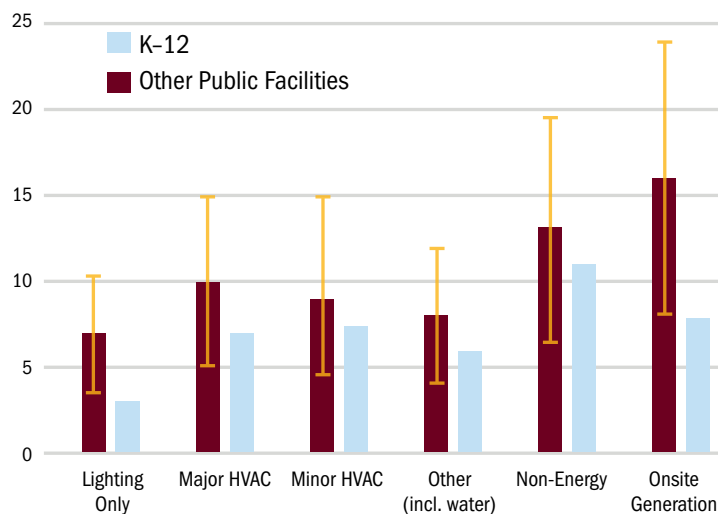
- ◆ **Upgrading Lighting/Installing Lighting Efficiency Measures.** Two examples of this would be replacing the lights in a facility with light-emitting diode (LED) lights and installing occupancy sensors so the lights are on only when people are present.
- ◆ **Replacing/Upgrading Major Heating Ventilating and Air Conditioning (HVAC) Systems.** This is typically capital-intensive equipment replacements or upgrades to boilers, chillers, cooling towers, controls, air handlers, and distribution systems to more efficient models.
- ◆ **Replacing/Upgrading Minor HVAC Systems.** This category involves the replacement of less capital-intensive heating and cooling equipment and controls, including fans, pumps, and programmable controls.
- ◆ **Installing Onsite Renewable Energy Generation.** The analysis made no differentiation as to the type of renewable technology used. Examples include the installation of solar panels or wind turbines in public facilities to produce electricity for their own use.
- ◆ **Upgrading Non-Energy Equipment and Remodeling.** These types of measures involve the installation of equipment and/or remodeling primarily for health and safety, not for energy savings. Examples include roof replacement and asbestos remediation.
- ◆ **Other Conservation.** This category covers efficiency equipment and practices that are not included in the above categories. Many strategies fall under this category, ranging from teaching students to save water while washing their hands in the school bathroom, to installing energy-efficient vending machines, to minimizing the mineral buildup in cooling towers and boilers to maximize the number of times water can be recycled through these systems.

Measuring Potential Electricity Savings

The economic effectiveness of a performance contract is generally measured by its payback period, also called simple payback period, which is calculated by dividing the initial project cost by the annual savings achieved by the project. Figure 9 illustrates how, depending on the specific project type, payback periods of performance contracts in public schools and other public facilities can range between 5 to 25 years. The K–12 sector typically has longer payback periods due to a lower baseline usage — schools are occupied for fewer hours per day than a commercial building and are often not fully occupied in the summer months, when cooling demand is highest and savings can be achieved. Studies conducted by Lawrence Berkeley National Laboratory also report high levels of deferred maintenance in the K–12 sector. Schools can use ESPC for energy and deferred maintenance projects — the combination of short paybacks and very long paybacks associated with maintenance improvements typically results in longer average paybacks. Additionally, performance contracting is not only used as a means to improve efficiency in K–12 facilities, but also to make improvements that may provide little savings but achieve health and safety goals.³²

Figure 9 Simple payback periods per project type³³

Note: The height of the bar represents the median of the range of data. The top and bottom points of the error bars represent the 75th and 25th percentiles.



*On average, performance
contracts can save public facilities
15% annually on their electricity
and gas costs.*

The simple payback periods per project type were converted to annual efficiency saving percentages. The average annual efficiency savings for all projects ranges between 12% to 17% savings (see Table 2). Based on this evaluation of project types, the study uses a 15% value for overall annual savings from performance contracting in public facilities.

To develop the estimate of \$673 million in annual energy savings, this study looked at total expenditures in commercial buildings and developed a subset of public facilities. The total estimate was lowered by values of existing market penetration. Estimated savings through performance contracts were applied to reach total savings values.

The EIA has calculated the total electricity and natural gas expenditures for commercial buildings for each of the Colorado River Basin states (see Table 3).

Table 2 Simple payback periods converted to annual savings, per project type³³

Project Type	K-12 Annual Savings	Other Public Facilities Annual Savings
Lighting only	14%	33%
Major HVAC	10%	14%
Minor HVAC	11%	13%
Other (incl. water)	13%	17%
Non-energy	8%	9%
Onsite generation	6%	13%
<i>Average percent efficiency</i>	12%	17%

The U.S. Department of Energy, in turn, has estimated that 24% of commercial buildings are government-owned facilities. This study calculates the total electricity use and cost for all public facilities in the Colorado River Basin states by multiplying a 24% public facilities proxy by the commercial building EIA data. The results are provided in Table 4.

Table 3 Electricity and natural gas consumption and cost in commercial facilities in the Colorado River Basin states, 2013³⁵

States	Total Commercial Electricity Use (Million kWh)	Total Commercial Electricity (\$ Million)	Total Commercial Natural Gas (MCF)	Total Commercial Natural Gas (\$ Million)	Total Energy (\$ Million)
Arizona	29,952	\$2,956	4,213	\$39	\$2,995
California	120,948	\$17,621	126,571	\$892	\$18,513
Colorado	19,750	\$1,949	4,061	\$31	\$1,980
Nevada	9,305	\$840	11,195	\$83	\$923
New Mexico	8,997	\$880	10,698	\$68	\$948
Utah	10,878	\$910	5,681	\$40	\$950
Wyoming	4,058	\$349	3,920	\$26	\$375
<i>Total</i>	203,888	\$25,505	166,339	\$1,179	\$26,684

Table 4 Annual electricity and natural gas cost for public facilities in the Colorado River Basin states, 2013^{36,37}

	Total Commercial Energy Cost (\$ Million)	% Public Facilities	Total Public Facilities Energy Cost (\$ Million)	Total Public Facilities Electrical Use (MWh)	Total Public Facilities Natural Gas Use (MCF)
Electricity	\$25,505	24%	\$6,120	48,933,120	
Natural gas	\$1,179	24%	\$280		39,921
<i>Total</i>	\$26,684	24%	\$6,400	48,933,120	39,921

Every year, energy bills in public facilities cost taxpayers over \$6 billion in the Basin states.

Applying a 15% savings rate to the total electricity and natural gas cost figures results in annual electricity savings of \$917 million and annual natural gas savings of \$45 million that can be achieved in public facilities in the Basin states. However, the 15% annual savings rate calculation must also take into account the savings already achieved through past and current performance contracts implemented in the Basin states. The existing market penetration of performance contracts in the K–12 sector in the Western region of the U.S. has been estimated at 30% (see Table 5).

Table

5

Median performance contracting market penetration estimates based on percentage total market floor area addressed by performance contracts from 2003–2012³⁸

70% of the K–12 public school sector is not using performance contracting.

		Market Segment by U.S. Census Region				
		Northeast	Midwest	South	West	U.S.
Vertical Market	K–12 schools	45%	40%	42%	30%	42%
	State/local government	39%	30%	30%	45%	30%
	Federal government	27%	28%	25%	27%	28%
	Higher education	25%	25%	23%	30%	25%
	Public housing	20%	15%	18%	18%	18%

Abundant opportunities exist for performance contracting in all public market segments in the West.

To be conservative, this study assumes that a 30% market penetration of performance contracts has already occurred in public facilities in the seven Colorado River Basin states (see Table 6). This estimate does not address the timing of previous energy savings performance contracting — for example, a facility improved in or before 2003 may be ready to replace and upgrade equipment in the 2015–2017 period.

Energy conservation with performance contracts can provide significant economic benefits to public entities and local communities in the Basin states.

Table

6

Total estimated annual electricity and natural gas savings potential in public facilities in the Colorado River Basin states through performance contracting³⁹

	Total Public Facility Energy Cost (\$ Million)	Avg. ESPC Project Savings (%)	ESPC Savings Opportunity (\$ Million)	With 30% Discount for Previous ESPC (\$ Million)	Total Public Facility Electrical Savings (MWh)	Total Public Facility Natural Gas Savings (MCF)
Electricity	\$6,100	15%	\$917	\$642	5,100,000	
Natural gas	\$300	15%	\$45	\$31		4,200
<i>Total</i>	\$6,400		\$962	\$673	5,100,000	4,200

Water Savings in Public Facilities

Water is critically important to operate and maintain facilities, and to keep facilities habitable for occupants. Public facilities use water for, among other things, bathrooms, kitchens, air conditioning systems, and outdoor landscaping.

Water Demand of Public Facilities

Using public water supply data published by the U.S. Geological Survey (USGS) report, *Estimated Use of Water in the United States in 2010*, this study calculated that public facilities in the Colorado River Basin states use 403,000 acre-feet of water per year, which represents 4% of the Basin states' total public water supply (see Table 7).^{40,41,42} This number does not include residential or commercial users. The current water rates of the largest metropolitan areas in each Basin state were used as a proxy for the cost of public water supply in each Basin state. The water demand figures for public facilities was then multiplied by the state water rate proxies, and these values resulted in a total annual water use cost of about \$773 million for public facilities in the Colorado River Basin states (see Table 7).

Table

7

Water utility bills in public facilities in the Colorado River Basin states^{44,45}

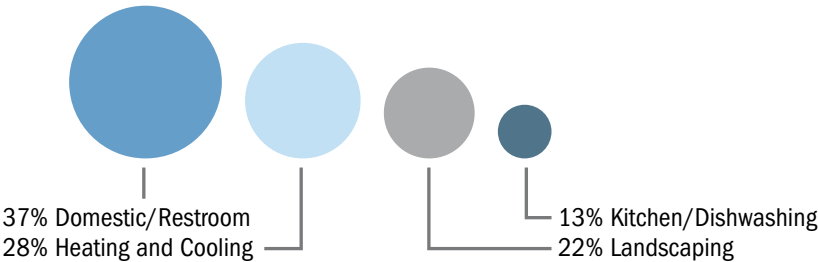
Public facilities in the Colorado River Basin states use approximately \$773 million worth of potable water each year.

State	Total Withdrawal (AF/yr)	Public Supply (AF/yr)	Public Facility Use (AF/yr)	Water Rate (\$/AF)	Total Public Facility Market (\$ Million)
Arizona	6,820,000	1,360,000	49,000	\$1,432	\$70
California	42,600,000	7,060,000	254,200	\$2,260	\$574
Colorado	12,300,000	950,000	34,200	\$1,241	\$42
Nevada	2,940,000	651,000	23,400	\$1,652	\$39
New Mexico	3,540,000	318,000	11,400	\$1,264	\$14
Utah	5,000,000	754,000	27,100	\$1,046	\$28
Wyoming	5,270,000	111,000	4,000	\$1,466	\$6
<i>Totals</i>	78,470,000	11,204,000	403,300		\$773

The largest water users of water in office buildings are restrooms, heating and cooling, and landscaping (see Figure 10).

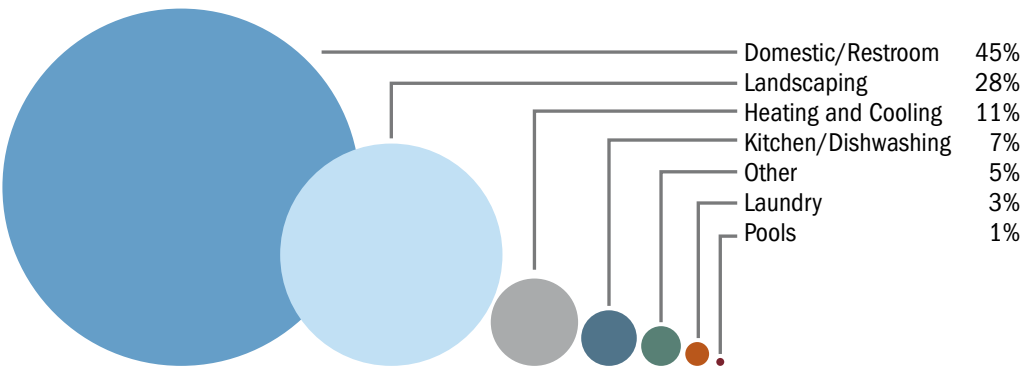
Figure 10 End uses of water in a typical office building⁴⁶

The three largest uses of water in office buildings are restrooms, heating and cooling, and landscaping.



Significant variation may exist with regards to how water is used in schools across the U.S. because of regional factors such as precipitation, temperature, and evapotranspiration. That said, restrooms and landscaping represent, on average, three-fourths (75%) of the total water use in schools in the U.S. (see Figure 11).

Figure 11 End uses of water in a typical school⁴⁷



Opportunities for Water Conservation

After evaluating how much water public facilities currently use and the cost of that water, potential water savings were estimated by assuming the implementation of new water efficiency practices and technologies, including, among other things:

- ◆ Water-efficient fixtures and appliances, including toilets, urinals, showerheads, and faucets
- ◆ Low-water-use landscapes, drought-resistant vegetation, and efficient irrigation systems
- ◆ Water reuse systems
- ◆ Public education and outreach regarding water efficiency measures, customer water use audits, and water-saving demonstrations
- ◆ Bundling of available water incentives and rebates to implement water conservation technologies and measures
- ◆ Water-efficient commercial kitchen equipment and lab/medical equipment
- ◆ Water-efficient laundry and cooling tower water management

Measuring Potential Savings

Public facilities in the Colorado River Basin can reduce their water use by 10% by implementing cost-effective water conservation measures through performance contracts, resulting in total annual water savings of 40,000 AF that reduce costs by \$77 million per year (see Table 8).

Numerous publications and historical data on municipal water conservation programs indicate that a 10% reduction in water use in public facilities is achievable within a 10-year time frame. Federal facilities, for example, are required to reduce their potable water use consumption intensity (gallons per square feet of facility space) by 2% per year or 36% through 2025 relative to their baseline water consumption in fiscal year 2007.⁴⁸ A review of all of the federal agencies’ sustainability scorecards shows that between 2007–2011, 85% of all federal agencies reduced their potable water use by an average of 4% per year.

The 10% reduction value, however, highlights the gap between water efficiency programs and energy demand management efforts. In general, water conservation has not received the same level of attention as energy conservation, and this is also the case in performance contracting. With performance contracts reaching 12% to 17% reductions in energy use for public agencies, as noted in Table 2 above, a concerted effort to achieve more water conservation in performance contracts could increase savings and reduce water consumption in public facilities in the Colorado River Basin states.

Public facilities in the Colorado River Basin can cut water bills by \$77 million per year and save 40,000 acre-feet of water annually with performance contracts. These savings can be achieved in just the first ten years.

Table 8 Water conservation potential through performance contracting in public facilities in the Colorado River Basin states

	\$ (Million)	Water (AF)
Government use market size	\$773	403,300
Average savings (%)	10%	10%
Total potential savings	\$77	40,000

Case Study:

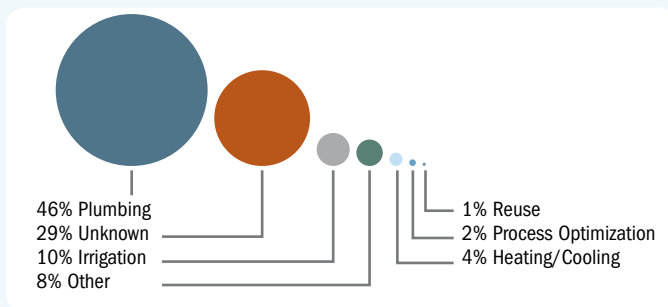
*New Tools to Realize Water Efficiency Savings Opportunities in Department of Energy Performance Contracts*⁵⁰

The Federal Energy Management Program (FEMP) at the U.S. Department of Energy has an energy savings performance contracting (ESPC) program that is promoting implementation of performance contracts between federal agencies and energy service companies. As of 2012, about \$2.7 billion has been invested in federal performance contracting projects, with total cost savings of \$7.1 billion.⁵¹

Low Implementation of Water Efficiency Measures in Federal Performance Contracts

In 2014, the Pacific Northwest National Laboratory, a Department of Energy research facility, investigated how effective Department of Energy ESPCs have been in integrating water efficiency in their portfolio of efficiency improvements. **Pacific Northwest National Laboratory estimates that only 3% of the total efficiency investments of Department of Energy ESPCs have been water-related. A breakdown of the implemented water efficiency measures in these ESPCs is provided in Figure 12.**

Figure 12 Water efficiency measures in Department of Energy ESPCs



Missed Opportunities

The Pacific Northwest National Laboratory study found that ESPCs rarely implemented the types of water efficiency upgrades that typically provide the shortest payback time (e.g., optimizing water processes) and the biggest savings (e.g., cooling tower water management and water-efficient irrigation).

Water Measure Type	Average of Simple Payback
Process optimization*	2.7
Cooling/heating	4.5
Irrigation	10
Unknown†	11.1
Plumbing	13.7
Other water conservation‡	16.1
Reuse	22.5

* This category includes, for example, increasing the efficiency of reverse osmosis systems for processes that require highly purified water (e.g., laboratory testing) and using high-quality detergents to shorten the length of time to clean vehicles and aircraft.

† Measures reported as water efficiency improvements, but with no specifics provided.

‡ These water measures represent a small set of projects that do not fall within the main categories and include measures such as meters, leak detection, and kitchen equipment.

Why Are So Few Water Measures Being Implemented in ESPCs?

The Pacific Northwest National Laboratory also conducted a water-efficiency-related gap analysis that looked at each of the major stages of the performance contracting process to better understand why so few innovative water measures are included in ESPCs (see Figure 13).

Next Steps

In 2015, FEMP utilized the results of the Pacific Northwest National Laboratory study to initiate the following improvements to the federal performance contracting process:

- ◆ Deployment of a new water project screening tool for agencies to use at the beginning of the performance contracting process to assess and realize the overall potential for effective water efficiency measures by major water end-use categories
- ◆ Integration of specific water efficiency components into the Notice of Opportunity template that allows the agency to choose specific water-efficient technologies in the Notice of Opportunity
- ◆ Addition of water-efficient technologies in the FEMP technology deployment program
- ◆ Inclusion of water-efficient technologies in a FEMP webinar on underutilized technologies in performance contracts

Some of the above actions may be transferrable and replicated at the state level with actions that are similar, but tailor-made for state agencies and state-specific performance contract processes.

Figure 13 Gap analysis of water efficiency in the Department of Energy performance contracting process

Phase 1: Project Planning	Phase 2: ESCO Selection	Phase 3: Negotiations and Award	Phase 4: Measurement and Verification (M&V)
Gap: Agencies receive no support on how to specify water efficiency in the Notice of Opportunity and Request for Proposal processes. Impact: Agencies without specific water-efficiency expertise will likely miss the opportunity to integrate water projects into their ESPC at the beginning of the contract	Gap: No water expertise is required in the ESCO technical approach document and the ESCO selection Impact: Water expertise is unlikely unless it is specified by the agency	Gap: Water baseline and water balance development is not required as part of the investment-grade audit Impact: The largest water users are not identified to help target innovative and cost-effective water-efficiency measures that will make a big impact in total site-level water reduction	Gap: lack of end-use metering and no specific guidelines for determining water use make M&V challenging Impact: ESCOs may be reluctant to implement innovative water measures without clear M&V protocols

CHAPTER HIGHLIGHTS

- ◆ Every year, public facilities in the Basin states spend over \$7 billion in energy and water bills — \$6.4 billion in energy and \$773 million in water bills — with electricity and natural gas representing approximately 90% of the combined energy and water use costs.⁴⁹
- ◆ Public facilities in the Colorado River Basin states can use performance contracts to collectively guarantee savings of \$750 million every year by implementing energy and water efficiency projects.
- ◆ Performance contracts can be used to guarantee \$77 million dollars in potable water savings every year in public facilities in the Basin states through water efficiency projects that would pay for themselves and annually save 40,000 acre-feet of water.



Chapter 4: Solving the Water Infrastructure Investment Gap of Public Water Systems With Performance Contracting

Public water systems run by public or private water utilities treat and deliver potable drinking water for domestic, commercial, industrial, and government uses.⁵² Public water systems are an energy-intensive sector that is facing formidable financial challenges in the coming decades.

Assuming pipes are replaced at the end of their service lives and systems are expanded to serve growing populations, the American Water Works Association (AWWA) has estimated that public water systems are facing a \$1 trillion dollar infrastructure investment gap in the next 25 years.⁵³

A 2014 survey conducted by Black & Veatch of water utilities in the U.S. recently found that **budget constraints and/or up-front costs are the primary reasons why water utility managers do not pursue sustainable solutions for their aging infrastructure and capital improvement challenges**. Performance contracts provide a mechanism that allows public entities to improve facilities without using capital funds. The operational and utility savings from the project can be used to repay the financing needed to fund the project. Typically, the entire project can be financed, preserving capital funds, and if the guaranteed savings are not realized, the ESCO makes up the difference between the guaranteed and actual savings.⁵⁴

Even though performance contracting removes the necessity to pay for improvements out of capital budgets, only 6.5% of the utilities surveyed are planning to use performance contracts to implement their energy efficiency and/or cost recovery programs, despite constrained budgets.

Water utilities should thus take note: The savings and revenues described in this chapter, which can be realized by energy and water conservation projects that pay for themselves via guaranteed performance contracts, can play an important role in helping water utilities meet their infrastructure investment gap in the next 25 years. Table 9 and Table 10 detail the total savings and revenues public water systems can realize with performance contracting.

Electricity Savings in Public Water Systems

Energy plays a critical role in the treatment of water to potable standards and in its distribution throughout service areas in the Western U.S. In a typical water treatment plant, energy costs are second only to staffing costs.⁵⁵ Some studies have calculated that between 75% to 80% of all municipal water processing and distribution costs are in the electricity bill.^{56,57} Water pumping is the biggest consumer of energy in the typical city energy budget in California.⁵⁸ The Central Arizona Project, which delivers Colorado River water to the Phoenix-Tucson “Sun Corridor,” is the largest single end-user of energy in the state of Arizona.⁵⁹ In sum, there can be a lot of energy embedded in the potable water that comes out of a faucet and, thus, many opportunities for public water system managers to reduce their operational costs and save money through energy efficiency improvements.

Table 9 Summary of the potential savings with performance contracts in the public water systems of the Colorado River Basin states

	\$ (Million)	Electricity (MWh)	Natural Gas (MCF)	Water (AF)
Savings in public water systems	\$74	950,000	-	-

Table 10 Potential benefits to public water utilities by water meter replacement projects

Performance contracts can provide water utilities in the Colorado River Basin annual energy savings of nearly \$74 million through efficiency improvements, plus new revenue streams through water meter replacement projects totaling \$593 million per year.

	\$ (Million)	Water (AF)
Gross Revenue and Reductions in Apparent Water Loss	\$624	485,000
End-user Savings by Reduced Demand	(\$31)	(24,000)
<i>Net Revenue and Total Reductions in Apparent Water Loss</i>	\$593	461,000

Numerous Opportunities Exist for Energy Conservation in Public Water Systems

Energy efficiency improvements can be achieved in public water systems through numerous strategies, including:⁶⁰

- ◆ **Upgrading HVAC and lighting systems.** Public water supply providers can reduce their energy use by up to 40% with efficiency improvements in the HVAC system alone — through using high-efficiency air conditioning, utilizing controls to reduce energy use, regularly cleaning air filters, using mixed-flow impeller fans, adding programmable thermostats, and installing ventilation fans, low-emittance windows, and reflective coatings on building roofs. Lighting upgrades (e.g., occupancy sensors and replacing traditional lights with LED lights) can also provide substantial energy savings.
- ◆ **Installing renewable energy.** Solar, wind, and geothermal renewable energy technologies can be installed in public water system facilities to generate power and reduce use and costs from the energy grid.
- ◆ **Proper equipment sizing.** Pumps should be appropriate to their intended duty and flow rate because oversized pumps require extra operating, energy, and maintenance costs. Water systems are often overdesigned as a result of conservative engineering practices and planning for population growth. Sometimes population projections are not realized or are realized after the useful life of the pump.
- ◆ **Using premium efficiency motors.** From intake plants to pumping stations, electric motors play an important role throughout the water treatment and delivery process. Motor efficiency measures can be implemented with little capital expenditure, such as by maintaining ventilation and temperature control to the optimal operating conditions provided by the motor manufacturer. The replacement of inefficient motors with higher efficiency models is also a common and effective way for drinking water systems to improve their energy performance.
- ◆ **Managing energy demand.** Public water systems can achieve significant energy cost savings by, for example, avoiding the highest electricity costs by planning pumping during off-peak hours.
- ◆ **Investing in water efficiency.** Water efficiency can reduce energy use by reducing the amount of water needed to be produced, treated, distributed, and heated.

Energy Demand of Public Water Systems in the Colorado River Basin States

To calculate the current energy demand in the public water supply system, we used recent data published by the Water Research Foundation on the annual electricity spent by public water systems in the U.S. The Water Research Foundation has estimated total electricity consumption by public water systems in U.S. at 39,200 MWh.⁶¹

USGS data indicates that the public water supply volume for the Basin states represents 23.8% of the total national public water supply volume (Table 11).⁶² Accordingly, this study assumes that 23.8% of the total annual electricity usage by public water systems in the U.S. is used by the public water supply systems in the Colorado River Basin states.

Western water service areas generally have significant changes in topography from their water source to their customers, thereby requiring higher amounts of energy to pump water than other areas of the country.⁶³ Because of these large variations in elevation within many municipal water distribution systems in the West, this report's methodology likely understates the energy demand (and consequently the potential energy savings) of the public water supply systems of the Colorado River Basin states.

Table 11 Public water supply and total water withdrawal volumes in the Colorado River Basin states⁶⁴

State	Public Water Supply (Thousand AF/yr)	Total Water Withdrawals (Thousand AF/yr)
Arizona	1,360	6,820
California	7,060	42,600
Colorado	950	12,300
Nevada	651	2,940
New Mexico	318	3,540
Utah	754	5,000
Wyoming	111	5,270
Basin Total	11,204	78,470
U.S. Total	47,100	397,000
<i>Basin % of Total</i>	23.8%	19.8%

Significant Money for Public Water Systems by Realizing Energy Savings Potential

In order to calculate the potential savings, the average price of electricity in each of the Colorado River Basin states was estimated using a combination of commercial rate data from the Energy Information Administration (EIA) and electric utility rate schedules for large commercial users in select states.

EIA data did not directly corroborate with current market prices for electricity. The EIA data were higher in every market than the available real-time data. Accordingly, the study reduced the EIA rates by approximately 20% to reflect market rates. The average value of these rates was used in the calculations (see Table 12).

Using the average value of \$0.0801/kWh as the cost of electricity, multiplied by estimated public supply energy use in the Colorado River Basin states, results in a **total annual energy cost of \$745 million to operate the public water systems in the Colorado River Basin states.**

There is a wide range of energy savings that can be implemented at a public water supply system, depending on what mechanical parts of the overall system are being improved and how inefficiently the system is currently operating. Conservative estimates on efficiency gains range from 5% to 25%.⁶⁵ This study uses a 10% savings rate as a middle performance metric (see Table 13).

Table 12 Electricity prices of public water systems in the Colorado River Basin states

State	EIA Data (Cost/kWh)	Rate Schedules (Cost/kWh)	80% EIA Rate (Cost/kWh)
Arizona	\$0.0987	\$0.0760	\$0.0790
California	\$0.1457	NA	\$0.1166
Colorado	\$0.0987	\$0.0750	\$0.0789
Nevada	\$0.0903	\$0.0750	\$0.0722
New Mexico	\$0.0978	\$0.0815	\$0.0782
Utah	\$0.0837	NA	\$0.0669
Wyoming	\$0.0860	NA	\$0.0688

Table

13

Savings from energy efficiency improvement in public water systems in the Colorado River Basin states

Energy efficiency improvements via performance contracts can save more than \$74 million in the annual energy bills of public supply water systems in the Colorado River Basin states.

Electricity consumption by public water systems in U.S. (Million kWh/yr)	39,200
Basin states public water volume as % of total	23.8%
Electricity consumption by public water systems in Basin states (Million kWh/yr)	9,300
Average \$/kWh	\$0.0801
Annual electricity spent by public water system operators in Basin	\$744,859,000
Efficiency savings potential	10%
Total savings potential	\$74,485,900

Water Meter Replacement Provides Sizeable New Revenue to Water Utilities

Water meter accuracy declines over time and can result in over- or under-billing. Typically, aging meters do not read low-flow volumes correctly, resulting in significant under-billing and creating lost revenue for the water system operator. Water utilities nationally are facing a \$1 trillion infrastructure investment gap in the next 25 years.⁶⁶ Replacement of old and failing water meters with new advanced metering technology represents a foundational municipal water conservation strategy that can often provide a sizeable new source of revenue for water utilities.

A single meter that is not performing accurately can undercharge customers and cost a water utility tens of thousands of dollars in lost revenue.⁶⁷

Research commissioned by Sensus has estimated utilities worldwide can save \$12.5 billion dollars annually through more accurate meter reading and infrastructure monitoring capabilities of available smart meter networks.⁶⁸

Performance contracts can be used for the installation of automatic meter reading (AMR) and advanced metering infrastructure (AMI) technologies in public water supply service areas. AMR provides data continuously at regular intervals (e.g., every 30 minutes), and enables meter data to be read remotely and sent directly to a utility's billing system. AMI is a two-way communications network between the utility and its water meters that fully automates the meter-reading-to-billing process by linking meters, distribution sites, and control devices in a single data network that allows the utility, among other things, to pinpoint and fix leaks across the whole spectrum of the storage-distribution-end-user system.

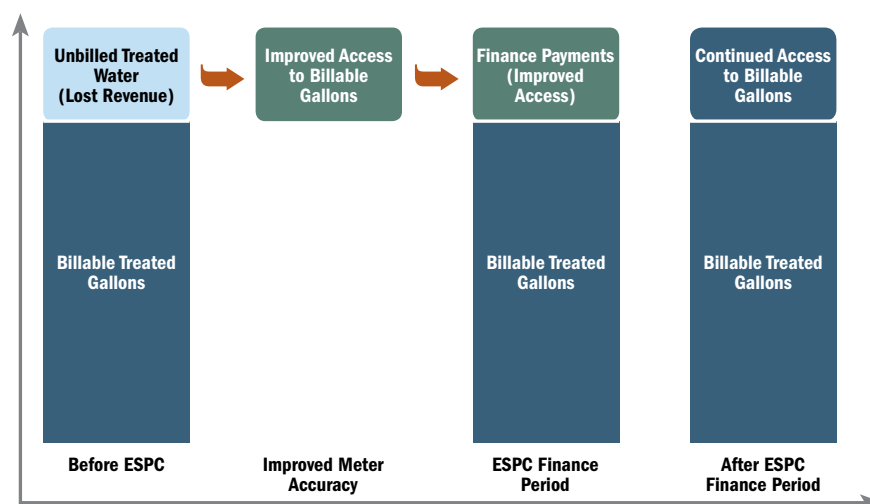
Using a 40% market adoption estimate and based on existing penetration levels of new water metering technologies, water meter replacements in the public water supply systems of the Basin states can provide water utilities with net annual revenues totaling \$593 million, while reducing apparent losses of water that is consumed but not billed by more than 461,000 acre-feet per year.

This level of meter replacement projects would also provide 24,000 acre-feet of saved water annually.

Performance Contracts and Water Meter Replacement Projects

As noted, aging meters do not read low-flow volumes correctly, resulting in significant under-billing and creating lost revenue for the water system operator (see Figure 14). In water meter replacement projects implemented with performance contracts, ESCOs guarantee the accuracy of the meters. The improved accuracy typically results in higher revenues by reducing the total volume of potable water that is not being billed by old, inaccurate water meters.

Figure 14 Project cycle of a performance contract water meter replacement project



A typical water meter replacement project begins with developing a 3- to 5-year baseline calculation of the volume of potable water that is not being billed as a result of inaccurate metering. This involves meter testing and a statistical sampling of a service area's meters using American Water Works Association standards. Based on this information, the ESCO then calculates the improved access to billable gallons of a meter replacement project, guaranteeing the accuracy of the water meters installed. Throughout the term of the contract, the ESCO covers any shortfall in revenue resulting from the new meters not performing to the level of accuracy that was guaranteed. The new revenue generated by the meter replacement project can be used to pay for the project. After the contract ends, all additional and subsequent cost savings and revenue resulting from the upgraded metering system accrues to the public entity.

Water Meter Replacement Opportunities in the Colorado River Basin States

The lifetime of traditional water meters is predicated by accuracy, with most water utilities using a range of 10 and 20 years for meter replacement due to the perception of decreasing meter accuracy with length of service.⁶⁹ It has been estimated that public water supply systems in the United States will need to spend \$97 billion for water loss control in the coming decades.⁷⁰ According to the American Water Works Association, the average water loss in Public Water Systems in the U.S. is 16%. When the City of Santa Maria, Calif., converted to advanced metering infrastructure, it was able to reduce its water losses to 2%.⁷¹

California is illustrative of water metering opportunities in the Colorado River Basin states, since it represents 65% of the total potential water meter market size of the Basin states (see Table 14) and is also considered a bellwether for water conservation policies.

In 2010, the Association of California Water Agencies conducted a large survey on automatic meter reading/advanced metering infrastructure with water agencies in the state. This survey found that more than half of water agencies in California have installed some amount of automatic meter reading technology, but that 40% of these have this technology installed in less than 10% of their systems. A full 75% of the utilities that participated in this survey also stated that they are considering or already have plans to evaluate or install automatic meter reading in their systems.⁷²

Over \$590 Million in New Annual Revenue for Water Utilities in the Basin States Through Water Meter Replacement Projects

This study estimates that water meter replacement projects via performance contracting can provide water utilities in the Colorado River Basin states with a significant source of revenue, while facilitating water savings and large reductions in apparent losses of water that is being consumed but not billed because of inaccurate water meters. These estimates are based on water withdrawal volumes for the public water supply published by the USGS.⁷³ These volumes were first multiplied by proxy water rates for each Basin state

to arrive at a total market value.⁷⁴ A 40% market adoption rate was assumed, taking into account existing systems and unmetered systems. The resulting value was multiplied against the average increase in billable water. These rates can range from 5% to 15%, depending on the age of the existing meters. With 40% market penetration of newer water meters across the Colorado River Basin states and 10% increase in revenues from more accurate billing, **water system operators in the Basin states would generate annually \$593 million in net revenue and reduce apparent water loss by 461,000 acre-feet per year.**

Basic economics plays a part in inspiring consumers to use less water once accurate meters are installed. When new meters are installed, users are likely to see their water bill increase as a result of the more accurate billing. Users then reduce consumption slightly in order to reduce associated cost. A comprehensive study on user behavior points to a 5% reduction in consumption that can be achieved when smart water meters are used together with water conservation communication campaigns.⁷⁵ This study assumes that, in the absence of a water conservation campaign, a 0.5% reduction in actual use will nonetheless occur when one's water meter is reading and billing accurately. A 0.5% reduction in use could save commercial, residential, and government consumers \$31 million in their bills.

Table 14 below shows the estimated water savings and revenue that water utilities in the each Basin state can realize with water meter replacement efforts implemented with performance contracts.

Table

14

Revenue increase, reductions in apparent water loss, and water savings potential from new water meter replacement projects in the Colorado River Basin states

State	Total Water Meter Market Size		Market Adoption	Potential Market Size		Increase in Revenue with 10% Increase in Billable Water		End-User Savings with 0.5% Total Consumption Reduction	
	\$ (Million)	Water (AF)		\$ (Million)	Water (AF)	\$ (Million)	Water (AF)	\$ (Million)	Water (AF)
Arizona	\$1,400	979,000	40%	\$560	587,000	\$56	59,000	\$3	2,950
California	\$11,500	5,083,000	40%	\$4,600	3,050,000	\$460	305,000	\$23	15,250
Colorado	\$900	684,000	40%	\$360	410,000	\$36	41,000	\$2	2,050
Nevada	\$800	469,000	40%	\$320	281,000	\$32	28,000	\$2	1,400
NewMexico	\$300	229,000	40%	\$120	137,000	\$12	14,000	\$1	700
Utah	\$600	543,000	40%	\$240	326,000	\$24	33,000	\$1	1,650
Wyoming	\$100	80,000	40%	\$40	48,000	\$4	5,000	-	250
<i>Total</i>	\$15,600	8,067,000		\$6,240	4,839,000	\$624	485,000	\$32	24,250

Benefits of New Water Meter Technologies

New smart metering technologies can significantly increase the amount of information regarding who is using the public water supply, when, and how much. This information, in turn, is critically important to design tailor-made, effective conservation programs for service areas, to effectively enforce critically important, mandatory water use restrictions due to drought, and to minimize system and customer water losses. Use of more accurate, real-time data communicated through wireless technology is a game-changer that enables water utilities to detect and react to issues from anywhere within the system. Automatic meter reading/advanced metering infrastructure meters have the following benefits:⁷⁶

- ◆ Increase revenue by reducing apparent losses of water that is consumed but not billed through more accurate meters
- ◆ Reduce meter-reading costs by eliminating the need to read meters on each customer's premises
- ◆ Facilitate rapid and accurate leak detection throughout the system and at the consumer level
- ◆ Significantly improve the billing process and customer service
- ◆ Increase safety and security for utility personnel (by reducing road accidents and meter-reading-related injuries in customer premises)
- ◆ Provide an extraordinary amount of data regarding water use quantities and time of use that can significantly enhance water conservation programs, from customer education to drought restrictions compliance monitoring and enforcement



Moving Forward With Performance Contracts: *The Colorado River Basin Water Supply Imbalance*

Performance contracts and ESCOs can help advance 80% of the Major Opportunities and almost half of the 51 Potential Actions identified for the municipal sector in the Moving Forward Phase 1 report.

In 2012, the Bureau of Reclamation, in collaboration with representatives of the seven Colorado River Basin states, published the Colorado River Basin Water Supply and Demand Study — the most comprehensive study of future supplies and demands on the Colorado River ever undertaken.⁷⁷ The study estimated that Colorado River water users will face average imbalances of 1 trillion gallons of water per year within the next 50 years, and developed and analyzed strategies to proactively help meet the gap between Colorado River water supply and demand.⁷⁸

In response to the findings of this Basin Study, the Bureau of Reclamation, the Basin States, and other stakeholders initiated in 2013 the Moving Forward effort, which is being conducted in a phased approach.⁷⁹ Phase 1 initiated three multi-stakeholder workgroups:

- ◆ Municipal and Industrial (M&I) Water Conservation and Reuse
- ◆ Agricultural Water Conservation, Productivity, and Transfers
- ◆ Environmental and Recreational Flows

The ultimate goal of each workgroup and the Phase 1 Moving Forward effort is to identify actionable steps to address water shortages in the future, in ways that have broad-based support and provide a wide range of benefits.⁸⁰

ESCOs have the expertise and the capacity to advance almost all of the major water conservation opportunities identified by the M&I Water Conservation and Reuse working group (see Table 15). These opportunities not only have broad-based support and would provide a wide range of benefits, but they can also be implemented with performance contract projects that pay for themselves, guaranteed. This speaks for the need for a Phase II pilot project to demonstrate how performance contracting can be used to accelerate the large-scale deployment of some of the identified Potential Actions with projects that are budget-neutral and provide robust monitoring and verification.

Appendix A provides a more detailed table with the specific Potential Actions that can be advanced with performance contracts and ESCOs.

Table 15 Performance contracts, ESCOs, and Potential Actions Identified by Bureau of Reclamation's Moving Forward Phase I Report

Major Opportunity	Number of Potential Actions That Could Be Advanced With Performance Contracts and ESCOs	Total Number of Potential Actions
1. Increase outdoor water efficiency through technology improvements and behavior change, and increase the adoption of low-water-use landscapes.	1	5
2. Increase the end-user understanding of individual, community, and regional water use.	4	5
3. Increase the integration of water- and energy-efficiency programs and resource planning.	3	4
4. Expand local and state goal-setting and tracking to assist providers in structuring programs.	2	3
5. Increase funding for water use efficiency and reuse.	2	5
6. Increase integration of water and land use planning.	0	5
7. Develop and expand resources to assist water providers in water conservation efforts.	2	7
8. Implement measures to reduce system water loss with specific metrics and benchmarking.	4	5
9. Increase commercial, institutional, and industrial water-use efficiency and reuse through targeted outreach and partnerships.	2	4
10. Expand adoption of conservation-oriented rates and incentives.	3	4
11. Expand adoption of regulations and ordinances to increase water efficiency and reuse.	0	4
<i>Total</i>	23	51
<i>Total number of Major Opportunities</i> 11		
<i>Major Opportunities that performance contracts and ESCOs can help realize</i> 9		

CHAPTER HIGHLIGHTS

- ◆ Performance contracts can provide \$593 million in net revenue and nearly \$75 million in energy savings to water providers in the Basin states that are facing significant budget constraints and infrastructure investment challenges.
- ◆ There is significant untapped potential in the seven Colorado River Basin states to implement efficiency and water management systems.
- ◆ Water meter replacement projects can help water-scarce, drought-prone communities in the Colorado River Basin states reduce apparent losses of water that is being consumed but not billed by 461,000 acre-feet per year, while also providing a continuous trove of data that would allow water utilities to design, prioritize, and implement water conservation programs and incentives that are tailor-made to the particular needs of their service area.
- ◆ The financial and water conservation benefits available to water utilities from performance contracts make a compelling case for water utility managers to get better acquainted with, and increase their investment in, performance contracting projects in the Basin states.



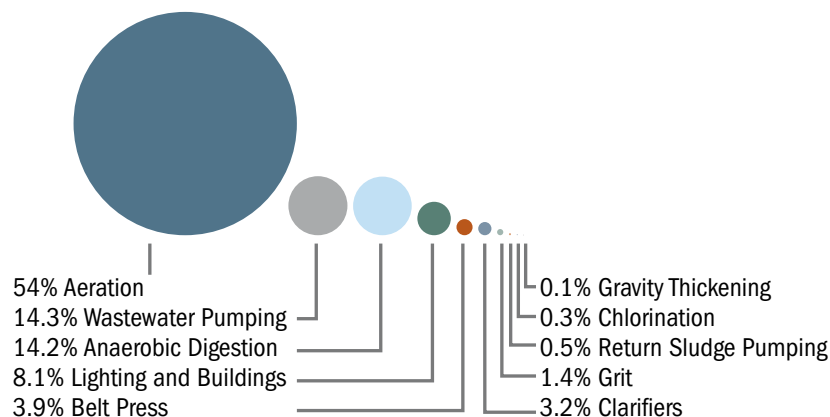
Chapter 5: Wastewater Treatment Plants

Wastewater management encompasses a broad range of processes, devices, and structures to treat and dispose of wastewater to protect public health and local watersheds. Although great variation may exist among water treatment plants with regards to equipment and treatment process used, energy is typically required in all stages of the treatment process, from the collection of raw sewage to the discharge of the treated effluent.⁸¹ These energy costs can be substantial, covering, on average, about one-third of the total operation and maintenance costs of wastewater treatment facilities.⁸² In the next 40 years, the substantial electricity bills in wastewater treatment facilities are expected to increase by at least 40%, mainly as a result of more stringent water quality regulations and a higher volume of wastewater driven by population growth.⁸³ Other factors will likely contribute to an increase in energy costs, including:⁸⁴

- ◆ Enhanced treatment of biosolids, including drying/pelletizing requiring additional energy
- ◆ Aging wastewater collection systems that result in additional inflow and infiltration, leading to higher pumping and treatment costs
- ◆ Increase in electricity rates due to development of new energy resources, increased investment in transmission and distribution infrastructure, rising requirements to generate electricity from renewable energy sources, and utility investment in demand-side efficiency⁸⁵

Pumping and aeration typically represent the largest energy uses in the wastewater treatment process (see Figure 15).⁸⁶

Figure 15 Energy used in wastewater treatment.⁸⁷



Opportunities for Energy Savings in Wastewater Treatment Plants

Because wastewater treatment facilities are not primarily designed around energy efficiency concerns, these facilities are often overlooked when communities evaluate investing in energy efficiency projects.⁸⁸ The substantial energy costs incurred by these facilities can be significantly reduced by implementing available energy conservation measures, including:

- ◆ Installing lighting, HVAC, and other building retrofit improvements that reduce energy use
- ◆ Installing high-efficiency pumps, motors, and aerators
- ◆ Reducing the load of organic waste entering the wastewater facility through water conservation
- ◆ Enhancing monitoring and operation control through Supervisory Control and Data Acquisition software for energy use optimization and immediate detection (and fast resolution) of energy-efficiency-related problems
- ◆ Developing waste to energy systems that use biogas to generate electricity and heat
- ◆ Turning wastewater into a revenue stream by converting sewer waste into high-quality fertilizer
- ◆ Implementing other energy management strategies, such as real-time power monitoring, peak electric demand reduction, and submetering, to identify and better manage the most energy-intensive processes

Measuring Reductions in Energy Use

Available data on wastewater treatment plants in the Colorado River Basin states is highly fragmented and incomplete.⁸⁹ Reconciling the different data sources required a substantial research effort that was not within the scope of this project. However, the savings potential calculated, which used a low estimate of the number of wastewater treatment plants, demonstrates that significant energy savings can be achieved in wastewater treatment plants through performance contracts and that a broader study effort would thus be warranted. Additionally, the lack of clear and consistent data from all wastewater treatment plants represents a need for policies to require better transparency and reporting for the industry as a whole.

Methodology

As with public water supply systems, wastewater systems have a wide range of energy-savings opportunities. Depending on the mechanical system improved, efficiency projects in wastewater treatment plants can yield savings from 5% to 30%. This study uses 15% savings as a conservative value for calculations.⁹⁰

Data from the American Biogas Council and the U.S. Environmental Protection Agency (EPA) was used to produce an estimate on the number of plants. Using resources from the Water Environment Resource Foundation and EPA, the average amount of electricity required to treat and process wastewater was calculated. The results from this research were corroborated by the technical resources of private performance contracting service companies and engineering consulting firms. The final research results in a better understanding of the wastewater treatment plant processes that consume the greatest amount of electricity — aerators, blowers, mixers, and pumps — and that thus could provide the ripest opportunities for energy savings.

Using electricity price estimates for public supply systems, **reducing electricity demand in wastewater treatment plants in the Basin states by 15% with performance contracts would result in annual cost savings of \$35 million** (see Table 16).

Table

16

Potential electricity savings in wastewater treatment plants by performance contracts in the Colorado River Basin states

	\$ (Million)	Electricity (mWh)	Natural Gas (MCF)	Water (AF)
Electrical conservation in public wastewater treatment	\$35	350,000	-	-

The methodology used to calculate these savings pulls data from several sources. First, as noted above, the number of wastewater treatment plants in the Colorado River Basin states was estimated, as was the daily water flow, measured in millions gallons/day (MGD). As wastewater treatment plants operate continuously, this MGD value was multiplied by 365 to arrive at an annual water flow estimate. This number was multiplied by an EPA-generated value of the amount of energy (in MWh) used to process a million gallons (MG). Taking the amount of energy typically used for aeration and pumping (68% of the total wastewater treatment process energy use) and applying a savings estimate of 15% produces the amount of potential energy and cost savings (see Table 17).

Table 17 Annual energy savings from wastewater treatment plant efficiency improvements in the Colorado River Basin states

Wastewater treatment plants in the Colorado River Basin states can save nearly \$35 million every year in energy bills with performance contracts.

Low estimate of wastewater treatment plants	665
Daily flow at wastewater treatment plants	4,619
Annual flow (MGD)	1,686,000
Million gallons/MWh	2.0
Energy consumption by wastewater treatment plants (MWh)	3,372,000
Total electricity consumed by aeration and pumping (%)	68%
Total electricity consumed by aeration and pumping (MWh)	2,306,000
Efficiency savings potential (%)	15%
Efficiency savings potential (MWh)	345,900
Average cost of power (\$/MWh)	\$100
<i>Annual energy savings potential</i>	\$34,590,000

CHAPTER HIGHLIGHTS

- ◆ On average, energy utility bills represent about one-third of the total operation and maintenance costs of wastewater treatment facilities.
- ◆ Energy efficiency improvements through performance contracts can save wastewater treatment plants in the Colorado River Basin states \$35 million per year.
- ◆ This energy savings estimate is conservative, for it does not account for significant additional energy use in wastewater treatment plants in the future due to more stringent water quality regulations and a higher volume of wastewater driven by population growth.
- ◆ New policies should be developed and implemented to require better transparency and reporting for the wastewater industry as a whole.



Chapter 6: Conclusion

The states that make up the Colorado River Basin share significant water scarcity and natural resource challenges. Each state needs to find ways to reduce energy, natural gas, and water use, and each state needs to reduce spending on increasingly costly public infrastructure in the face of a constrained fiscal outlook.

Performance contracts are a powerful tool that can help create substantial water and energy savings. After sizing the market opportunities in public facilities, public water supplies, and wastewater treatment plants, this study finds over \$850 million in potential savings that the performance contracting approach can deliver.

This opportunity is too great to relegate to an afterthought. The seven Colorado River Basin states, together with local governments and the federal government, must look into the performance contracting potential in all public facilities and work closely with local communities, the ESCO industry, the banking sector, and nonprofits to fully realize the benefits of performance contracting. To do this, we specifically recommend that:

- ◆ All schools (from K–12 to higher education), state agencies, counties, municipalities, and special districts in the water-scarce West should evaluate whether performance contracting could save operational costs while conserving water and energy.
- ◆ Governors and state legislators should find ways to spur full market penetration of performance contracts to drive economic development in order to attain clean air and water conservation goals.
- ◆ States should invest in robust state performance contract programs that use established best practices for performance contracting, including those for qualification of energy service companies, measurement and verification standards, and ongoing reporting.

- ◆ All Basin states should ensure their performance-contracting-enabling legislation allows the upgrading of water meters using performance contracts to enhance water utility revenues from more accurate measurements, advance water conservation, and promote drought preparedness.
- ◆ The Basin states need to provide strong technical support and best practices guidance for water meter replacement projects implemented through performance contracting.
- ◆ Federal and state funding measures and programs that support the replacement of aging infrastructure should incentivize the use of budget-neutral tools like performance contracting.
- ◆ Energy and water utilities should consult with federal, regional, and state regulatory bodies to develop collaborative efficiency programs, and coordinate with and use ESCOs for large-scale deployment of joint incentives and synergistic programs.

Appendix A:

Performance Contracts and Potential Actions Identified in the Bureau of Reclamation's Moving Forward Phase I Report

Major Opportunity: Increase outdoor water efficiency through technology improvements and behavior change, and increase the adoption of low-water-use landscapes.

- ◆ **POTENTIAL ACTION:** Expand social norming and budget-based pricing to reduce or improve the efficiency of outdoor water use of the most inefficient and largest users.
COMMENT: Studies on user behavior point to a 5% reduction in consumption that can be achieved when smart water meters are used together with social norming types of water conservation programs.⁹¹

Major Opportunity: Increase the end-user understanding of individual, community, and regional water use.

- ◆ **POTENTIAL ACTION:** Promote adoption of advanced metering infrastructure technology in each major metropolitan area to improve data collection, understanding of demand trends, identification of high water use, and leak detection, plus to facilitate improved feedback to customers regarding their water use.
- ◆ **POTENTIAL ACTION:** Expand application of social norming (providing customers with water use information, comparisons, and possible reduction measures) to reduce water use.
COMMENT: Studies on user behavior point to a 5% reduction in consumption that can be achieved when smart water meters are used together with social norming types of water conservation programs.
- ◆ **POTENTIAL ACTION:** Speed implementation towards 100% metering.
- ◆ **POTENTIAL ACTION:** Provide funding and financial support for additional water conservation staff at water agencies.
COMMENT: Water and energy retrofit projects, plus water meter replacement projects, can free up and generate millions of dollars for water utilities in savings and revenue that can be used to help fund and support additional water conservation staff.

Major Opportunity: Increase the integration of water- and energy-efficiency programs and resource planning.

- ◆ **POTENTIAL ACTION:** Improve integration of federal and state water and energy programs that are simultaneously attempting to conserve resources.
COMMENT: ESCOs, state performance contract programs, and the Federal Energy Management Program (which already has a performance contracting and water program) can play an important role in achieving this action.
- ◆ **POTENTIAL ACTION:** Develop partnerships between water and energy utilities, and their respective regulatory bodies, on synergistic programs, rebates and incentives, and customer outreach to more effectively target customers.
COMMENTS: ESCOs have achieved about the same amount of energy efficiency investments as energy utilities in the U.S., as well as play a key role in identifying large energy- and water-use clients and in deploying rebates and incentives. They also provide rigorous M&V to these rebates and incentives. Accordingly, ESCOs can play an important role in identifying clients for, and deploying efficiency rebates and incentives (with M&V) to, synergistic partnerships.
- ◆ **POTENTIAL ACTION:** Document the financial, water, and energy benefits realized when water and energy conservation programs are integrated.
COMMENT: Because performance contract guarantees hinge on performance and M&V, and ESCOs have been doing both energy and water retrofits for decades, this industry has the capacity and expertise to help do this action at all scales.

Major Opportunity: Increase funding for water use efficiency and reuse.

- ◆ **POTENTIAL ACTION:** Document and publicize innovative funding and financing programs, including public-private partnerships to provide incentives or funding of conservation programs.
COMMENT: Performance contracting is a very good fit for this action.

- ◆ **POTENTIAL ACTION:** Explore funding mechanisms to help providers minimize system water losses.
COMMENT: Performance contracting is a very good fit for this action, specifically with regards to implementing water meter replacement projects that pay for themselves and reduce water losses, apparent and real.

Major Opportunity: Develop and expand resources to assist water providers in water conservation efforts.

- ◆ **POTENTIAL ACTION:** Support water providers to develop standard methods to quantify, monitor, and evaluate water conservation measures with respect to actual savings.
COMMENT: See M&V comments above.
- ◆ **POTENTIAL ACTION:** Encourage providers to adopt AWWA standards for water conservation programs, integrated water resource planning, and water loss management.
COMMENT: Water meter replacement projects via performance contracts use AWWA water-loss-management methodologies and protocols.

Major Opportunity: Implement measures to reduce system water loss with specific metrics and benchmarking.

- ◆ **POTENTIAL ACTION:** Promote advanced metering infrastructure.
- ◆ **POTENTIAL ACTION:** Speed implementation towards 100% metering and automated meters.
- ◆ **POTENTIAL ACTION:** Encourage providers to adopt AWWA standards for water conservation programs, integrated water resource planning, and water loss management.
COMMENT: Water meter replacement projects via performance contracts use AWWA water-loss-management methodologies and protocols.
- ◆ **POTENTIAL ACTION:** Implement funding measures to accelerate asset management programs and replace aging infrastructure.
COMMENT: Performance contracting is a powerful tool that can be used to help achieve this.

Major Opportunity: Increase commercial, institutional, and industrial water use efficiency and reuse through targeted outreach and partnerships.

- ◆ **POTENTIAL ACTION:** Promote the development of a greener industrial sector with reuse pilot projects with short payback periods.
COMMENT: ESCOs are probably the industry with the most capacity and expertise to do comprehensive “green” projects with large water users that pay for themselves.
- ◆ **POTENTIAL ACTION:** Improve understanding of cost-effective water-use efficiency measures through consistent documentation and measurement of specific best practices applicable for different types of industries and regions.
COMMENT: ESCOs can play an important role in documenting and educating about the different cost-effective water-use efficiency measures that pay for themselves.

Major Opportunity: Expand adoption of conservation-oriented rates and incentives.

- ◆ **POTENTIAL ACTION:** Encourage the application of conservation-oriented rate structures (tiered or budget-based) that incentivize water use efficiency, while ensuring revenue stability, avoiding negative impacts, and accounting for public preferences.
COMMENT: Water meter replacement projects that pay for themselves by more accurate billing optimize water rate structures and can provide significant support (through net new revenue streams) with regards to revenue stability, avoiding negative impacts, and understanding public preferences.
- ◆ **POTENTIAL ACTION:** Increase the awareness of successful and unsuccessful approaches for implementation of conservation-oriented rate structures among water providers receiving Colorado River water.
COMMENT: Optimizing conservation-oriented rate structures with more accurate billing through water meter replacement projects is part of the educational/sales outreach messaging not only of the water meter companies (e.g., white papers and case studies), but also of a sophisticated, water-focused ESCO industry — a goal worth pursuing.
POTENTIAL Action: Implement innovative funding programs to provide incentives or funding of conservation programs.
COMMENT: Performance contracting is a powerful tool that can be used to help achieve this.

End Notes

1. Earth Economics. 2014. *Nature's Value in the Colorado River Basin*. Tacoma, Wash. May.
2. Summit Technologies, Inc. 2015. "Lake Mead Water Database." Accessed May 13, 2015. <http://lakemead.water-data.com>.
3. U.S. Department of the Interior, Bureau of Reclamation. 2012. *Colorado River Basin Water Supply and Demand Study*, Figure 12, Historical Supply and Use and Projected Future Colorado River Basin Water Supply and Demand, SR-34. http://www.usbr.gov/lc/region/programs/crbstudy/finalreport/Study%20Report/CRBS_Study_Report_FINAL.pdf.
4. Cook, E.R., R. Seager, M.A. Cane, and D.W. Stahle. 2007. "North American Drought: Reconstructions, Causes, and Consequences." *Earth Science Reviews* 81: 93–134.
5. Stine, S. 1994. "Extreme and Persistent Drought in California and Patagonia During Mediaeval Time." *Nature* 369: 546–549.
6. Hughes, M.K., and G. Funkhouser. 1998. "Extremes of Moisture Availability Reconstructed From Tree Rings for Recent Millennia in the Great Basin of Western North America." In *The Impacts of Climate Variability on Forests*, edited by M. Beniston and J. L. Innes, pp. 99–107. New York: Springer.
7. Benson, L., M. Kashgarian, R. Rye, S. Lund, F. Paillet, J. Smoot, C. Kester, S. Mensing, D. Meko, and S. Lindstrom. 2002. "Holocene Multidecadal and Multicentennial Droughts Affecting Northern California and Nevada." *Quaternary Science Reviews* 21: 659–682.
8. Cook, E.R., C. Woodhouse, C.M. Eakin, D.M. Meko, and D.W. Stahle. 2004. "Long-Term Aridity Changes in the Western United States." *Science* 306 (5698): 1015–1018.
9. Cook, B.I., T.R. Ault, and J.E. Smerdon. 2015. "Unprecedented 21st Century Drought Risk in the American Southwest and Central Plains." *Science Advances* 1 (1): e1400082.
10. Krieger, L. 2014. "California Drought: San Joaquin Valley Sinking as Farmers Race to Tap Aquifer." *San Jose Mercury News*, March 29.
11. World Economic Forum. 2015. *Global Risks 2015*, 10th Edition. Geneva, Switzerland.
12. Ibid.
13. U.S. Department of the Interior, Bureau of Reclamation. 2015. *Colorado River Basin Stakeholders Moving Forward to Address Challenges Identified in the Colorado River Basin Water Supply and Demand Study*. Phase I Report: Executive Summary. May.
14. American Water Works Association. 2012. *Buried No Longer: Confronting America's Water Infrastructure Challenge*. Denver, Colo.
15. ICF International. 2007. *Introduction to Energy Performance Contracting*. Prepared for U.S. Environmental Protection Agency, ENERGY STAR Buildings. October.
16. Ibid.
17. State of Idaho. 2008. *Guide to Energy Performance Contracting: A Guide to Implementing Energy Efficiency Retrofits That Will Upgrade Facility Infrastructure and Reduce Energy Consumption and Facility Operations and Maintenance Costs*. August.
18. Alabama Department of Economic and Community Affairs, Energy Division. 2010. *Alabama Energy Performance Contracting Guide*. October.
19. State of Idaho. 2008. *Guide to Energy Performance Contracting: A Guide to Implementing Energy Efficiency Retrofits That Will Upgrade Facility Infrastructure and Reduce Energy Consumption and Facility Operations and Maintenance Costs*. August.
20. Ibid.
21. Shonder, J. 2013. *Beyond Guaranteed Savings: Additional Cost Savings Associated with ESPC Projects*. Prepared by Oak Ridge National Laboratory for the U.S. Department of Energy. Report ORNL/TM-2013/108. March.
22. Alabama Department of Economic and Community Affairs, Energy Division. 2010. *Alabama Energy Performance Contracting Guide*. October.
23. Shonder, J. 2013. *Beyond Guaranteed Savings: Additional Cost Savings Associated with ESPC Projects*. Prepared by Oak Ridge National Laboratory for the U.S. Department of Energy. Report ORNL/TM-2013/108. March.
24. Bayer, C.W., S.A. Crow, and J. Fischer. 2000. *Causes of Indoor Air Quality Problems in Schools: Survey of Scientific Research*. Prepared by Oak Ridge National Laboratory for the U.S. Department of Energy. January.
25. Redding, Y.S., and J. Harrison. 1999. "Indoor Air Quality and Performance Contracting in Schools in the U.S." In *Proceedings Indoor Air 1999* 1:13–17. Paper presented at the 8th International Conference on Indoor Air Quality and Climate, Edinburgh, Scotland, August 8–13.

26. Smedje, G., and D. Norback. 2000. "New Ventilation Systems at Select Schools in Sweden — Effects on Asthma and Exposure." *Archives of Environmental Health* 55 (1): 18–25.
27. National Association of Energy Companies. 2015. Summary of Deliverables Achieved by Energy Service Companies Since 1990. Available at <http://www.naesco.org>.
28. D&R International, Ltd, Pacific Northwest National Laboratory. 2012. 2011 Buildings Energy Data Book. Prepared for U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Buildings Technologies Program. March.
29. Deru, M., K. Field, D. Studer, K. Benne, B. Griffith, P. Torcellini, B. Liu, M. Halverson, D. Winiarski, M. Rosenberg, M. Yazdani, J. Huang, and D. Crawley. 2011. U.S. Department of Energy Commercial Reference Building Models of the National Building Stock. National Renewable Energy Laboratory Technical Report, NREL/TP-5500-46861. February.
30. The data used from the Commercial Reference Building Models of the National Building Stock uses the following reference cities from the Colorado River Basin states: Phoenix, Ariz., Los Angeles, Calif., Las Vegas, N.V., San Francisco, Calif., Albuquerque, N.M., and Boulder, Colo.
31. Larsen, P.H., C.A. Goldman, and A. Satchwell. 2012. Evolution of the U.S. Energy Service Company Industry: Market Size and Project Performance From 1990–2008. U.S. Department of Energy, Lawrence Berkeley National Laboratory, Report LBNL-5447E. July.
32. Ibid.
33. Ibid.
34. Ibid.
35. U.S. Department of Energy, Energy Information Administration. 2015. "EIA Electricity Sales Database." Accessed February 10, 2015. Available at <http://www.eia.gov/electricity>.
36. D&R International, Ltd, Pacific Northwest National Laboratory. 2012. 2011 Buildings Energy Data Book, pg. 114. Prepared for U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Buildings Technologies Program. March.
37. U.S. Department of Energy, Energy Information Administration. 2015. "EIA Electricity Sales Database." Accessed February 18, 2015. Available at <http://www.eia.gov/electricity>.
38. Stuart, E., P.H. Larsen, C.A. Goldman, and D. Gilligan. 2013. Current Size and Remaining Potential of the U.S. Energy Service Company Industry. U.S. Department of Energy, Lawrence Berkeley National Laboratory, Report LBNL-6300E. September.
39. Ibid.
40. Maupin, M.A., J.F. Kenny, S.S. Hutson, J.K. Lovelace, N.L. Barber, and K.S. Linsey. 2014. Estimated Use of Water in the United States in 2010. U.S. Geological Survey Circular 1405. Available at <http://dx.doi.org/10.3133/cir1405>.
41. Using data from the 2005 USGS report for each of the Colorado River Basin states, the total amount of public supply withdrawals was reduced by 85% to reflect the 15% representation of the commercial sector in overall public supply. To get the water demand from public facilities, the total public water supply was further reduced by 76% to reflect the 24% of government-owned buildings out of total building stock. For the 24% government-owned building assumption, see: D&R International, Ltd, Pacific Northwest National Laboratory. 2012. 2011 Buildings Energy Data Book. Prepared for U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Buildings Technologies Program. March.
42. For purposes of this study, we use the USGS definition of public supply, which refers to water withdrawn by public and private water suppliers that provide water to at least 25 people or have a minimum of 15 connections. Public supply water is delivered for public services and domestic, commercial, and industrial uses.
43. Water rates may vary significantly within and across the Basin states. The current 2-inch meter nonresidential water rates from the largest water providers of each Basin state were selected as a reasonable proxy for the institutional sector in each Basin state. The water rates used for each basin state came from the following: Los Angeles Department of Water and Power and City of San Diego (California); City of Phoenix and City of Tucson (Arizona); Salt Lake City (Utah); City of Denver and City of Colorado Springs (Colorado); Las Vegas Valley Water District (Nevada); Albuquerque Bernalillo County Water Utility Authority (New Mexico); and City of Cheyenne (Wyoming). Because these service areas represent most of the urban water use of Colorado River water in the Colorado River Basin states, together with the expected water rate escalation across service areas in the Basin states in the coming decades, we believe that they represent a reasonable proxy for the Basin states. Western Resource Advocates compiled the current water rate information from the utility websites and, when clarification was warranted, confirmed the water rates with utility officials via phone conversations.
44. For water rates, see note 43.
45. Maupin, M.A., J.F. Kenny, S.S. Hutson, J.K. Lovelace, N.L. Barber, and K.S. Linsey. 2014. Estimated Use of Water in the United States in 2010. U.S. Geological Survey Circular 1405. Available at <http://dx.doi.org/10.3133/cir1405>.
46. This graph was created by the U.S. Environmental Protection Agency, analyzing data from New Mexico Office of the State Engineer, American Water Works Association, AWWA Research Foundation, and the East Bay Municipal Utility District. See: U.S. Environmental Protection Agency. 2012. "Saving Water in Office Buildings." Water Sense Fact Sheet, EPA-832-F-12-032. November.

47. Ibid.
48. U.S. President. 2015. "Executive Order — Planning for Federal Sustainability in the Next Decade." March 19.
49. This estimate does not take into consideration sewer bills, but even taking these into account, energy costs would still generally represent the bulk of the combined energy and water bills of public buildings.
50. All of the information in this sidebar comes from: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Federal Energy Management Program. 2015. "Water Efficiency and ESPCs." FEMP Fact Sheet, PNNL-SA-109658. http://energy.gov/sites/prod/files/2015/06/f23/water_efficiency_espcs.pdf.
51. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Federal Energy Management Program. 2013. "Funding Federal Energy and Water Projects." FEMP Fact Sheet, DOE/EE-0943. July.
52. This study uses the USGS definition of public supply, which refers to water withdrawn by public and private water suppliers that provide potable water to at least 25 people or have a minimum of 15 connections.
53. American Water Works Association. 2012. *Buried No Longer: Confronting America's Water Infrastructure Challenge*. Denver, Colo.
54. Black & Veatch. 2014. *2014 Strategic Directions: U.S. Water Industry*. Overland Park, Kan.
55. Biel, W.H., and J.A. Inman. 2010. "Energy Optimization for Water Systems." *Journal - American Water Works Association* 102 (6): 50–55.
56. Powicki, C. 2002. "The Water Imperative." *Electric Power Research Institute Journal*. July.
57. Electric Power Research Institute. 2002. *Water & Sustainability (Volume 4): U.S. Electricity Consumption for the Water Supply & Treatment – The Next Half Century*. Topical Report 1006787. Prepared by ICF Consulting under contract to the Electric Power Research Institute. Palo Alto, Calif.: EPRI. March.
58. Means, E., McGuire Environmental Consultants. 2004. *Water and Wastewater Industry Energy Efficiency: A Research Roadmap*. Jointly sponsored by AWWA Research Foundation and the California Energy Commission. Denver, Colo.: AWWA Research Foundation.
59. Central Arizona Project website. Accessed April 7, 2015. <http://www.cap-az.com>.
60. U.S. Environmental Protection Agency, Office of Water. 2013. *Strategies for Saving Energy at Public Water Systems*. EPA 816-F-13-004. July.
61. Pabi, S., A. Amarnath, R. Goldstein, and L. Reekie. 2013. *Electricity Use and Management in the Municipal Water Supply and Wastewater Industries*. Report 3002001433. Prepared by EnerNOC, Inc. and Washington University under contract to the Electric Power Research Institute and jointly sponsored by Water Research Foundation. Palo Alto, Calif.: EPRI. November.
62. Kenny, J.F., N.L. Barber, S.S. Hutson, K.S. Linsey, J.K. Lovelace, and M.A. Maupin. 2009. *Estimated Use of Water in the United States in 2005*. U.S. Geological Survey Circular 1344. October.
63. There are exceptions to this generalization. In Colorado, the amount of energy used by water utilities varies dramatically. Front Range water utilities like Denver Water and Fort Collins Water Utility, which rely on gravity-fed supplies, use minor amounts of energy to treat and deliver water to their customers. Utilities in the South Metro area, in contrast, use substantial amounts of energy to pump groundwater from the Denver Basin aquifers. See: Western Resource Advocates. 2009. *Water Conservation = Energy Conservation: A Report for the CWCB*. Prepared for the Colorado Water Conservation Board. Boulder, Colo. June.
64. Ibid.
65. U.S. Environmental Protection Agency, Office of Water. 2013. *Strategies for Saving Energy at Public Water Systems*. EPA 816-F-13-004. July.
66. For the water infrastructure investment gap estimates for the next 25 years, see: American Water Works Association. 2012. *Buried No Longer: Confronting America's Water Infrastructure Challenge*. Denver, Colo.
67. Neptune Technology Group, Inc. 2011. *Total Life Cycle Value — Why the Purchase Price of ICI Meters Means Less Than You Think...* Tallassee, Ala. March.
68. Sensus. 2012. *Water 20/20: Bringing Smart Water Networks into Focus*. Raleigh, N.C.
69. Davis, S.E. 2005. "Residential Water Meter Replacement Economics." Paper presented at the International Water Association Water Loss Leakage Conference, Halifax, Nova Scotia, September.
70. Thornton, J., R. Sturm, and G. Kunkel. 2008. *Water Loss Control*, 2nd Edition. New York: McGraw-Hill.
71. Godwin, A. 2011. "Advanced Metering Infrastructure: Drivers and Benefits in the Water Industry." *WaterWorld* 27(8). <http://www.waterworld.com/articles/print/volume-27/issue-8/editorial-features/special-section-advanced-metering-infrastructure/advanced-metering-infrastructure-drivers-and-benefits-in-the-water-industry.html>.
72. House, L.W. 2010. *Smart Meters and California Water Agencies: Overview and Status*. Prepared for California Energy Commission, Public Interest Energy Research Program, Report CEC-500-200-008. February.
73. Kenny, J.F., N.L. Barber, S.S. Hutson, K.S. Linsey, J.K. Lovelace, and M.A. Maupin. 2009. *Estimated Use of Water in the United States in 2005*. U.S. Geological Survey Circular 1344. October.
74. See note 43 for an explanation of the state water rate proxy methodology.

75. Mitchell, D.L., and T.W. Chesnutt. 2013. Evaluation of East Bay Municipal Utility District's Pilot of WaterSmart Home Water Reports. Prepared for California Water Foundation and the East Bay Municipal Utility District. December.
76. House, L.W. 2010. Smart Meters and California Water Agencies: Overview and Status. Prepared for California Energy Commission, Public Interest Energy Research Program, Report CEC-500-200-008. February.
77. U.S. Department of the Interior, Bureau of Reclamation. 2012. Colorado River Basin Water Supply and Demand Study, Figure 12, Historical Supply and Use and Projected Future Colorado River Basin Water Supply and Demand, SR-34. http://www.usbr.gov/lc/region/programs/crbstudy/finalreport/Study%20Report/CRBS_Study_Report_FINAL.pdf.
78. Ibid.
79. U.S. Department of the Interior, Bureau of Reclamation. 2015. Colorado River Basin Stakeholders Moving Forward to Address Challenges Identified in the Colorado River Basin Water Supply and Demand Study. Phase I Report: Executive Summary. May.
80. Ibid.
81. Daw, J., K. Hallet, J. DeWolfe, and I. Venner. 2012. Energy Efficiency Strategies for Municipal Wastewater Treatment Facilities. National Renewable Energy Laboratory Technical Report, NREL/TP-7A30-53341. January.
82. Carns, K. 2005. "Bringing Energy Efficiency to the Water and Wastewater Industry: How Do We Get There?" In Proceedings of the Water Environment Federation, WEFTEC 2005, Session 91 through Session 100. Alexandria, Va.: Water Environment Federation.
83. Electric Power Research Institute. 2002. Water & Sustainability (Volume 4): U.S. Electricity Consumption for the Water Supply & Treatment – The Next Half Century. Topical Report 1006787. Prepared by ICF Consulting under contract to the Electric Power Research Institute. Palo Alto, Calif.: EPRI. March.
84. U.S. Environmental Protection Agency, Office of Wastewater Management. 2010. Evaluation of Conservation Measures for Wastewater Treatment Facilities. EPA 832-R-10-005. September.
85. U.S. Department of Energy, Energy Information Administration. 2015. "Short-Term Energy and Summer Fuels Outlook." Accessed April 7. <http://www.eia.gov/forecasts/steo>.
86. U.S. Environmental Protection Agency, Office of Wastewater Management. 2010. Evaluation of Conservation Measures for Wastewater Treatment Facilities. EPA 832-R-10-005. September.
87. Zahreddine, P., and D. Doerr. 2012. "Innovative Energy Conservation Measures at Wastewater Treatment Facilities." Presentation by the U.S. Environmental Protection Agency, Office of Wastewater Management, May 17. <http://water.epa.gov/infrastructure/sustain/upload/EPA-Energy-Management-Webinar-Slides-May-17.pdf>.
88. Daw, J., K. Hallet, J. DeWolfe, and I. Venner. 2012. Energy Efficiency Strategies for Municipal Wastewater Treatment Facilities. National Renewable Energy Laboratory Technical Report, NREL/TP-7A30-53341. January.
89. There are significant differences between data from the U.S. Environmental Protection Agency and the American Biogas Council, and also data collected through state-specific surveys completed by water and wastewater research and management groups with regards to total wastewater treatment capacity and the actual flow of wastewater delivered to wastewater treatment facilities in the Basin states.
90. Liu, F., A. Ouedraogo, S. Manghee, and A. Danilenko. 2012. A Primer on Energy Efficiency for Municipal Water and Wastewater Utilities. Washington, D.C.: The World Bank, Energy Sector Management Assistance Program, February.
91. Mitchell, D.L., and T.W. Chesnutt. 2013. Evaluation of East Bay Municipal Utility District's Pilot of WaterSmart Home Water Reports. Prepared for California Water Foundation and the East Bay Municipal Utility District. December.





