

July 2016 | Research No.108

Making the Business Case for Water Projects

Supporting the Export of Israeli Water-Saving Technologies
to California, Using Innovative Financial Mechanisms

Shira Eting

Milken Innovation Center Fellow,
The Jerusalem Institute for Israel Studies



Jerusalem Institute for Israel Studies **מכון ירושלים לחקר ישראל**
Milken Innovation Center **מרכז מילקן לחדשנות**

About the Milken Innovation Center Fellows Program

The Milken Innovation Center Fellows Program accelerates Israel's economic growth through innovative, market-based solutions for long-term economic, social, and environmental issues. The program focuses on connecting government, philanthropic, and business resources that are vital to national growth and development.

The program awards annual fellowships to outstanding graduates of Israeli and international institutes of higher education. Fellows serve yearlong internships at the center of the nation's decision-making—the Knesset, government ministries, and other Israeli agencies—and aid policymakers by researching and developing solutions for various economic and social challenges.

In addition, fellows craft their own policy studies aimed at identifying barriers to economic and employment growth in Israel. The fellows' studies, carried out under the guidance of an experienced academic and professional staff, support legislators and regulators who shape the economic reality in Israel. The program offers the ultimate educational exercise, combining real-life work experience with applied research five days a week.

Throughout the year, fellows receive intensive training in economic policy, government processes, and research methods. They acquire tools for writing memorandums, presentations, and policy papers, and they develop management, marketing, and communication skills. The fellows participate in a weekly research seminars, where they meet senior economic and government professionals, business leaders, and top academics from Israel and abroad. They also participate in an accredited MBA course graduate-level academic credits that are transferable to other universities in Israel. The course, which focuses on financial and economic innovations, is taught at the Hebrew University of Jerusalem's School of Business Administration by Professor Glenn Yago, Senior Director Milken Innovation Center and senior Fellow / Founder, Financial Innovation Labs.

Fellows Program alumni can be found in senior positions in the public and private sectors. Some serve as advisers to government ministries while others work at private-sector companies or go on to advanced studies at leading universities in Israel, the United States, and Great Britain. Within the program's framework, more than 80 research papers have been published, catalyzing reforms, reducing barriers, bringing about economic growth, and improving the quality of life for Israeli citizens.

The Milken Innovation Center Fellows Program is nonpolitical and nonpartisan.

More about the program: www.milkeninnovationcenter.org

Acknowledgments

I would like to thank the Milken Innovation Center for a unique program that enabled me to pursue an applied research project, in parallel to a fellowship at the Israeli government. Specifically, thanks go to Glenn Yago, for his vision and leadership; to Steven Zecher, for his extraordinary guidance in the technical and financial aspects of the research; to Jacob Udell, for his wise advice and generosity; and to Orly Movshovitz-Landskroner, for exceptional professional and personal support.

My fellowship at Israel NewTech, under the auspices of the Ministry of Economy and Industry, was interesting, enjoyable, and thought-provoking, thanks to Oded Distel and Adi Yefet, who are bravely and positively leading a one-of-a-kind government environmental program. Oded and Adi gave me the opportunity to organize an international water conference in California involving 23 Israeli companies. This was arranged in collaboration with the Israel Export Institute and Israel's Economic Mission to the West Coast, to both of whom I am also grateful.

Thanks to Ram Fishman and Tally Zingher, for their professional guidance and for introducing me to development concepts and ideas.

Thanks to the dozens of individuals involved in the Israeli and Californian water sectors who were willing to engage with my research, answer questions, and share information.

And finally, thanks to my colleagues at the Milken Fellows program.

Contents

- 1. Introduction 5
- 2. Background 6
- 3. Results and Discussion 23
- 4. Summary 56
- Bibliography 57
- Appendix A—List of Interviewees 64
- Appendix B—The Metropolitan Water District (MWD) and West Basin Municipal Water District (WBWMD) 67
- Appendix C—Existing Financial Support 69
- Appendix D—List of Existing Israeli Water Projects in California 71

1. Introduction

“California will discover, as did Israel, that there is no magic bullet to ending the water crisis. Substantial and urgent change is required that will affect many stakeholders. Success will involve revolutionary technologies, institutional and legislative reforms, new financial and economic mechanisms, and changes in attitude and behavior, all integrated and implemented together through a portfolio of water technology transfers and a focus on continued managed innovation in the water sector.” (Financial Innovation Lab report, Milken Innovation Center 2016).

This research study builds further on the work of the Milken Innovation Center’s Financial Innovation Lab on financing water technologies, held in July 2015, and on the resulting report published in February 2016, “Financial Models for Water Sustainability.” It focuses specifically on innovative financial mechanisms that could support the implementation of Israeli water technologies in municipal water utilities in California. The study takes the conceptual model outlined in the February 2016 report and applies it to real-world data, in order to test the feasibility of making the business case for water.

The research questions is designed accordingly, and used both qualitative and quantitative methods to address them. The questions are as follows:

1. How should an Environmental Impact Financing (EIF) mechanism for water-saving technologies in Californian municipalities be designed?
2. How can sustainable, scalable, and market-driven solutions be created?
3. What is the general roadmap that could be applied in other regions of the world?

The research begins with a background chapter giving an overview of the following topics: (1) the unsustainable global water situation; (2) the water situation in California, specifically regarding barriers to attaining sustainability; (3) the Israeli water success story; and (4) differences and similarities between Israel and California. I then continue with a description of Environmental Impact Financing (EIF) and its potential contribution to solving the water problem. Subsequently, I examine each of the research questions and provide answers to them, followed by recommendations and conclusions.

The motivation for finding solutions to the challenges California faces is first and foremost an environmental one—to remediate the deteriorating water ecosystem in California, which is vital for sustaining life and ensuring a prospering economy. The second motivation is to develop and expand the reach of the Israeli water industry, which offers innovative and proven water technologies that are applicable in California and elsewhere, and has the potential to reach a great many new markets worldwide. Beyond these straightforward aspirations, there is also the hope that this research might contribute to efforts to address the global water problem: California, as the world’s eighth-largest economy and with unequalled global social and cultural influence, has the potential to serve as a global leader in this crucial effort; while Israel, with its technical expertise and proven experience, could help many other countries attain far better outcomes.

My 10-month Milken Fellowship included an internship at Israel NewTech—the Ministry of Economy and Industry’s “Sustainable Water and Energy Program.” This placement enabled me to get to know the Israeli water ecosystem first hand, and to interview dozens of key players from the Israeli and the Californian water sectors. It also enabled me to participate in joint working teams with representatives from Californian state offices, via the California-Israel Global Innovation Partnership¹ convened by the Milken Innovation Center.

The work on this project was carried out along two parallel channels: a short-term channel that focused on working with existing tools and seizing business opportunities; and a long-term policy channel, focused on changing the current realities through extensive research and innovative problem solving. The main outcome of the former channel was the ICWater Conference—a water conference held in California in July 2016, with the participation of 23 Israeli companies; the outcomes of the latter are the findings and recommendations presented in this research study. Needless to say that both channels are interlinked, and that efforts in each contributed to the other.

By presenting the business case for water—one which combines both practical steps and research, as well as the establishment of new channels of collaboration—I hope to bring new lines of thought and innovative solutions to the Californian water ecosystem, to the Israeli water sector, and to the global water problem.

2. Background

I. The Unsustainable Global Water Situation

In recent years, global water scarcity is increasing and becoming an impediment to growth. In January 2015, the World Economic Forum declared the water crisis as the number one global risk in terms of potential impact. Pressures come from both the supply side and the demand side: vast population growth, increased per-capita water demand, water contamination, aging infrastructure, and lack of water management constitute the main reasons for growing scarcity (Ajami et al. 2014; Goldman Sachs 2013; Merrill Lynch 2011; Deutsche Bank Research 2010; McKinsey 2009). These trends are expected to be exacerbated by climate change, which will result in higher temperatures, less precipitation in various locations, and higher frequency of extreme events such as drought, heat waves, and floods (PPIC 2015). By 2030, global water requirements are projected to exceed sustainable water supplies by 40 percent, and 30 percent of the world’s population (mostly in developing countries) may experience

¹ The Milken Innovation Center acts as a hub organizing, managing, and strengthening networks that lead to research and development collaborations, financial innovations, and practical, ready-to-go solutions. More information is available at: <http://milkeninnovationcenter.org/projects/california-israel-global-innovation-project/>

deficits larger than 50 percent (Merrill Lynch 2011; McKinsey 2009). There are possible scenarios in which potable water becomes more scarce than oil (World Economic Forum 2015).

Water is a challenge for the business sector as well. It is mainly financed and operated by public institutions; it is highly regulated; and it involves massive infrastructure, such as collection and distribution systems, wastewater treatment plants, and desalination plants. The funding needed to make the water sector sustainable via the use of technologies is enormous, and was estimated globally by McKinsey (2009) at \$50–60 billion annually. Capital expenses are often high, while largely regulated water rates (revenues) are low, leading to limited rates of return on investment. Other hurdles include absence of regulatory incentives, decaying infrastructure, lack of awareness, and concerns about public health—all of which are obstacles to new investment and innovation. Generally, the water sector is underinvested (Quesnel et al. 2016; Ajami et al. 2014; Ernst & Young 2013; Merrill Lynch 2011; Deutsche Bank Research 2010; McKinsey 2009).

A major factor in this inadequate development is the issue of low water prices, globally and specifically in the United States. Too often, water prices do not reflect the true cost of water, including infrastructure, operation and maintenance, energy, and ecosystem services. This inhibits water suppliers from meeting basic costs, let alone being able to invest in innovative technologies (Ajami et al. 2014; Ernst & Young 2013; Merrill Lynch 2011).

Young water technology companies struggle to survive because of low levels of interest in water enterprises, an under-developed water investment market, a relatively long research and development (R&D) time-horizon, and complex regulatory requirements. At later stages, risk aversion and a lack of financial incentives to adopt innovative technologies stand in the way of commercialization. Moreover, inconsistency and fragmentation across locations, sectors and end-users prevent effective scale-up (Quesnel et al. 2016; Ajami et al. 2014; Ernst & Young 2013; Merrill Lynch 2011; Deutsche Bank Research 2010).

Another key aspect of the water sector is the associated energy use, or what is known as the “water-energy nexus.” Water production and distribution requires a considerable amount of energy, while the production of different sources of energy demands intensive amounts of water (Goldman Sachs 2013; ADAN 2013). The US National Intelligence Council identified the food-water-energy-climate change nexus as one of four megatrends set to shape the world in 2030, and projections are that in order to meet energy needs in 2035, associated water demand will increase by 85 percent (World Economic Forum 2015).

The good news is that, with the deterioration of the global water situation and with global efforts to combat climate change, water conservation endeavors are multiplying. There is a growing understanding that “business as usual” is no longer a viable option (McKinsey 2009), and that water use and pollution must be decoupled² from economic growth in order to develop in a sustainable

² “Decoupling” refers to the ability of an economy to grow without a corresponding increase in environmental pressure (UNEP 2015).

matter (UNEP 2011, 2015). The result of this development is a growing interest in new solutions—whether financial, technological, behavioral or managerial—and in investment in water enterprises (Ernst & Young 2013; McKinsey 2009).

The global water market is on the rise, currently estimated at \$500 billion annually, and projected to reach between \$800 billion and \$1 trillion by 2030–35. With a 6 percent annual growth rate, the water sector offers numerous growth opportunities (Goldman Sachs 2013; Merrill Lynch 2011; Deutsche Bank Research 2010). In the rapidly-growing US water market, the largest market in the world, new approaches are emerging. These include demand management, smaller-scale and decentralized sources of water supply, and introduction of innovative technologies. Furthermore, new business models are being introduced to address some of the aforementioned financial barriers (Quesnel et al. 2016; Ajami et al. 2014).

The time to effect change is now. Because water scarcity is already standing in the way of economic growth in several locations and sectors, any delays in system upgrades will result in substantially higher future environmental, health, and economic costs. The shift currently underway is still too slow, and substantial changes must be made in order to make sure that future generations' needs are met. This include the shaping of new market dynamics, adopting systemic approaches, and investing in water projects and reforms (Ernst & Young 2013; McKinsey 2009).

II. The Unsustainable Water Situation in California

The Californian water story is an interesting case study in light of the global situation. California is a modern democracy with a highly developed economy that, due to several years of consecutive drought, is experiencing a severe water shortage, and is struggling to adapt. Projections of population growth and climate change testify to the need for a substantial shift in policy, regulation, legislation, investment, and behavior in California's water sector (PPIC 2016; Pacific Institute 2014b). This section provides an overview of California's characteristics, water use, and water sources, and of the recent drought and its implications.

California's climate encompasses winters with highly variable precipitation coupled with long, dry summers. Several large annual storms make the difference between a rainy and a dry year, and droughts are a recurring feature in the state, taking place every 15 to 40 years (PPIC 2015). Most of the state's precipitation falls in the north, while most of California's 39 million residents and irrigated land are located in the south. Consequently, California is reliant on massive infrastructure built about a century ago to collect and convey water (See Figure 2-1) (Mount et al. 2015; Hanak et al. 2012; CPUC 2010).

Figure 2.1: Map of California’s water infrastructure



Source: Legislative Analyst’s Office 2008.

The Californian economy is the eighth largest in the world, and one in which water plays a decisive role, mainly because of agriculture production. That being said, in recent years the economy has become less reliant on water: since the 1980s, real GDP (Gross Domestic Product) per capita has doubled, while per-capita water use has halved (Hanak et al. 2012; PPIC 2015).

The allocation of water used for human purposes raises some important questions regarding efficiency, value and fairness, in light of the crisis. Agriculture, although contributing only 2 percent to the state’s GDP, consumes 80 percent of its water, and plays a significant role in the American agricultural sector. California is the nation’s largest agriculture producer, home to more than 15 percent of the country’s irrigated land and responsible for 8 percent of the food produced in it. It can be argued that California, by exporting crops to other American states and to international markets, is in reality exporting water (PPIC 2016; Financial Innovation Lab report, Milken Innovation Center 2016; Hanak et al. 2015; Pacific Institute 2014b; Famiglietti et al. 2011).

The remaining 20 percent of water for human use goes to the urban sector: 14 percent for residential use, 4 percent to institutions and commercial businesses, and 2 percent to industry (PPIC 2015; Pacific Institute 2014b). Thanks to increased awareness, higher water rates, and a 25 percent reduction goal set by the governor in 2014 (California Natural Resources Agency 2014), per-capita water use has declined significantly—from 232 gallons (880 liters) per day in 1990, to 178 gallons (670 liters) in 2010, and 125 gallons (473 liters) in 2014 (PPIC 2015; Pacific Institute 2014a). Yet, despite this positive trend, more work can be done: landscape irrigation, for instance, is the largest urban water user, consuming 50 percent of urban water (Mount et al. 2015).

The breakdown of water supply resources serves to illuminate another aspect of California's water problem. The majority of the water supply usually comes from surface water that is conserved in reservoirs and then distributed (CPUC 2010a). However, because of the importance of a reliable and stable water supply, groundwater is also an essential source, especially for farmers, providing 30 percent of water in average years and up to 60 percent in dry years. California actually supplies 20 percent of all groundwater demand in the United States (Mount et al. 2015; Pacific Institute 2014b; Famiglietti et al. 2011). Furthermore, treated wastewater supplies only 1 percent of water demand for agriculture (Pacific Institute 2014b), although it is a reliable source for various purposes, both in terms of quality and quantity.

Reflecting the global situation, another important aspect of the water challenge in California is the water-energy nexus. Water, conveyed from north to south, is transported hundreds of miles, sometimes across two mountain ranges, which results in water having to be powered over an altitude differential of more than 2,000 feet. Overall, most of the energy consumed by the water sector is used for water transmission and distribution, with groundwater pumping being the next largest user. In the summer months, however, groundwater pumping becomes the largest energy consumer (Water in the West 2013; CPUC 2010a). A major incentive for water saving can be found, therefore, in the energy sector.

Beginning in 2012, California experienced four consecutive years of drought. Although droughts are a recurring feature in the state, this most recent episode has been the most severe in 120 years of record keeping, with 2014 also being the hottest year on record (PPIC 2015). Immediate responses by end-users of state water to minimize their economic losses included crop fallowing, water transfers, and over-pumping of groundwater. Over-pumping has resulted in falling groundwater levels, dry wells, decreased water quality and higher energy use (Howitt et al. 2015; PPIC 2015; Pacific Institute 2014b).

The damage caused to the water sector and to the environment as a whole during this drought has been great. California is home to the nation's largest number of indigenous plants and animals, supported by various natural water sources such as rivers, lakes, and wetlands. These ecosystems are

experiencing the most severe impacts so far, and many plant and animal species are under extreme threat (PPIC 2015; Hanak et al. 2015). California's aquifers are also overburdened by the current water system, and are being depleted faster than they can be replenished because of the need to cover surface water shortages. Over the last 50 years, more than 50 million acre-feet (16 trillion gallons, or 61 billion cubic meters) have been lost due to unbalanced groundwater use (Pacific Institute 2014b), and NASA data indicate that total natural water storage has been in decline since at least 2002 (Milken Innovation Center 2016; Famiglietti et al. 2011). This situation is leading to deteriorating quality of water, higher pumping costs, drying wells, and land degradation (PPIC 2015).

The implications of all this for California's agriculture, industry, and municipal sectors have varied greatly according to geography and purpose of use. In the agricultural sector, the impact is mainly dependent on available groundwater reserves. Overall in 2015, more than 5 percent of irrigated crops had to be fallowed, and the total economic impact is estimated at \$2.74 billion so far, including the loss of almost 21,000 jobs (Howitt et al. 2015; PPIC 2015). In the urban sector, the effects have been less severe, due to a higher level of preparedness and to the diversified nature of the water supply resources on which municipalities rely. However, where users are reliant on a single water resource (mostly in rural areas), the shortage was keenly felt—wells ran dry, severe shortages occurred, and the state had to provide emergency aid to more than 100 communities (Hanak et al. 2015; Mount et al. 2015). In addition, two of California's largest water providers had to dramatically reduce water deliveries, and hydropower generation, which normally provides 10-15 percent of the state's electricity supply, was reduced by 50 percent (PPIC 2015).

According to the Pacific Institute (2014b), the total annual water consumption across all sectors stands at 60 billion cubic meters. The annual water deficit is 7.5 billion cubic meters, and the amount of water needed to "replenish" reserves is estimated at 42 billion cubic meters. This implies that one rainy year would not be enough to solve California's water problem.

Despite the drought's major environmental implications, its impacts on the Californian economy have not been significant enough to drive systemic change (Hanak et al. 2015). Various barriers, mainly financial, regulatory, and behavioral, still stand in the way of addressing the water problem in California in a sustainable and long-term manner (Financial Innovation Lab report, Milken Innovation Center 2016; PPIC 2015; Pacific Institute 2014b). These are elaborated in the following section.

III. Barriers to Attaining Water Sustainability in California

The local challenges facing California's water sector reflect the global barriers described earlier. These barriers are summarized here in five categories: (1) Financial challenges (lack of upfront capital,

low water prices, and insufficient financial incentives); (2) lack of monitoring; (3) lack of systemic management; (4) a complex regulatory environment; and (5) the conservative nature of the water sector. All of these barriers are, of course, interconnected (Mount et al. 2015; PPIC 2015; Ajami et al. 2014).

1. Financial Challenges

The water sector is underinvested globally, and the United States is no exception; the Environmental Protection Agency (EPA) estimates that \$384 billion are needed over the next 20 years to replace all failing water infrastructure in the United States (GAO 2016). Complicating this even more is the low price of water; according to a recent paper that compared the funding of the water and the energy sectors in the United States (Quesnel et al. 2016): “Water services are the most expensive utilities to operate in terms of capital required per dollar of revenue, yet water is typically the least expensive of Americans’ monthly utility bills.”

As mentioned above, the primary lever to save water and invest in new solutions is its price, yet the low price of water in the United States in general, and in California in particular, currently does not provide enough motivation to do so. This affects all members of the value chain across all sectors, and creates difficulties in financing new water projects (Quesnel et al. 2016; Ajami et al. 2014; Goldman Sachs 2013; Ernst & Young 2013).

A reliable estimation of the price of water in California is very difficult to make, as there is no market price for a specific region or user, and prices are a function of the source of water, California’s water rights structure,³ the water utility, and water necessity (Financial Innovation Lab report, Milken Innovation Center 2016; Ellen Hanak pers. comms. 2015). What is clear, however, is that the lowest price for water in the United States is paid by the agriculture sector, followed by the industrial and the municipal sectors (Goldman Sachs 2013), and California is no different. Table 2-1 in section 2-V presents a comparison between water prices in Israel and California, and highlights potential price increases.

Another financial challenge standing in the way of water conservation is the fact that water sales are coupled with revenues: since the primary source of revenues for most water utilities is the volume of water being sold, water reductions harm economic productivity (Nahai 2016; Mercer and Christensen 2013).

Generally, there is a lack of policy intervention that could alter water rates or stimulate water reductions, in the form of pricing reforms, tax-exempt financing, loans, guarantees, and more (PPIC 2015).

³ “A water right is a legal entitlement authorizing water to be diverted from a specified source and put to beneficial, non-wasteful use. Water rights are property rights, but their holders do not own the water itself. They possess the right to use it” (Water Resources Control Board, 2016).

Tiered pricing⁴ could be used to incentivize end-users to save water, and Water Revenue Adjustment Mechanisms (WRAM)⁵ could be introduced in order to incentivize municipalities to sell less water. Both mechanisms are partially implemented in California today, yet there is great room for improvement.

Another example for possible modifications to existing policy is the California Infrastructure and Economic Development Bank (IBank)'s⁶ CLEEN program, which offers relatively little support for water-saving projects (IBank 2016). This support is essential for new technologies, as it can enable development of a proof-of-concept, dramatically impact a project's financial feasibility, and speed the adoption of technologies in additional locations as other users might quickly follow. Extending CLEEN's list of eligible water technologies to include smart metering, leak detection, desalination, wastewater treatment and recycling, precision irrigation, and more, could offer a real game-changer for the more widespread introduction of these technologies.⁷

2. Lack of Monitoring

"If you can't measure it, you can't fix it".

A major obstacle is the absence of essential data: California lacks basic information about water supply and demand, water usage, and water leakage (Pacific Institute 2014b; Mercer and Christensen 2013). Reasons for this include the low price of water, policies that do not require users to report water use, fragmented water supply systems, and utilities that track information in cumbersome ways (Hanak et al. 2015; Ajami et al. 2014; Hanak et al. 2012). The lack of essential data may also be due to social or political resistance to changing the current water situation. For example, a statewide comprehensive assessment of groundwater overdraft has not been conducted since 1980 (Pacific Institute 2014b), and

⁴ "High-water-using customers pay a higher rate, and low-water-using customers pay a lower rate. The quantity charge is lowest for the first several units of water a customer uses, and the quantity charge goes up in steps as usage increases. These rates are designed to reward water conservation" (California Water Service).

⁵ The WRAM mechanism decouples water sales from revenues by implementing surcharges on users. It was first introduced in California in 2008, and has since undergone several design changes (California Water Service, Office of Ratepayer Advocates).

⁶ IBank's mission is "to finance public infrastructure and private development that promote economic growth, protect and sustain the environment, support clean energy and efficiency, revitalize communities, and enhance the quality of life for the citizens of California" (IBank, 2016).

⁷ More information about the CLEEN program and other financial support programs can be found in Appendix C.

the percentage of non-revenue water (NRW)⁸ is not accurately tracked by many municipalities (Efrat 2016; Financial Innovation Lab report, Milken Innovation Center 2016).

Water in California is measured in acre-feet. One acre-foot is 325,851 gallons or 1,233,000 liters, and represents the amount of water needed to spread one foot of water over an acre of land, or the annual water supply for an average household (Hanak et al. 2012). While in Israel water is paid for on a per-cubic-meter basis, in California payment is per-1,233-cubic-meters. This unit demonstrates the scale of the water challenge in California, and it may also reflect how abundant water is conceived to be.

3. Lack of Systemic Management

Water in California is managed in a very fragmented manner. Ideally, there would be one “parent” institution responsible for tracking trends of supply and demand, allocating water according to the state’s priorities, and making sure that water is used sustainably. In California, various government agencies are responsible for oversight, in addition to non-state entities such as the Environmental Protection Agency (EPA), and municipal water utilities may be owned by the state, by private non-profit entities, or by private for-profit entities (GAO 2016; Legislative Analyst’s Office 2008). The organization of water utilities is complicated, and a general overview is not easy to find. Utilities can be divided by the following categories: cities—285; county districts—129; special districts—537; and public utilities— 138. In addition, there are approximately 1,200 mutual water companies and 467 mobile home parks (Private Water Law Blog 2013; Legislative Analyst’s Office 2008). Thus in total there are more than 3,000 water utilities. Making holistic decisions in such a disjointed environment, with each stakeholder having different views, perspectives, and interests, seems impossible.

Moreover, water management systems that were designed decades ago are no longer suitable to confront contemporary challenges (Quesnel et al. 2016; PPIC 2015; CPUC 2010a). For instance, California’s historical allocation of water rights on a “first-in-time, first-in-right” basis awards various users higher water priorities. Ever since the beginning of the 20th century, when this allocation was instituted, no comprehensive policy on water allocation priorities has been established, and conflicts among water users have ensued, especially between urban water districts and farmers with senior water rights (Financial Innovation Lab report, Milken Innovation Center 2016; Water Resources Control Board 2016; PPIC 2015; Mercury News 2015). Another example is groundwater management, which until recently was loosely regulated. Although some urban areas do now manage and regulate their

⁸ Non-revenue water is the difference between system input volume and billed authorized consumption, and it consists of the following: unbilled authorized consumption (usually a minor component of water balance), apparent losses, and real losses (Asian Water Supply 2003).

groundwater overdraft, most agricultural areas do not (Hanak et al. 2015). The new groundwater law does hold great promise for a more holistic groundwater management, but the current timeline affords more than 25 years to attain sustainable use (Mount et al. 2015).

In short, decision making regarding water management under conditions of a severe water shortage, a lack of information, outdated state policies, and fragmented governance all result in short-term thinking and unequal water allocations that harm specific users, future generations, and the environment (PPIC 2015).

4. Complex Regulatory Environment

For meaningful solutions to be set in place, a user-friendly regulatory environment is necessary. This can be done through both “push” and “pull” mechanisms: removing unnecessary restrictions (push) and providing incentives (pull). California should do more on both fronts (Ajami et al. 2014; Hanak et al. 2014). Requirements for specific technologies such as desalination and wastewater treatment are considered to be notoriously strict in California (Posy 2015; Tirosh 2015). Moreover, raising funds for local water services has become very difficult due to a series of constitutional amendments. Proposition 218, for example, restricts the use of collected fees to the provision of local services, further complicating investment in new water solutions (Hanak et al. 2014). Removing the restrictions that prevent technology implementation would make meaningful solutions more accessible.

5. Conservatism of the Water Sector

Many water entities take a conservative stance on technology implementation and structural change to water policy, resulting from the critical nature of the service they provide, the potential negative health consequences, and the constrained budgets they are operating under. Moreover, adopting new technologies involves taking a range of financial, economic, technical, and political risks (GAO 2016). This innate conservatism, coupled with the uncertainties and risks of technology implementation, prevents or holds back the adoption of innovative technologies.

IV. Israel’s Water Success Story

The previous section presented the main barriers to attaining water sustainability in California, and the complexity involved in trying to overcome them. Despite these barriers, California’s unsustainable water situation can very well be seen as either a wake-up call or as an opportunity (Milken Innovation Center 2016; PPIC 2015; Pacific Institute 2014b). California is in a unique position to become a global water leader: it is amongst the first developed regions in the world to witness a severe water shortage,

all while having a strong economy, developed institutions, and advanced cleantech industry (PPIC 2016). Interestingly, another developed country that witnessed severe water shortages and has already solved its water problem is the State of Israel. The next two sections detail what has been done in the Israeli water sector, which faced similar challenges about a decade ago, and suggest lessons that could be applicable for California's situation, despite the differences between the two cases (Financial Innovation Lab report, Milken Innovation Center 2016).

Israel has been dealing with water scarcity since its establishment in 1948, faced with a low water supply and a growing population. Today, however, Israel is no longer reliant on its natural water supply, and even exports water to neighboring countries. Israel's water sector is now highly developed in terms of its political structure, government involvement, regulatory environment, social awareness, and industry (Israel NewTech 2015; ISO, Standards Institution of Israel, and University of Haifa 2015).

The Israeli water story demonstrates the importance of policy and management, as well as the current implications of several influential decisions that were made decades ago. Thanks to those decisions, Israel not only decoupled its water use from its food security during the 1970s, but also from its natural water supply during the early 2000s. While the first decoupling is relatively easy, low-risk, and common to many countries, decoupling from the natural water supply is unique and associated with very challenging political and economic shifts (Gilmont 2014). In 2014, for example, a sudden end to rainfall earlier in the year than usual had zero impact on Israel's water sector and economy. Nowadays, the Israeli water management model is considered to be a role model for other countries, and the Israeli water industry is recognized as a global leader (Financial Innovation Lab report, Milken Innovation Center 2016; Israel NewTech 2015; IWA 2015a; ISO, Standards Institution of Israel, and University of Haifa 2015). The Israeli story is briefly presented here along two axes: policy and management; and innovative technologies.

The first legislation relating to water use, the Israel Water Law, was established during the early stages of the country back in 1959. The law claims water as a national resource and regulates water management, conservation, distribution, and prices. It mandates the distribution of water using a national and holistic perspective, in order to ensure optimal and sustainable use and water pricing that reflects real costs (IWA 2015b). In 2006, following several years of drought, the Water Law was updated, calling for the establishment of the Israeli Water Authority (IWA), which marked the beginning of a new era for the Israeli water ecosystem. Until then, management authorities were scattered among various governmental entities, and conflicting interests and political fragmentation sabotaged policy setting and decision making. In 2007, the IWA received full authority over the management of water in Israel. The overarching idea was to create a professional entity with a broad national perspective, and with

the political capabilities necessary to manage and supervise all aspects of water and wastewater in the most efficient and adequate way (IWA 2015a).

The development of the Israeli water sector has seen its fair share of political and ideological disputes, negotiations between stakeholders with conflicting interest, and hard decisions, though each of these barriers were made easier to surmount by the establishment of the IWA. Over the past 70 years, Israel has moved from a self-sufficient food policy that focused on increasing water supply, toward relying on virtual water,⁹ growing higher water-yield crops, developing advanced wastewater reuse policies, and investing heavily in desalination plants. Moreover, when water shortages were too severe to address through augmented supply, sustained demand management was developed that included reduced water allocations for agriculture, awareness campaigns and education to reduce domestic consumption, and politically contentious price rises (Gilmont 2014).

National efforts to solve the water crisis also resulted in the emergence of dozens of new Israeli technology companies, offering innovative water solutions in various fields such as desalination, wastewater treatment, water contamination, leak detection, and more. There are now more than 300 water companies in Israel, 120 of which are start-up companies established in the last seven years (Israel NewTech 2015). In 2014, Israel topped the Global Cleantech Innovation Index, which also stated that “the country generates the culture, education and ‘chutzpah’ necessary to breed innovation, plus it has the survival instincts to manage a resource-constrained geography” (Cleantech Group and WWF 2014).

This evolution of a successful water industry was made possible not only by the innovative Israeli ecosystem, but also as a result of strong governmental support (Milken Innovation Center 2016; ISO, Standards Institution of Israel, and University of Haifa 2015; Ezekiel 2015). In 2006, the government of Israel established a national program called Israel NewTech in order to further promote the Israeli water industry. The program works through four channels: (1) investment in human capital, through educational programs; (2) supporting R&D activities, by providing grants for innovative water companies; (3) bridging the commercialization gap, by providing grants for first commercial installations in water utilities; (4) penetrating the international market, using improved communications, marketing, and standardization processes (Israel NewTech 2015).

Currently, the annual water cycle of Israeli water companies is estimated at \$3.7 billion dollars, of which \$2 billion dollars come from export activity, with a 25 percent increase over the last four years (Israel NewTech 2015; ISO, Standards Institution of Israel, and University of Haifa 2015). This high export share is not exceptional for the Israeli market as a whole, which relies heavily on international

⁹ The hidden flow of water if food or other commodities are traded from one place to another (Allan, 1999).

activity: export activity provides 25 percent of jobs and 22 percent of GDP in Israel (Israel Export Institute 2015). All of the above place Israel in a unique position to export water technologies and related expertise to other countries.

Some Israeli water technologies—such as water and wastewater treatment, water management, leak detection, desalination, and rainwater capture—are already installed in California today (a list of projects is given in Appendix D). Yet Israeli water technologies remain largely under-utilized in California. Supporting the export of Israeli water technologies to California will benefit both. The environmental situation in California in general, and the water ecosystem in particular, will gain from a reduction in water demand and an increased water supply; while the Israeli water technology sector will grow and increase its ability to enter additional markets worldwide (Financial Innovation Lab report, Milken Innovation Center 2016; Ezekiel 2015). More importantly, perhaps, introducing these technologies more widely to the Californian market may serve as a bridge to other markets in both developing and developed countries, and thus help tackle the global water challenge through innovation.

V. California and Israel

While the previous section ended with a description of the potential for collaboration and synergy between Israel and California, this section examines similarities and differences between the two. This is done in order to better understand what lessons from the Israeli water sector could be applicable in California, and to identify which Israeli water technologies can be implemented there. Figure 2-2 compares Israel and California's water performance, table 2-1 compares water prices in both countries, and table 2-2 compares Israel and California by general characteristics and by the five barriers identified in section 2-III.

Figure 2-2 (below) presents the gaps between Israel and California's water performance and highlights California's potential for improvement. The first row shows that the average per-capita water consumption in California is three times higher than in Israel. The second and third rows show that wastewater recycling rates in general, and particularly in agriculture, could be substantially higher. Finally, California's electricity use for water is three times higher than the Israel's, despite Israel's massive desalination rates. This is explained by the long distance of water conveyance and the extensive groundwater pumping in California, as described in section 2-II above. Moreover, California's 80-percent share of water for agriculture could be reduced, as has been done in Israel through the decoupling of food security from water use, increasing yields per drop, and growing lower water-consuming crops.

Figure 2.2: Comparing Israel's and California's water performance

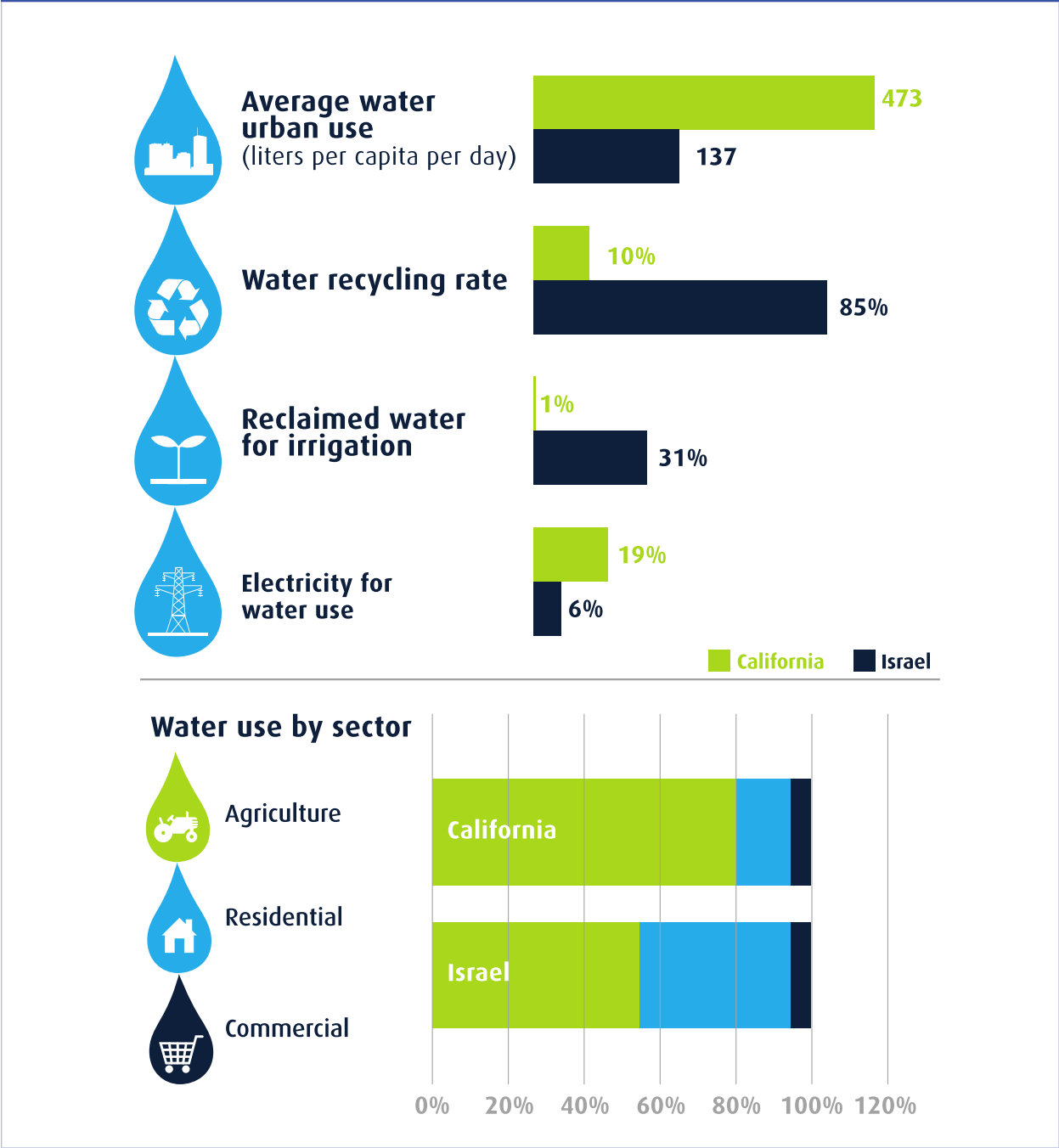


Table 2-1 presents a comparison between water prices in Israel and California. The price for agricultural use is based on the price paid by farmers in 2015 to trade water (Howitt et al. 2015), and the price for municipal use is based on an average price paid by West Basin Municipal Water District water

consumers (West Basin Municipal Water District 2014). It is important to mention that many farmers do not pay for water as a result of the California water rights structure, and that prices for municipal and industrial use are very diverse. The table demonstrates that, on average, water users in California pay a quarter of the price paid in Israel.

Table 2.1: Comparison between water prices in Israel and California in 2015

Water tariff	California (\$ / acre-foot)	California—translated rates ⁹ (NIS / cubic meter)	Israel (NIS / cubic meter)	California / Israel tariff ratio
High / Municipal	1000	3.14	12.355	25%
Low / Agricultural	650	2.02	7.676	26%

Source: IWA 2016; Howitt et al. 2015; West Basin Municipal Water District 2014.

Finally, table 2-2 compares Israel and California’s general characteristics and their performance in relation to the identified barriers.

Table 2.2: Comparing Israel and California by general characteristics and by the five barriers to attaining water sustainability

Barrier	California	Israel
Population	<ul style="list-style-type: none"> ▪ 39 million 	<ul style="list-style-type: none"> ▪ 8 million
Climate	<ul style="list-style-type: none"> ▪ Mediterranean climate ▪ Experiences droughts every several years 	<ul style="list-style-type: none"> ▪ Mediterranean climate ▪ Experiences droughts every several years

¹⁰ US dollars (\$) were translated into New Israeli Shekel (NIS) using a rate of 3.86 (as of July 14, 2016) and acre-foot was translated to cubic meters, when 1 acre-foot is equal to 1,233 cubic meters.

Table 2.2: Comparing Israel and California by general characteristics and by the five barriers to attaining water sustainability (Cont.)

Barrier	California	Israel
Economy	<ul style="list-style-type: none"> ▪ Developed economy, eighth-largest economy in the world ▪ Prospering hi-tech sector ▪ World leader in energy ▪ Devotes majority of water to agriculture 	<ul style="list-style-type: none"> ▪ Developed economy, export oriented ▪ Prospering hi-tech sector ▪ World leader in water ▪ Devotes majority of water to agriculture
Size	<ul style="list-style-type: none"> ▪ 163,696 mi² ▪ Long distances of water distribution, increasing energy demand 	<ul style="list-style-type: none"> ▪ 8,019 mi² ▪ Shorter distances of water distribution, lowering needed infrastructure and energy demand for treated wastewater reclamation and for water distribution
Financial challenges: Water prices	<ul style="list-style-type: none"> ▪ Different prices according to water rights, water use, water source, and geographic location ▪ Prices are about 75% lower than in Israel ▪ Water revenues are coupled with water sales 	<ul style="list-style-type: none"> ▪ Unified prices: high and low tariffs ▪ Price reflects the real cost of water ▪ Water revenues are decoupled from water sales
Financial challenges: Incentives	<ul style="list-style-type: none"> ▪ Low incentives to conserve water due to low water pricing ▪ New funding sources for water projects exist. Some are undersubscribed ▪ Several governmental programs such as WET and IBank’s CLEEN program ▪ Proposition 1: \$7.545 billion in general obligation bonds for water projects ▪ No tax-exempt financing 	<ul style="list-style-type: none"> ▪ Water prices incentivize water saving ▪ Grants for first commercial installation: a company and a water utility apply for funding to install an innovative technology at the water utility. Funding provided up to 70% of total costs

Table 2.2: Comparing Israel and California by general characteristics and by the five barriers to attaining water sustainability (Cont.)

Barrier	California	Israel
Water monitoring	<ul style="list-style-type: none"> ▪ Lack of sufficient data about water use, aquifer levels, NRW, and more ▪ Data is scattered between thousands of entities 	<ul style="list-style-type: none"> ▪ Water is monitored across all water users ▪ Advanced monitoring technologies are installed ▪ Data is accessible at the IWA website
Water management	<ul style="list-style-type: none"> ▪ More than 3,000 water utilities ▪ EPA sets nationwide drinking water standards, and state and local requirements can also be added 	<ul style="list-style-type: none"> ▪ IWA—single water authority ▪ Mekorot—National Water Company, accountable to the IWA ▪ 55 water corporations manage water for the majority of population. Water revenues are designated for investment in water.
Water regulation	<ul style="list-style-type: none"> ▪ Water rights ▪ Strict regulation for use of new technologies such as desalination and wastewater reuse ▪ New constitutional amendments make fundraising for water services very difficult ▪ Action Plan (2014): path to sustainable water use, including a goal of a 25% total reduction in municipal use 	<ul style="list-style-type: none"> ▪ Water regulation is set and managed by the IWA ▪ Advanced approvals for desalination and wastewater reuse
Conservatism	<ul style="list-style-type: none"> ▪ Conservatism still serves as a major barrier 	<ul style="list-style-type: none"> ▪ Innovation is embedded in Israeli culture, and serves as a main engine for growth in the “startup nation” ▪ Conservatism is addressed through policy

Source: IWA; Mekorot; Private Water Law Blog; PPIC 2015; Water Resources Control Board; Water Resources Control Board; GAO 2016; Israel NewTech 2015.

Table 2-2 shows that California can learn from Israel's proven water success, notably in the fields of financial incentives, regulatory approvals, systemic management, and the importance of monitoring. Yet some lessons are much easier to implement than others; as Gilmont (2014) states, decoupling water use from the natural water supply in Israel "was very demanding economically and very politically stressful." Hence, some changes that could be made in California, such as the establishment of a single water authority, setting higher water prices, or tackling the water rights system, may be extremely complicated, although highly desirable.

At the same time, certain modifications to financial programs and regulatory approvals might be easier to implement and could substantially change the playing field. Two practices that were successfully implemented in Israel during the last few decades and might be relevant for California are the decrease in municipal NRW rates by 50 percent, and the creation of government policies that significantly increase wastewater reuse by farmers (Greenwald 2015).

Recognizing the potential contribution to both Israel and California, as well as the importance and the complexity of overcoming barriers, this paper focuses on the implementation of innovative Israeli water technologies in California municipalities, using innovative financial mechanisms. Although the agriculture sector in California is by order of magnitude its biggest water consumer and thus offers substantial potential for water savings, the aforementioned institutional and political barriers imply that a more promising avenue for commercial engagement can be found in the domestic sector. The question to be addressed, then, is how these water-saving projects should best be designed.

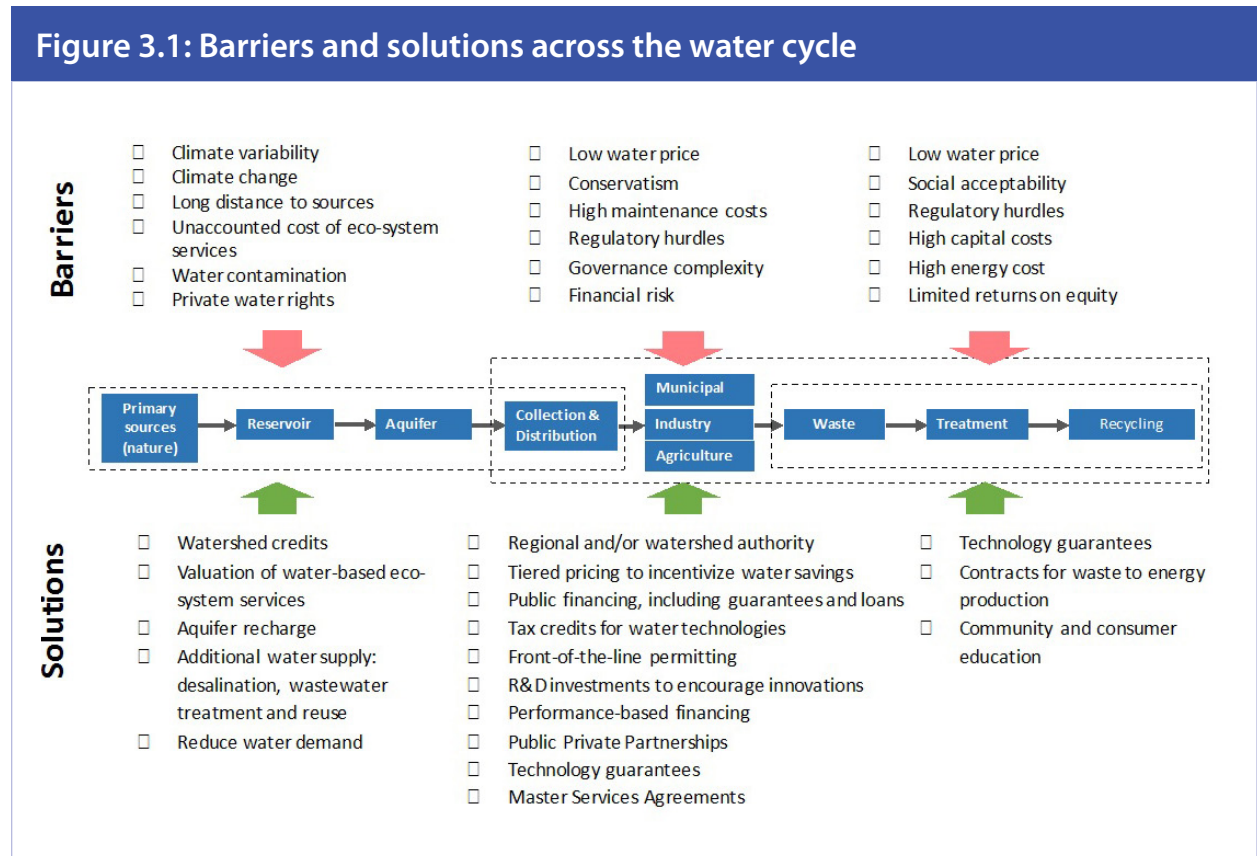
3. Results and Discussion

This chapter begins with a general explanation of an important part of the solution to California's water situation—innovative financial mechanisms to help overcome water barriers, based on the Milken Innovation Center report (2016). The relevant background is summarized and key concepts defined, and then answers are given to the three research questions. The first research question introduces the principles on which the model is designed, to ensure it overcomes existing barriers. These principles are based on a deeper understanding of what motivates municipalities, on existing business models, and on lessons from the energy sector. The second research question presents the financial model: a general explanation, assumptions, a sensitivity analysis and, finally, the modelling results, followed by a discussion. The third research question then summarizes lessons and recommendations, and suggests a general roadmap.

Innovative Financial Mechanisms for Overcoming Barriers in the Water Sector

Figure 3-1 presents a general analysis of barriers and solutions across the water cycle, represented here in a linear fashion. The barriers and solutions are divided between water supply (the left side of

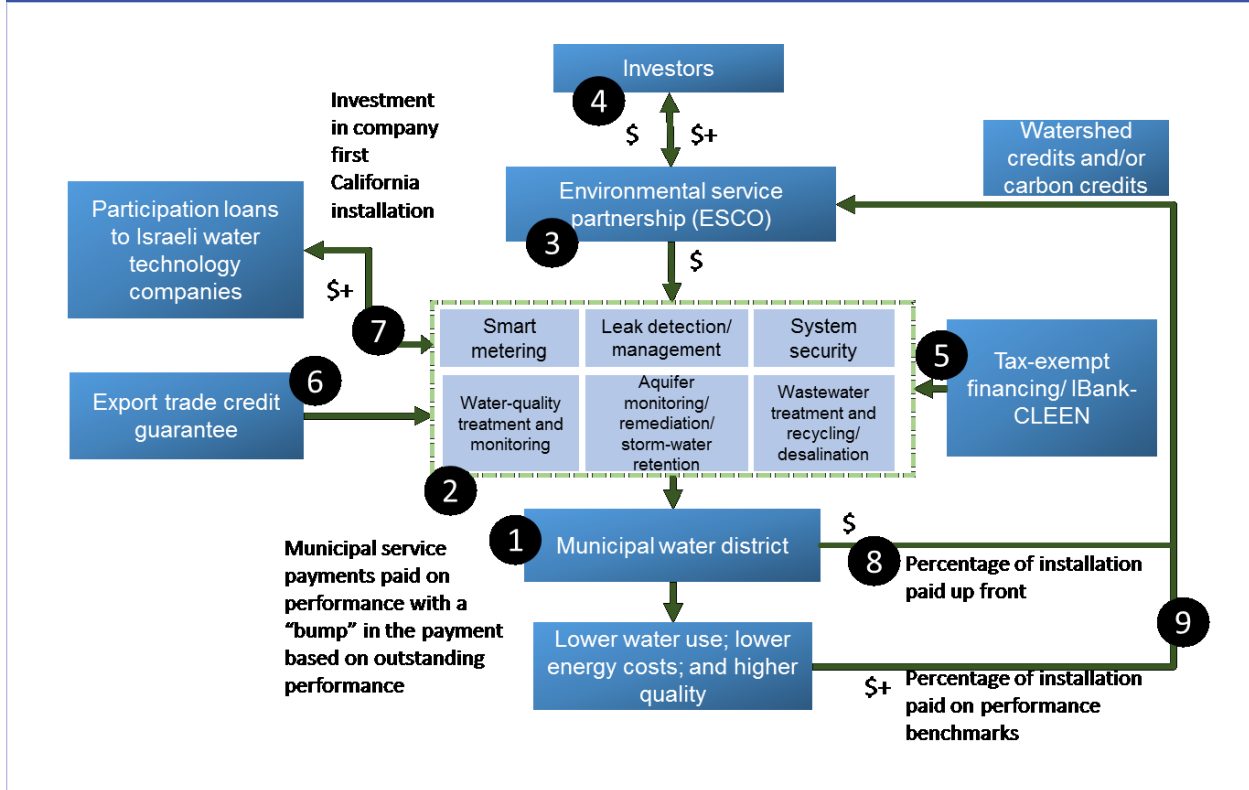
the diagram) and water demand (the right side) (Financial Innovation Lab report, Milken Innovation Center 2016). The detailed list of barriers includes the barriers that were identified in section 2-III, as well as more general barriers like climate change, or specific examples such as financial risk. The list of solutions is also detailed, and allows to examine which solutions are most relevant in this case.



Source: Financial Innovation Lab report, Milken Innovation Center 2016.

Based on this “barriers and solutions” analysis, the Milken Innovation Center came up with innovative financial mechanisms for several sectors in California. Figure 3-2, taken from the report, presents a proposed financial model for the California municipal sector.

Figure 3.2: Capital and project structure for municipalities



Source: Financial Innovation Lab report, Milken Innovation Center, 2016.

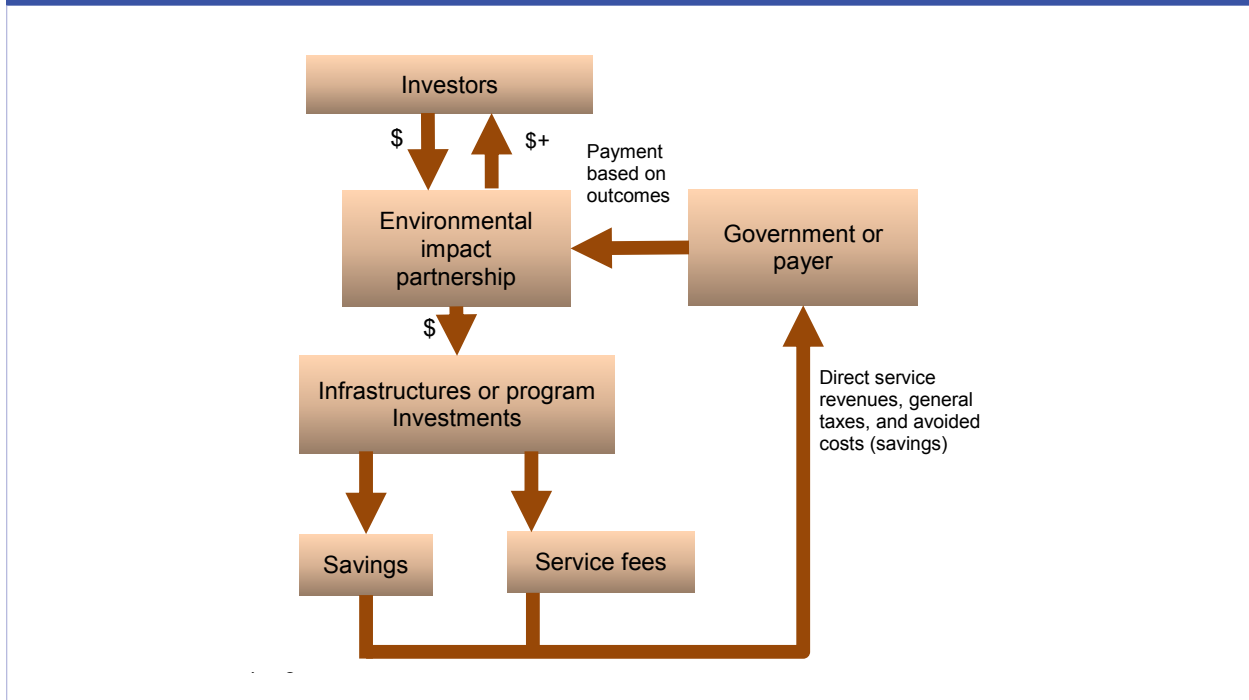
The figure presents the municipal model in which (1) a municipal water district or utility implements (2) a bundle of water technologies using (3) an “environmental service partnership,” also known as an ESCO (Environmental Service Company).¹¹ The ESCO uses (8,9) performance-based mechanisms, which include payment based on a series of performance milestones and savings thresholds. Several governmental mechanisms, such as (5) tax-exempt finance, (6) export trade credit guarantee, and (7) special loans, serve to increase yields and the return on investment for the (4) investors (Milken Innovation Center 2016; Larsen et al. 2014).

A key concept in this model is Environmental Impact Financing (EIF) (figure 3-3), defined as: “using ‘avoided costs,’ i.e., savings resulting from the success of the project, to attract private capital. By shifting the risk from government to private investors, and compensating the private investors for

¹¹ Found mostly in the energy sector, ESCOs perform multiple services for their clients, including helping them engineer efficient solutions and harvest benefits from improved performance through a special purpose company. Monetized savings are paid to the ESCO and dividends are then paid to investors and reward them for their risk-taking (Milken Innovation Center 2016).

assuming the risk, government obtains a successful project and the investors see a risk-adjusted return on their funds. The model can be applied to environmental and water sectors as well, where reduced water usage results in savings” (Milken Innovation Center 2016).

Figure 3.3: Environmental Impact Financing



Source: Financial Innovation Lab report, Milken Innovation Center, 2016.

A summary of the principles of EIF that are applied in this research is set forth below (Milken Innovation Center 2016; Quesnel et al. 2016):

- Joint agreement between a municipal water utility (“Municipality” / “Utility”), water technology companies, and an Environmental Service Partnership that integrates, engineers, and invests in the project (“ESCO” / “Investor”).
- Using avoided costs (profit resulting from water and energy savings and/or decreased associated costs) to attract private capital;
- Shifting risk from municipalities to private investors and / or companies;
- Performance-based payments;
- Risk-adjusted return on investment;
- Project-based, with limited or no recourse to other parties, including the municipality or private investors.

Question 1—How should an Environmental Impact Financing (EIF) mechanism for water-saving technologies in Californian municipalities be designed?

In order to design a financial mechanism for the existing water ecosystem in California municipalities, a preliminary examination of the current situation was carried out. This examination included: (1) municipal motivation for water projects; (2) municipal barriers to implementing water-saving technologies, and how EIF addresses those barriers; (3) how EIF is currently applied by water companies; and (4) relevant lessons from the energy sector. The answers to these questions define the characteristics for a proposed EIF model.

For the purpose of this research, the definition for water municipalities is taken from a recent GAO report (2016): “The municipal water sector is comprised of municipal water utilities, their source waters, and their treatment and distribution infrastructure. A municipal water utility is an entity that distributes potable water to domestic, commercial, and industrial customers in their service area. These entities also provide water for public uses such as firefighting, street washing, and maintaining public parks and swimming pools.”

I. Municipal Motivation for Water Projects

Municipalities facing water scarcity can address it either by reducing water demand or by increasing water supply, and both can be done with the use of technology. Non-technological approaches to reducing demand include education to conserve water, improved awareness, and pricing tools, while technologies to reduce demand include leak detection, pressure management, and smart metering. Increasing water supply is done through the development of non-traditional water sources, mainly wastewater treatment and reuse, brackish or seawater desalination, and storm-water capture (GAO 2016).

But it is not just water scarcity that gives municipalities a strong motivation for conserving water or diversifying their water portfolio. There are other reasons, too:

- Increasing profitability

Despite low water prices and the fact that water revenues are directly driven by the volume of water sold, water-related technologies can increase profitability. Examples include technologies that detect leaks or decrease water evaporation, both of which increase the amount of water available to be sold by the municipality. In these cases, a Cost-Benefit Analysis (CBA) or a Return On Investment (ROI) analysis could be done to determine the costs associated with the technology installation and the resulting revenues from water and energy savings.

Another possible analysis is the estimation of indirect revenues. Examples here include the value of collected water data, avoided contamination fines, and avoided infrastructure costs. When water data is tracked, ongoing operations can become more efficient (Feldman 2016), and contamination sources can be accurately identified and treated (Goldfarb 2016). In addition, discovering specific

locations of pipe leakage or infrastructure damages allows for selective infrastructure replacement and repair. Bearing in mind that replacing one kilometer of pipelines costs approximately \$1 million, this information may be worth the investment (Irving 2016; Efrat 2016).

- Improved cost-effectiveness

In some cases, new and more advanced technologies perform better and therefore are more cost-effective, particularly in regard to reductions in energy use and in produced waste. For instance, technologies that treat wastewater while using less energy or producing less sludge, or that treat water to a better quality, may justify the investment (Hubner 2015).

- The true scarcity price of water

There is evidence in California that water scarcity limits development, such as real estate projects dependent on additional water sources to be developed (Irving 2016). In such cases, the value of water (its true scarcity price) is higher than its cost in the market, incentivizing stakeholders (including municipalities in some cases) to invest in solutions.

- Answering regulatory / legislative requirements

Beyond purely financial and economic considerations, regulatory and legislative requirements can also compel municipalities to save water. Outstanding examples of such requirements include health regulation for water and wastewater treatment, and the recent action plan published by Governor Brown in 2014 (California Natural Resources Agency 2014) that sets a goal of 25 percent water reduction across all Californian municipalities. This means that municipalities must treat water, conserve water or increase their water supply, even if these changes result in higher costs.

- Public Opinion

This final consideration is neither financial nor regulatory, but may be just as meaningful as the others. Bearing in mind that municipalities are expected to deliver reliable water supply and that many water utilities are elected entities or appointed by elected leadership, water managers are looking for ways to satisfy their clients (in some cases voters) and provide them with long-term water security (Mercer and Christensen 2013).

II. Municipal Barriers and How EIF Addresses Them

Although incentives exist, the adoption of water technologies is a complicated task subject to several barriers. Following the background chapter in which general barriers for the municipal, industrial, and agriculture sectors in California were identified (see sections 2-III and 2-VI), the focus here is on barriers for municipalities. These are: (1) lack of up-front capital; (2) insufficient financial incentives (including low water prices); (3) lack of monitoring; (4) fragmented management; and (5) a conservative environment.

Each of these barriers can be addressed by the principles of EIF:

1. Barrier: Lack of upfront capital

- Proposed solution: Capital from the private sector and using “avoided costs”

Making the water sector sustainable requires massive amounts of funding that the public sector will find difficult to raise on its own. At the same time, the private sector is an enormous source of global wealth and constantly searches out investment opportunities with high potential for success. Thus private capital, or collaboration between the public and the private sector, is needed in order to fund water projects (Quesnel et al. 2016; Ernst & Young 2013; Deutsche Bank Research 2010). Moreover, performance-based water projects are based on future savings instead of increased debt or tax raising (Larsen et al. 2014). In this way, capital from the private sector combined with the use of “avoided costs” lowers the burden on a municipality’s balance sheet.

2. Barrier: Insufficient financial incentives

- Proposed solution: Realignment of incentives

A strong incentive to conserve resources, and perhaps the most important of all, is cost (Quesnel et al. 2016). As long as water prices are low and complementary financial incentives are insufficient, municipalities are reluctant to install innovative technologies. EIF addresses this barrier by taking into account incentives that are usually left outside the equation (such as associated energy, infrastructure, and chemical treatment costs) and by taking a long-term view on ROI. In addition, performance-based payments ensure that the technology provider is in charge of reaching water-saving targets and is incentivized to perform. These pre-defined goals can be planned to guarantee profits or to adhere to a regulatory requirement.

3. Barrier: Lack of monitoring

- Proposed solution: Monitoring technologies

Since performance-based contracts are dependent upon accurate measurement of water use, monitoring is a vital component (Efrat 2016; Wiesner 2015; Mercer and Christensen 2013). Monitoring can be made a mandatory requirement of any project, and an adequate monitoring technology can be a part of a bundle of technologies installed.

4. Barrier: Fragmented management

- Proposed solution: Distributed solutions, and Master Services Agreements (MSA)

EIF in this case is applied to a certain project and involves all of its key players, including the municipality, the technology companies, and the investors. Because of the nature of this mechanism, EIF does not require collaboration among a large number of stakeholders, who may or may not have conflicting interests or be dependent upon changes in regulation. Furthermore, the installed water technologies suggested by the ESCO could be pre-approved as part of a Master Services Agreement

(MSA)¹² and in this way save time and bureaucracy (Hazlett 2016).

While EIF on its own will not solve the Californian water problem, it offers a way to implement water-saving technologies on the current playing field. Moreover, EIF fosters the establishment of distributed solutions, which can decrease transportation costs and energy requirements (Quesnel et al. 2016).

5. Barrier: Conservative environment

- Proposed solution: Shifting the risk to the company / ESCO

The adoption of new technologies includes elements of financial, economic, technical, trade and political risks (GAO 2016). EIF answers this gap by shifting risks to the technology companies and/or to the ESCO. Not only do the companies and the ESCO provide successful practices such as efficient and sustainable economic models, and take some of the financial risk, they also mitigate the technical risk by providing technical knowledge relating to project execution (Deutsche Bank Research 2010). This combination results in a lower risk for the municipality as well.

Furthermore, technology efficacy insurance mechanisms can be developed to shift part of the risk from the private sector to the government, and so ensure greater fiscal stability and attract investors (Ernst & Young 2013). Altogether, a group effort is created among private and public actors and supported by policy makers, creating a stable ground both practically and psychologically (Distel 2016).

III. What Are Companies Doing Now?

Given that EIF is a valuable and immediately applicable mechanism for municipalities, this study also endeavored to collect best practices and key elements from existing EIF business models. Based on a literature review and interviews with key players in the Israeli and California water sectors (a list is provided in Appendix A), this section presents and compares several practices and business models used by Israeli companies in California, namely: Demonstrating economic benefits; Software-as-a-Service; and Water-as-a-Service.

- Demonstrating economic benefits: ROI, indirect costs, and cost-effectiveness

Perhaps the most straightforward way to attract clients is by demonstrating their Return On Investment (ROI) from the project. The ROI for EIF projects is a function of the sources of financing,

¹² "A master services agreement is a contract that spells out most but not all of the terms between the signing parties. Its purpose is to speed up and simplify future contracts. The initial time-consuming negotiation is done once, at the beginning. Future agreements need spell out the differences from the contract and might require only a purchase order. MSAs are common in information technology, union negotiations, government contracts and long-term client/vendor relationships. They can affect a wide area such the country or a state, with subset terms negotiated at the local level." (Locsin 2016).

capital expenses (Capex), operation and maintenance expenses (Opex), estimated savings on direct and indirect costs, and the length of the project (Tietenberg and Lewis 2012). Leak detection companies, reservoir covering companies, and water data and management companies that were interviewed are using this method in California.

A valuable feature of these calculations is that they include and demonstrate savings on indirect costs, such as selective replacement of infrastructure and avoided fines on water contamination, costs that might tip the scales in favor of the project. In addition, companies that offer more cost-effective technologies compared to those set in place today can monetize this efficiency and present it to proposed clients. Examples include desalination, water treatment, and wastewater treatment companies.

- Technology-as-a-service

The concept of selling services instead of products is not new and is being extensively used, often by software companies that use the Software-as-a-Service (SaaS) model—defined as: “a software distribution model in which a third-party provider hosts applications and makes them available to customers over the Internet” (TechTarget 2016). SaaS minimizes or eliminates Capex on hardware and software, often reduces Opex by providing know-how and outsourcing installation and operations for the client, and offers flexible payment methods such as shifting Capex to Opex (Goldfarb 2016; Avrahami 2016; Feldman 2015). Furthermore, users enjoy automatic updates to software, integration with other services, and scalable usage upgrades, and can terminate the service at any point (TechTarget 2016).

Related to this method, a relatively new service model developed in the water realm is to sell “Infrastructure-as-a-service.” The concept is similar to solar Power-Purchase-Agreements (PPAs), and has been recently introduced by wastewater treatment companies under the name “Water-as-a-Service” or “WEPA”—Water and Energy Purchase Agreement (BusinessWire 2015). In this model, a financial partner works with the technology company to finance, install, and operate wastewater treatment systems, and sells back treated water to the client. The client enjoys the benefits of onsite wastewater treatment and clean energy generation and pays an affordable monthly fee based on usage (Irving 2016; Shenkar 2016).

This innovative model offers the client avoided Capex, lower Opex, increased water security thanks to a stable stream of water and hedging against increased water costs, and finally, avoided operational headaches. The financial partner enjoys a protected stream of positive income and, potentially, a positive Internal Rate of Return (IRR); and the technology company enjoys increased adoption of its technology and recurring revenue streams (Irving 2016; BusinessWire 2015).

Before assessing the models according to desired environmental and economic outcomes, it is important to mention that these business models are technology-dependent. For the Water-as-a-Service model to work, for example, the technology must deliver a stable source of water and offer a substantial operating advantage, such as extensive savings on energy (Irving 2016; BusinessWire

2015). With that being said, different combinations of the aforementioned models can be developed to best suit the company and the client needs and requirements (Goldfarb 2016).

- Comparing business models

The following table (3-1) compares the “standard” model, which is a “plain” financial model that sells products with no reference to ROI, with the three business models presented above. The criteria were chosen in accordance with the goals of this research—water savings and satisfied stakeholders, which will make it easier to surmount the aforementioned barriers. Each color signifies a different stakeholder/outcome: the municipality (blue); the ESCO (orange); the technology company (yellow); and environmental benefits (green). (+) represents satisfaction, (~) represents partial satisfaction, and (-) represents no satisfaction.

Table 3.1: Comparing existing business models according to desired environmental and economic outcomes; each color signifies a different stakeholder

Method/Criteria	“Standard” model	Demonstrating ROI	Software-as-a-Service	Water-as-a-Service
Environmental benefits (water and energy savings)	-	~ A final outcome is not declared but savings can be projected	~ A final outcome is not declared but savings can be projected	+
Municipality ROI	-	+	~ ROI is not guaranteed, but may be estimated	+
Municipality reduced risk	-	~ Demonstrated, not guaranteed	~ Demonstrated, not guaranteed	+
Municipality reduced Capex	-	-	+	+

Table 3.1: Comparing existing business models according to desired environmental and economic outcomes; each color signifies a different stakeholder (CONT.)

Method/Criteria	“Standard” model	Demonstrating ROI	Software-as-a-Service	Water-as-a-Service
Environmental service partnership (ESCO / investor)	-	-	-	+
Company (technology provider)	-	+	+	+

Source: Milken innovation Center, 2016.

The table shows the advantages and disadvantages of each business model, and indicates that Water-as-a-Service is the best model for satisfying stakeholders and overcoming barriers to entry. However, it is not suitable for most technology companies. Therefore, in my research I searched for a model that is relevant to as many technologies as possible, while generating (+) for all criteria. The solution is presented in the next research question (Question 2).

IV. Lessons from the Energy Sector

The energy sector provides lessons from the recent energy-saving revolution, which was notably successful in California. While major differences exist between the energy and the water sector, including public health requirements, approaches to efficiency, ownership structure, pricing, and regulatory requirements, there is certainly room for learning (GAO 2016; Quesnel et al. 2016). My model therefore borrows several features from the energy sector:

First and foremost, the energy sector has proved that the primary motivator for the deployment of innovative technologies is monetary savings. Thus, the model’s most important outcome is to generate profits to all stakeholders; the model also includes performance-based incentives. Second, the energy sector has gone through a successful decoupling of revenues from the volume of energy sold: California “has been using electric revenue decoupling strategies since 1982, with a more recent ‘decoupling-plus’ policy implemented in 2007, which combines decoupling with energy efficiency performance-based incentives” (Quesnel et al. 2016). Therefore, the model tackles the revenue-decoupling challenge with surcharges that gradually increase water prices.

To conclude, this section has collected a number of best practices to facilitate the design of an EIF mechanism for water-saving technologies in California municipalities. It enabled the identification of characteristics for a financial model that will best suit the water ecosystem in California and overcome barriers to the entry of innovative water technologies. These best practices include:

- Generating profits for all stakeholders, including environmental benefits
- Public-private partnerships between municipalities, technology companies, and environmental service partnerships (investors)
- Performance-based incentives
- Decoupling revenues from volume of water sold
- Incorporating monetized avoided costs: direct costs of water and energy and indirect costs such as infrastructure
- Shifting financial, technological and political risk from the municipality to the private sector, and providing the latter with risk-adjusted return on investment
- Moving from selling technology / infrastructure as a product to selling technology / infrastructure as a service
- Creating scale and feasibility through a bundle of technologies to provide a comprehensive solution for the municipality, including monitoring technologies

Question 2—How can sustainable, scalable, and market-driven solutions be created?

In order to answer this question, a conceptual model was structured that tests the financial and economic feasibility of implementing water-saving technologies in Californian municipalities, while incorporating the best practices identified in the first research question. The first section details how the model works, and its data sources, assumptions, and limitations. The second section presents the sensitivity analysis design and results. The third section presents the modelling outputs and offers some observations about the model's performance and general insights.

1. How the model works, data sources, assumptions, and limitations

The model simulates cash flows of a system comprising a water municipality in California, an engineering company (ESCO), and a bundle of water technologies, after the installation of water-saving technologies at the water utility. It results in the following outputs:

1. Municipal water savings achieved
2. Generated IRR for a 20-year period for three main stakeholders:

- c. The municipality
- d. The ESCO
- e. Water technology companies

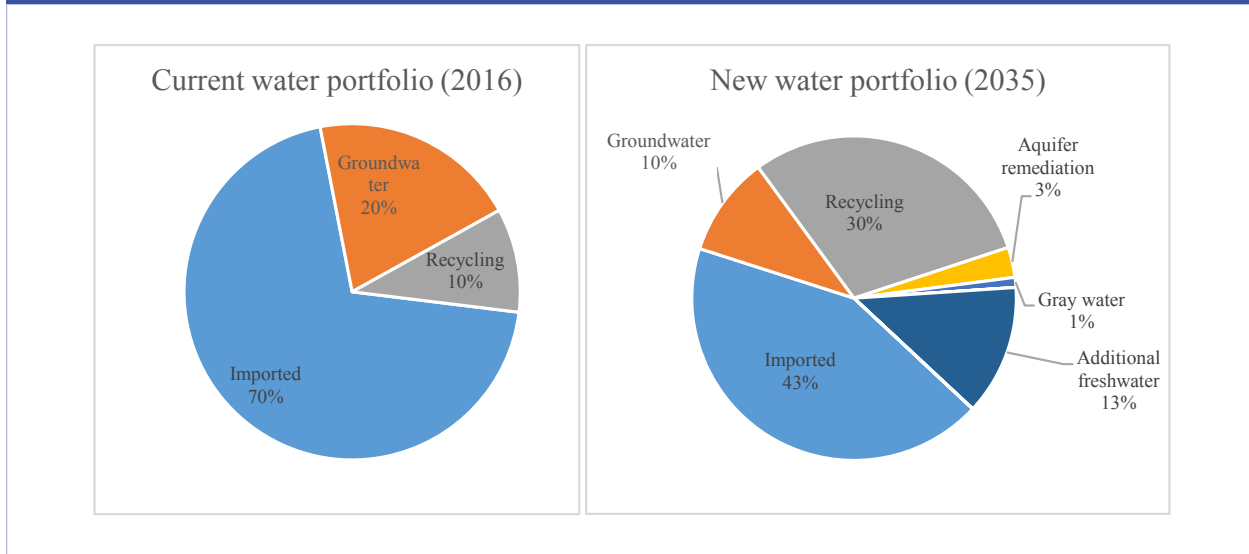
The model is based on the following structural assumptions:

1. 2015 baseline of water consumption, water resources (portfolio), and socio-economic parameters for a specific water district.
2. Projections of water consumption are a function of estimated population growth and expected water consumption per capita from 2016 until 2035.
3. A suggestion of a new sustainable water portfolio for 2035 is proposed (figure 3-4), including changes in per-capita consumption, new water resources, reduction in leaks, and better water management. This new portfolio is based on actual plans of the West Basin Municipal Water District and the Metropolitan Water District (MWD), while the exact design is my own combination of published data.
4. The following technologies are implemented in order to reach the new water portfolio requirements: wastewater reuse, aquifer remediation, leak detection, water management, covering reservoirs, and gray water systems.¹³
(All parameters can be modified, and the use of a specific technology can be turned on and off and set for a specific water saving goal.)
5. An estimation of the costs and revenues of the new water-saving technologies:
 - i. Projections for water and electricity prices through to 2035
 - ii. Capex, Opex, and estimated water and energy savings for the chosen technologies
 - iii. Supporting financial sources: low-interest loans / bonds, rebates for water projects, and support programs offered by the Israeli government
6. Costs and revenues are then shared among the municipality, the ESCO, and the companies over a period of 20 years, based on agreements that determine the share of Capex and Opex, share of savings and rebates, and length of contract period. This is designed to ensure that all stakeholders benefit and receive suitable returns.

Figure 3-4 displays the outcome of the model in terms of the different compositions of the current (2015) water portfolio and the projected 2035 water portfolio.

¹³ This choice is based on technologies currently installed in California, lessons from the Israeli experience, insights from interviews with water experts, and projected water savings and costs from each technology.

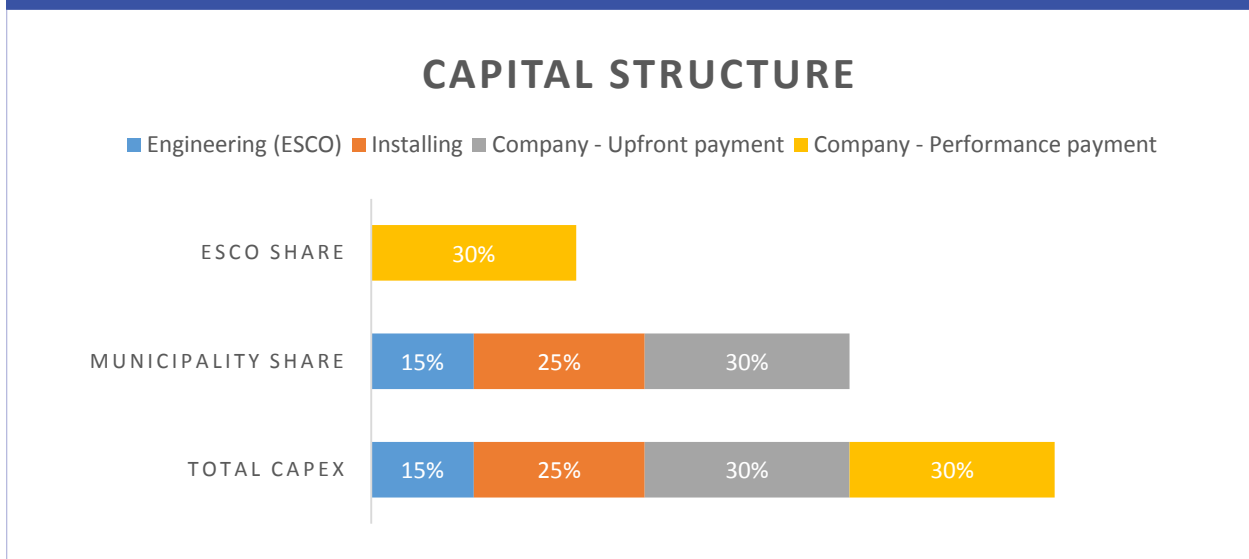
Figure 3.4: The current water portfolio (2016) and the new water portfolio (2035)



Source: Milken Innovation Center 2016.

Figure 3-5 shows the breakdown of the Capex outlay: (1) engineering—payment to the ESCO; (2) installation; (3) upfront payment to the technology companies; and (4) performance payment to the technology companies. It also shows which elements are paid by the municipality and which by the ESCO.

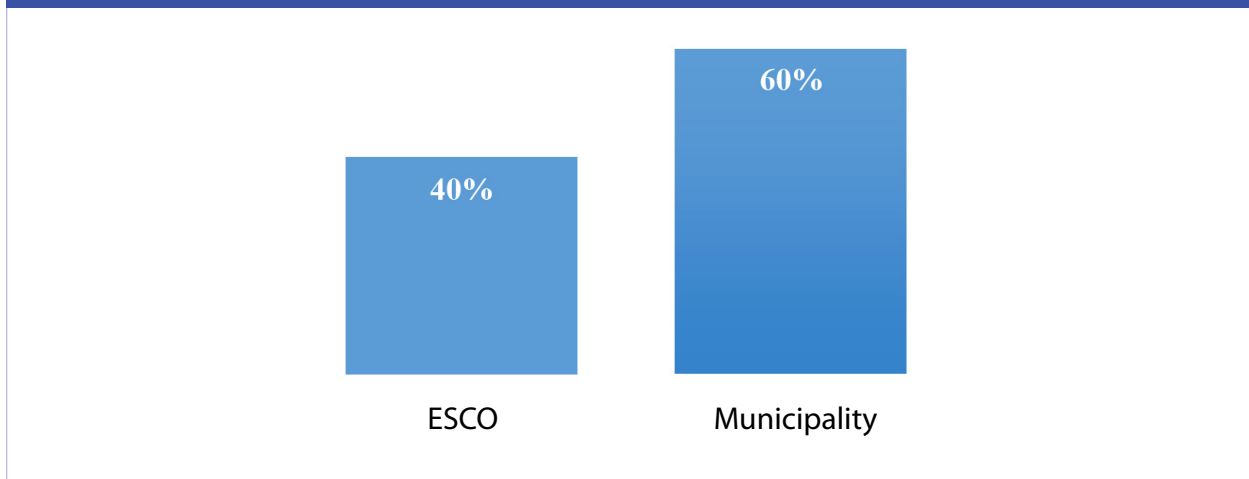
Figure 3.5: Share of Capex between the municipality and the ESCO, and breakdown of the municipal payment



Source: Milken Innovation Center 2016.

Figure 3-6 presents the share of Opex and revenues (water savings and rebates) between the municipality and the ESCO. In this model, it is assumed that the technology companies receive only half of their money upfront (30 percent of the total Capex), while the rest is paid to them by the ESCO based on performance, after successful implementation and projected savings are achieved.

Figure 3.6: Share of Opex and revenues (water savings and rebates) between the municipality and the ESCO



Source: Milken Innovation Center 2016.

Data for the model is taken from the following sources:

- California municipality figures are based on reports from the West Basin Municipal Water District (WBMWD) (Deshmukh 2016; West Basin Municipal Water District 2015; West Basin Municipal Water District 2014) and the Metropolitan Water District (MWD) (MWD 2015a; MWD 2015b; MWD 2015c), and complemented by figures taken from various research sources (PPIC 2016; Pacific Institute 2014b). More information about WBMWD and the MWD is provided in Appendix B.
- Companies’ cost and operating data was derived from interviews with water companies.
- Agreements between the ESCO, the municipality and the companies are based on actual energy projects carried out by ESCOs in California (Weisman 2016).
- Socioeconomic assumptions such as population growth, escalation, and discount rate are based on literature. All figures and sources are given in the following table (3-2):

Table 3.2: Figures and sources for the model

Data	Figure	Unit	Source
Price of water sold for residential use	1200	\$/Acre-Feet	WBMWD 2015
Price of imported water from the Metropolitan Water District (MWD)	950	\$/Acre-Feet	WBMWD 2015
Price of desalinated water	1060	\$/Acre-Feet	WBMWD 2015
Price of wastewater sold	1000	\$/Acre-Feet	WBMWD 2015
Price of electricity	0.1485	\$/kWh	EIA 2016
Escalation rate—inflation rate	2	%	Sacramento Forecast Project 2016, Cook 2013
Discount rate	5	%	Pogue 2015
Population size	1 million	-	WBMWD 2015
Population growth rate	0.80	%	MWD 2015b
Water consumption 2016	570	Liter per capita per day	Deshmukh 2016
Water consumption annual decrease	0.5	%	MWD 2015b
Related energy intensity	0.7	kWh/cubic meter	CPUC 2016
Wastewater Capex (\$/cubic meter)	5	\$	Interviews
Wastewater Opex (\$/cubic meter)	1	\$	Interviews
NRW	20	%	Ajami et al. 2014
Rebates for water projects	475	\$/Acre-Feet	MWD 2015a
Interest rate for loans for water projects	1	%	IBANK 2016 (SWEEP program)
Government support for export activity	120,000	\$/pilot project	Foreign Trade Administration 2016

Additional important assumptions had to be made to allow for simplicity. The most important of these are:

- Implementation time is taken as two years from idea to operation (for purposes of calculating escalation in capital costs), with partial water savings achieved during the first six years.
- Energy savings are based on the savings on energy required to distribute water.
- Payments for the construction of purple pipelines (for treated wastewater) are not included, assuming distributed wastewater plants.
- Payments for repairs to infrastructure (mainly leakage) are not included, assuming a reduction in general repair costs thanks to improved detection.
- Future cost of water is based on escalation rates and on the source of water (e.g. treated wastewater, remediated aquifers, and other sources). It does not include the potential implications of increasing scarcity.
- Payments to the companies are made for the bundle as a whole and are not divided between them according to performance.
- Desalination is included in the model, but is not included in the financial results due to its relatively high Capex and Opex (mostly energy costs).

This study provides a general estimation of the possible contribution of innovative financial mechanisms that can enable the implementation of projects not feasible in traditional financial structures. However, it should be noted that it is not suitable for testing the feasibility of specific projects, and is not accurately adjusted for geographical characteristics, customer preferences, and other factors that might impact the contribution and costs of technologies.

2. Sensitivity analysis

In order to validate the credibility of the model, a sensitivity analysis was conducted to better understand “how the output of [the] model can be apportioned to different sources of uncertainty in the model input” (Saltelli et al. 2008). Although its original purpose is to test model feasibility, it also served to improve the model and the research design through an iterative process. The sensitivity analysis was conducted using a one-at-a-time technique (Breierova and Choudhari 1996) in which each parameter was independently altered twice—increased by 20 percent and then decreased by 20 percent—while the others were kept constant. Findings are presented in table 3-3, in which white represents zero impact and black represents maximal impact. The shades of gray were normalized according to the relative impact of each input, meaning that increasingly darker shades represent a larger impact (Herman et al. 2014). An index is given to explain the meaning of each shade.

Table 3.3: Sensitivity analysis results

Model inputs		Model outputs	
		Stakeholder performance—IRR & Breakeven	Water savings
Economic parameters	Discount rate	Low impact	No impact
	Escalation rate	Low impact	No impact
Stakeholder agreement	ESCO agreement (terms, share of investment, savings, and payments)	Low impact	No impact
Municipality characteristics	Population growth rate / per-capita consumption rate	Low impact	Low impact
	Price of water sold	High impact	No impact
	Price of electricity	Low impact	No impact
	Water rebate programs	Low impact	No impact
	New water portfolio	High impact	High impact
Technologies	Capex	Low impact	No impact
	Opex	Low impact	No impact

Shade:	No impact	Low impact	Medium impact	High impact	Significant impact
---------------	-----------	------------	---------------	-------------	--------------------

An observation to illustrate the meaning of table 3-3: The discount rate used has low impact (light grey) on the stakeholder financial performance (IRR and breakeven), while the price of water sold has a significant impact (dark grey) on it. In contrast, the discount rate has no impact on water savings, as this figure is determined by policy in this model.

The results of this sensitivity analysis provide some valuable insights. First, water savings are mostly affected by the behavior of the local residents (population growth and per-capita consumption) and by the design of the new water portfolio. This implies that while technology of course plays a crucial role, awareness and social behavior also matter. It also shows that the model is designed to achieve certain water savings, regardless of their financial and economic implications. Second, the financial

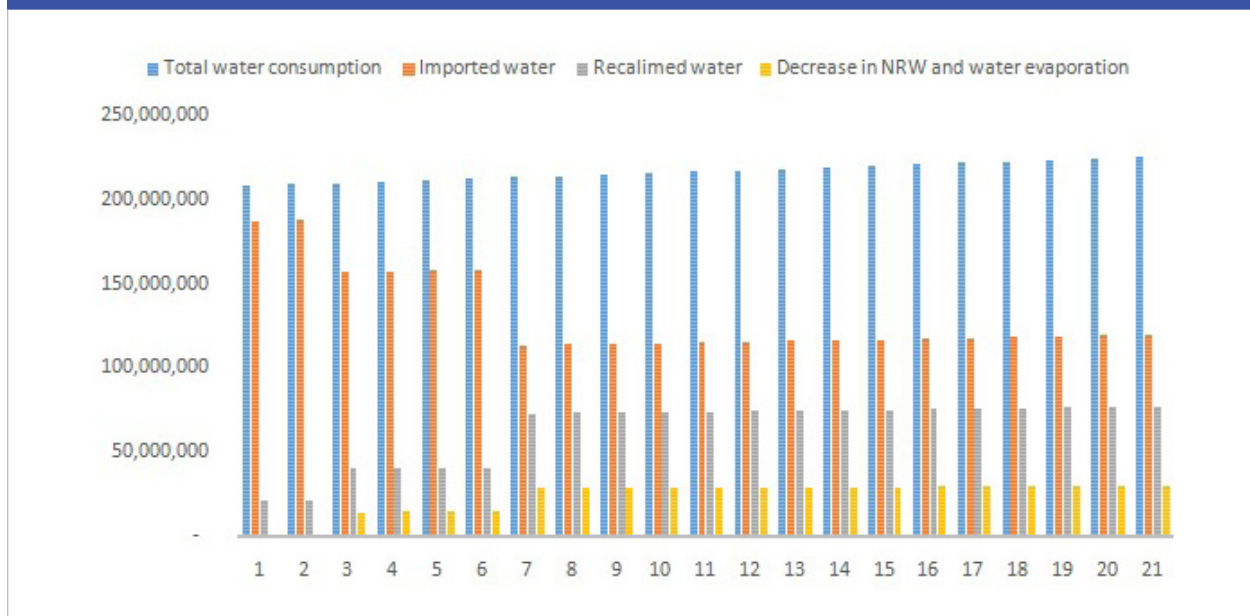
performance for the stakeholders is affected by many parameters across various areas. The most important variables are the price at which water is sold and the cost of technologies (both Capex and Opex). Inevitably, the designed water portfolio affects stakeholders' IRR, as it both determines the scale of implementation of each technology, and affects water prices, as each water source is sold at a different price.

3. Modelling results and discussion

The modelling results are given in the next ten charts (figures 3-7 to 3-16); each is followed by particular insights offered by the model and the sensitivity analysis.

The first graph (figure 3-7) displays changes in the water portfolio from 2016 to 2035:

Figure 3.7: Changes in water portfolio across 20 years. Technology and behavior are both parts of the solution.



Source: Milken Innovation Center 2016.

Total water consumption is supplied from three water sources: imported from the MWD, reclaimed treated wastewater, and decreased water loss. The contribution of technologies to water supply makes it possible to cut the share of imported water. It can be seen that the technologies begin to have an effect after two years due to assumed implementation time, and that they operate at 50 percent capacity until the sixth year, after which they start operating at full capacity.

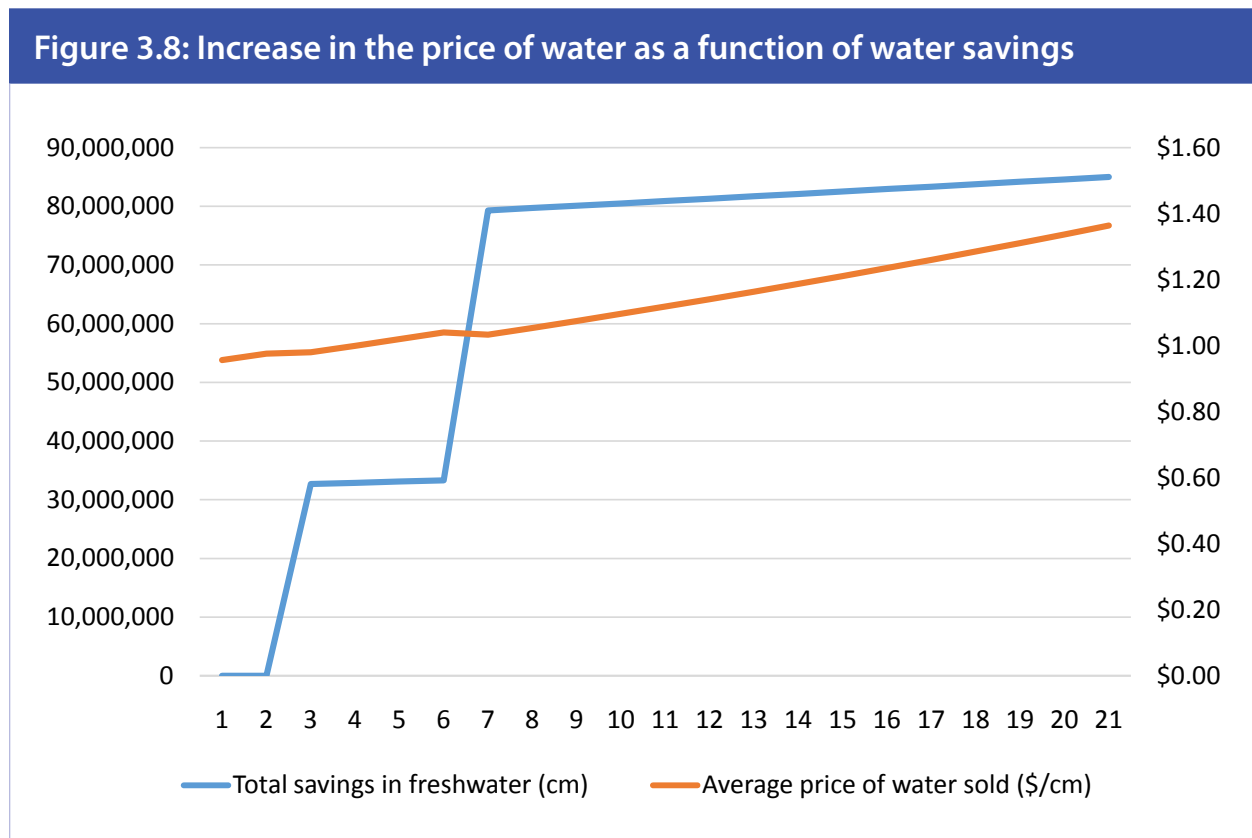
The main insight from this chart is the importance of behavior: despite estimated population growth there is only a modest estimated increase in total water consumption, thanks to projected decrease in

per-capita consumption. Moreover, as per-capita reduction grows, the scale at which technologies are installed and operated can be reduced.

The second chart (figure 3-8) demonstrates the necessary increase in the price of water, as a function of water savings. Increase in price is a result of three processes:

1. Escalation over time
2. The need to pay for investment in technology and infrastructure
3. The need to compensate for the avoided revenues from water savings. This increase can serve to decouple water sales from water revenues through the creation of a surcharge.

In other words, the price of water gradually adjusts to reflect its real value.



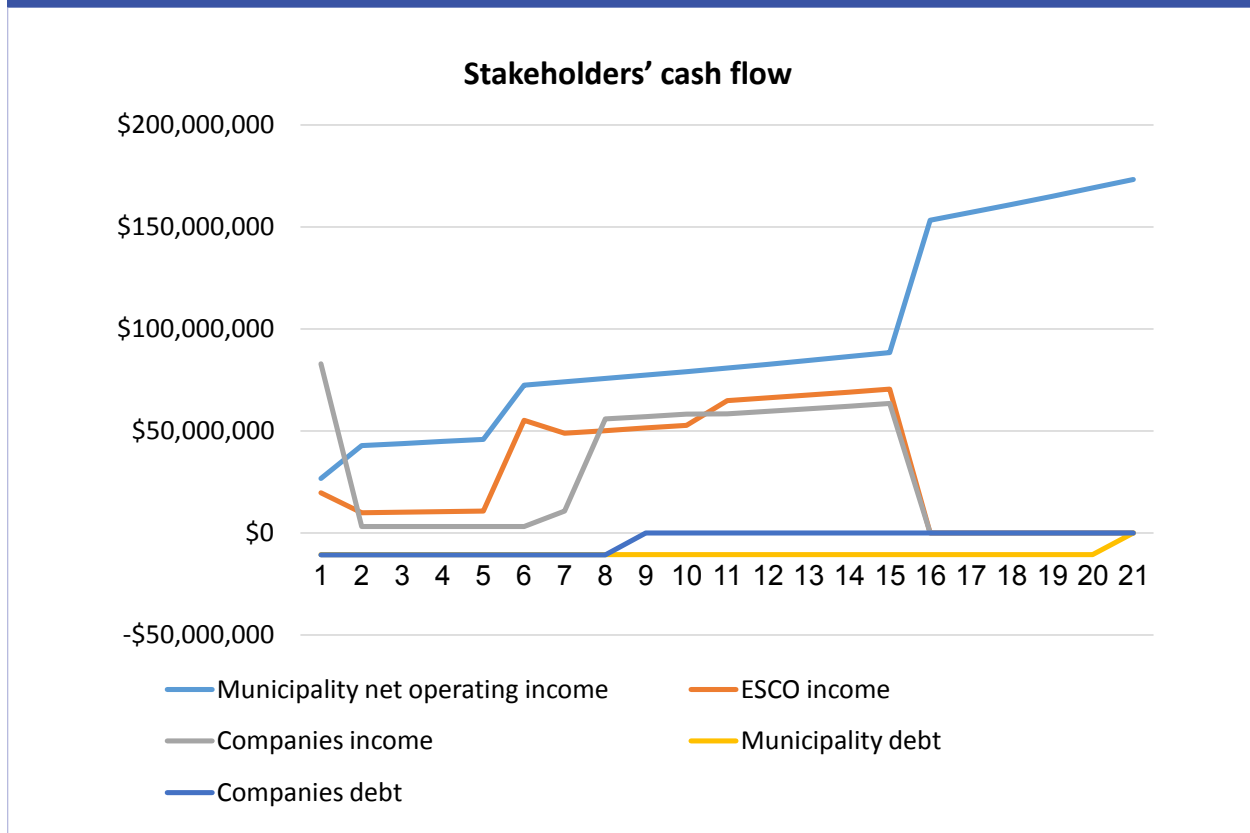
Source: Milken Innovation Center 2016.

Increasing the price of water may be a contested political decision (Gilmont 2014). Water is conceived by many as a basic human right that should be sold at a low price, or should be free of charge (like the air we breathe). Therefore, increases in water prices should be very well communicated and carefully designed (Distel, 2016; Mercer and Christensen 2013). This can also include tiered pricing mechanisms and income-adjusted pricing. Another point to mention here is that, as presented in table 2-1, the

price of water in Israel is, on average, four-times higher than in California.

The next chart (figure 3-9) presents the distribution of revenues among the three stakeholders over a 21-year period of time. It represents outcomes of the agreements between the three stakeholders—the eight-year agreement between the ESCO and companies, and the 15-year agreement between the municipality and the ESCO—and of the initial Capex outlays (first year payments), as given in figure 3-5.

Figure 3.9: Cash flow payments among the three stakeholders over the 21-year period. Agreements matter and there is room for flexibility and creativity

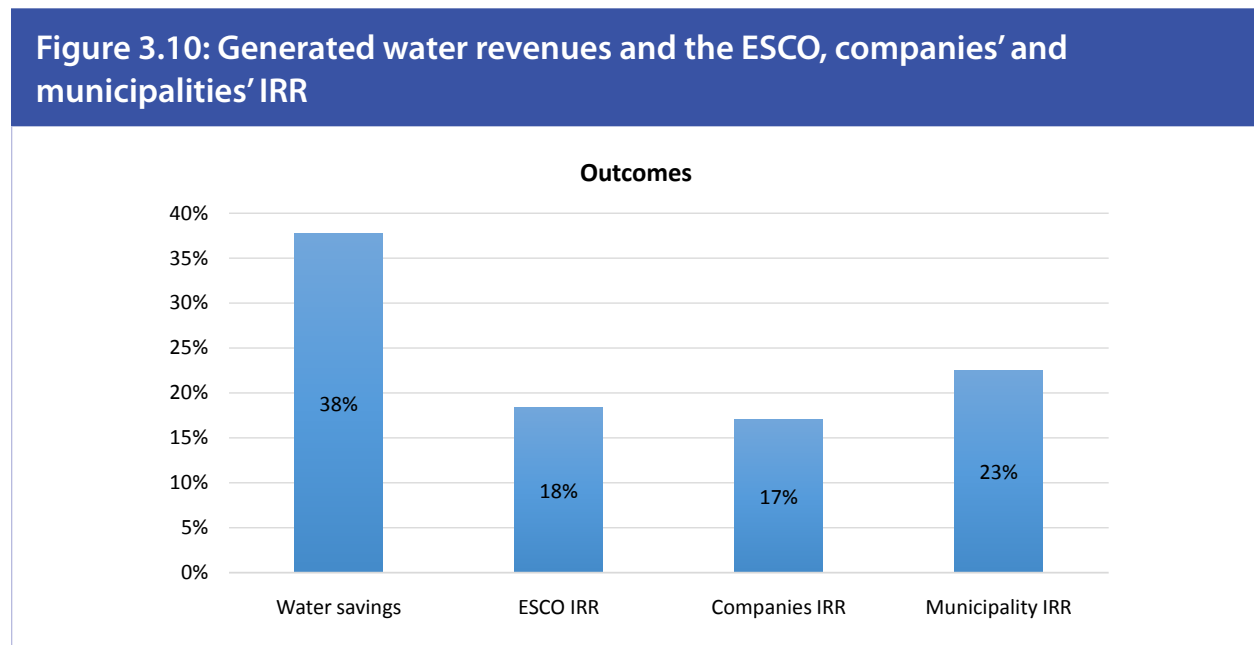


Source: Milken Innovation Center 2016.

It can also be seen that when water savings are generated, the ESCO and the municipality are the first ones to enjoy revenues, so that the municipality can start paying back its 20-year loan and the ESCO can start paying its investors. The companies receive only a small payment at the beginning, to help them cover their debt. Only after the ESCO IRR is positive (year 8) do the companies start receiving a higher share of the revenues. In year 15, two important things happen: first, the agreement between the ESCO and the municipality expires, and all costs and revenues are transferred to the municipality; and second, the rebate program ends and therefore the stream of overall revenues decreases.

Importantly, in structuring this type of financing, terms and conditions will be modified to ensure that all stakeholders benefit proportionately in relationship to their investment and risk, and that their breakeven point and returns are sufficient to attract their participation in the transaction. As such, performance premiums can be paid to the technology companies in order to incentivize performance. Another important financial aspect is support sources, namely low-interest loans (or bonds) for water projects, rebate programs, and government support for export activities. Low-interest loans do not only lower the cost of capital, but in some cases allow access to capital that would not otherwise be available. Rebate programs are key as they augment revenues and sometimes tip the scale between negative and positive cash flows. MWD’s Local Resources Program (LRP) (MWD 2015a), for example, has a significant impact on this model’s feasibility, as demonstrated by the sensitivity analysis results (table 3-3) and by the scenarios analysis (table 3-4). Finally, the contribution of Israeli export support programs may be negligible in terms of total project expenses, but are vital to the Israeli companies in two ways. First, young companies with low capital may need this money to keep them alive. Second, such support for innovation can have an important psychological effect, especially for companies with zero or very few commercial installations.

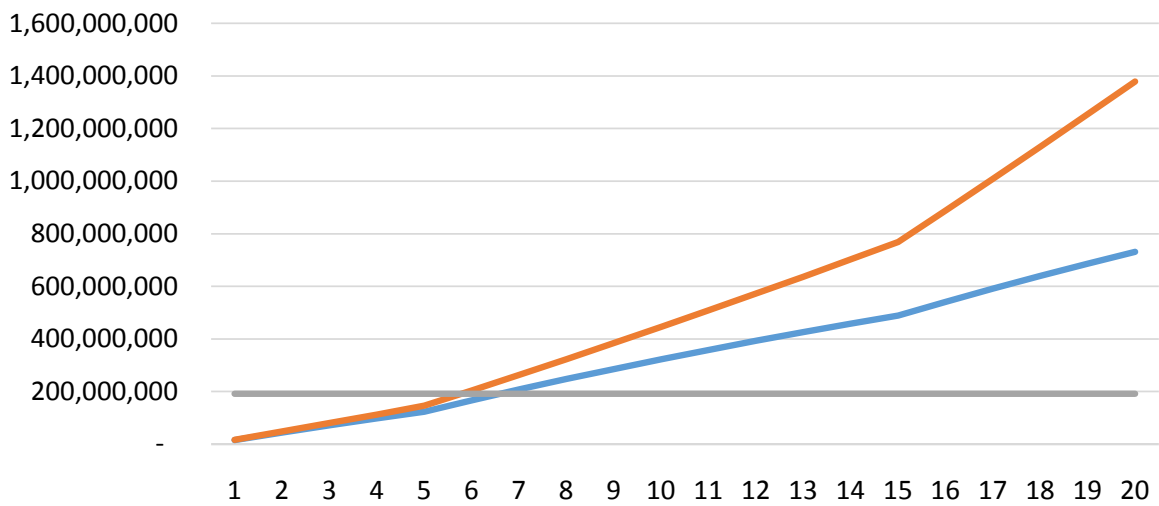
The next chart (figure 3-10) shows the model outcomes: water savings and the three stakeholders’ IRR. The next three charts (figures 3-11, 3-12, and 3-13) complement it by demonstrating the stakeholders’ breakeven point—both “standard” (upper line) and “discounted” (lower line)¹⁴.



Source: Milken Innovation Center 2016.

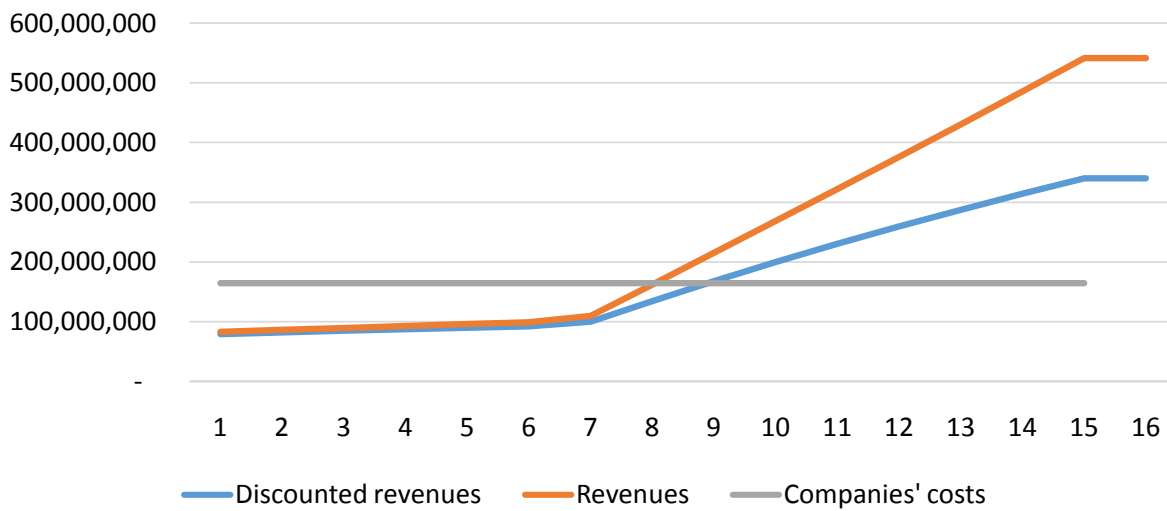
¹⁴ “Standard” refers to cumulative future cash flows, while “discounted” refers to cumulative future cash flows after applying the discount rate in order to calculate their Net Present Value (NPV).

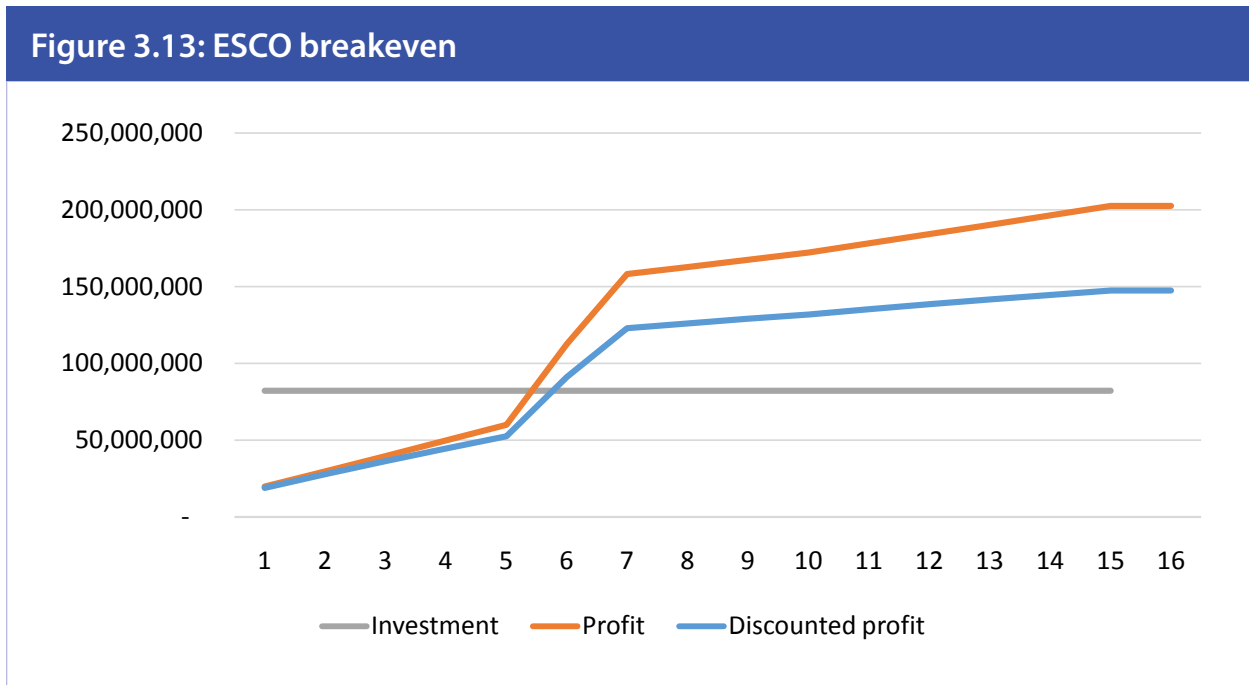
Figure 3.11: Municipality breakeven



Source: Milken Innovation Center 2016.

Figure 3.12: Companies breakeven





Source: Milken Innovation Center 2016.

Because the driver of this financial structure is the ESCO, which brings investors willing to invest their capital in the project, the most important outcome is that the ESCO model is feasible. And indeed, it generates substantial water savings (38 percent savings in all), while at the same time generating worthwhile IRR values to all stakeholders (ESCO—18%, companies—17%, municipalities—23%). It is important to mention that the slight differences in the breakeven and IRR values can be easily “traded” in line with the design of the agreements. Finally, the choice of discount rate has a real impact on the project’s outcomes (e.g., discounted profit), a finding that is also understood from the sensitivity analysis results (table 3-3) and from the scenarios analysis results (table 3-4).

The last piece of this analysis is a comparison between three scenarios—best case, central case, and worst case—designed in order to address uncertainty in future parameters. Each scenario comprises different values for six parameters, as presented at table 3-4 and explained in the next paragraph. Generally, the best case scenario describes a future in which policy is designed to support water savings to the highest degree, the local population consumes the smallest amount of water, and the cost of technology is the cheapest. The worst case is the opposite, and the central case is in between.

Table 3.4: Parameters for the three scenarios

Scenario			
Parameter	Best case	Central case	Worst case
Escalation rate (%)	3	2	1
Discount rate (%)	3	5	8
Water consumption annual decrease (%)	1	0.5	0.2
Rebates for water projects (\$/acre-foot)	550	475	400
Wastewater Capex (\$/cubic meter)	4	5	6
Wastewater Opex (\$/cubic meter)	0.7	1	1.3

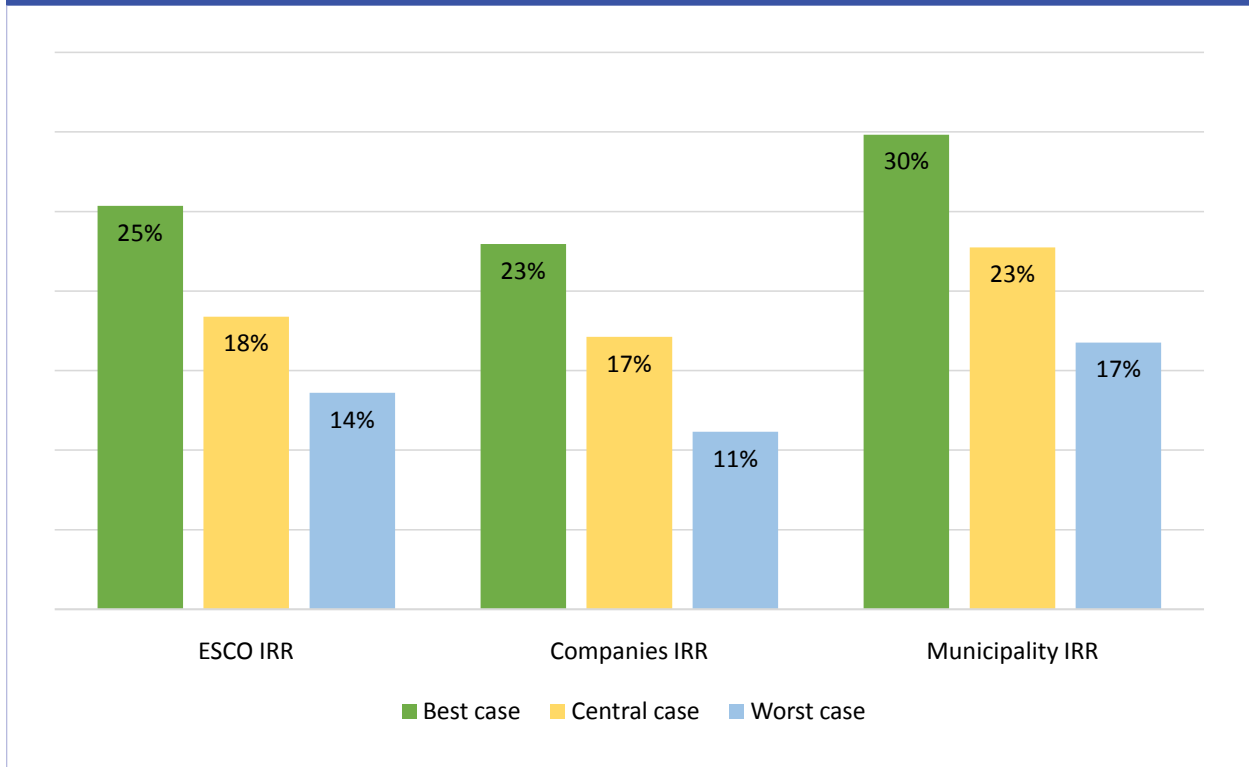
The specific parameters used to create the three scenarios were chosen for the following reasons:

- The escalation rate was used to simulate different economic growth scenarios; since its biggest impact in this model is on future water prices, a higher escalation rate results in better financial performance.
- The discount rate was used due to its impact on long-term decisions, or as Pogue (2015) puts it: “higher discount rates will mean that future investments with a long-term horizon for payoff will be worth less today and will have a harder time being approved by decision making bodies. Conversely, applying a low discount rate will result in high future investment, which might crowd out better current uses of resources.” Here, the discount rate impacts the discounted breakeven point.
- Decrease in water consumption affects the scale to which technologies need to be installed, and so lowering consumption rates directly results in lower technology costs (both Capex and Opex).
- The “rebates for water projects” parameter reflects the amount provided by the MWD for each unit of water saved. This is a direct and active way for policy makers to support water conservation, and the higher the rebate is, the better the financial performance becomes.
- Finally, technologies’ Capex and Opex directly affect project costs and thus financial performance.

Figure 3-11 compares the three scenarios according to each stakeholder’s IRR; figure 3-12 compares

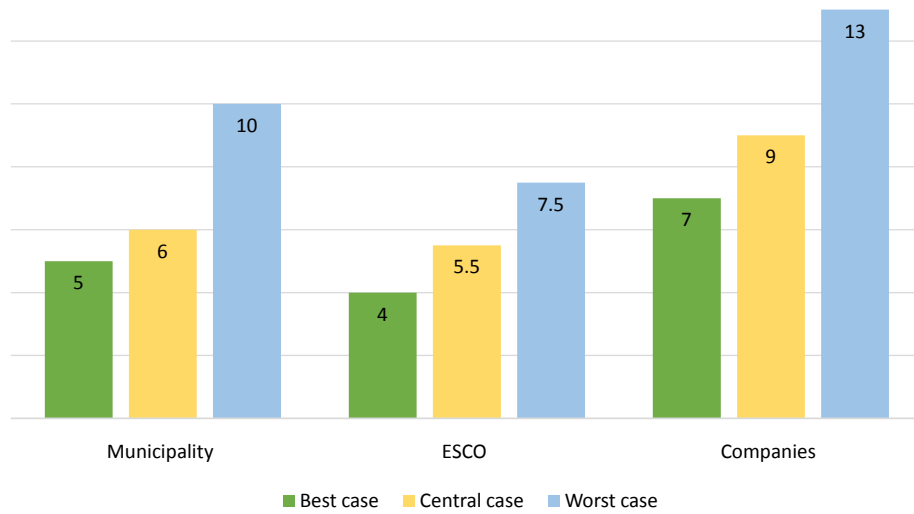
the three scenarios according to each stakeholder’s discounted breakeven point; and figure 3-13 compares them according to total Capex and Opex required. It is important to stress that the new water portfolio was kept constant in all scenarios, so that the rate of water savings remained the same.

Figure 3.14: Comparing the three scenarios according to each stakeholder’s IRR



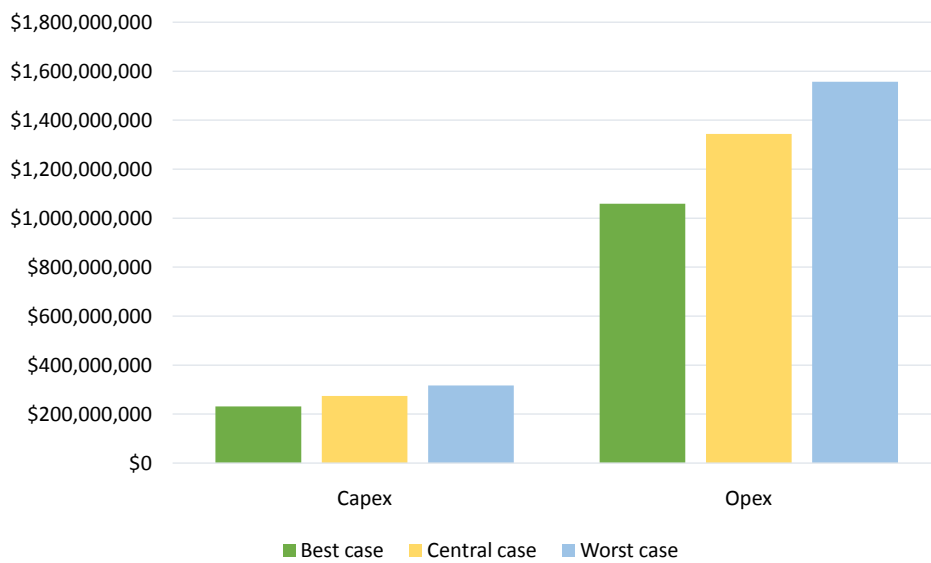
Source: Milken Innovation Center 2016.

Figure 3.15: Comparing the three scenarios according to each stakeholder's discounted breakeven point (in years)



Source: Milken Innovation Center 2016.

Figure 3.16: Comparing the three scenarios according to total Capex and Opex required



Source: Milken Innovation Center 2016.

From the three figures (3-14, 3-15, 3-16) it is evident that future uncertainty matters a lot. While in all scenarios the IRR values are positive and higher than ten percent, and the worst case scenario breakeven point is still under 15 years, performance deteriorates to the extent that the investment is questionable. However, while some parameters are market-dependent (e.g., the escalation rate) others are in the hands of policy makers—mainly water rebates, assigned discount rates, and the decrease in water consumption through education and awareness. Thus, the business case for water is very much driven by policy.

Another key aspect is the cost of technology, both Capex and Opex. The more cost-effective the technology, the better the financial performance. Many of the proposed technologies are already performing at the required level of cost-effectiveness to make the business case for water, and additional improvements could be achieved through R&D, or also through creative solutions such as distributed installations that substantially reduce energy (Quesnel et al. 2016). Generally, as seen in the sensitivity analysis results (table 3-3) and in the first figure comparing the 2016 and 2035 water portfolios (figure 3-7), technology performance matters, yet it is only a part of the solution.

To conclude, the results of this financial model show that all stakeholders can benefit from water savings. When internalizing additional benefits from water savings, taking advantage of financial support, taking a long-term view and calculated risks, gradually increasing the price of water and carefully designing terms and conditions among stakeholders, the business case for water-saving projects can be made.

Question 3—What are the general recommendations for making the business case for water projects?

This final section contains recommendations on how to make the business case for water projects, based on the Israel-California case study. It begins with a summary of lessons learned so far followed by insights from the model, and based on which recommendations for stakeholders and policy makers are given. The section ends with recommendations for other regions worldwide.

Summary of lessons and insights

How can Environmental Impact Financing (EIF) be used to tackle Californian barriers?

- Financing challenges:
 - Lack of upfront capital ← Attract capital from the private sector and use avoided costs.
 - Insufficient financial incentives ← Realignment of incentives, particularly by internalizing incentives that usually remain external, and incentivizing technologies to perform via

performance-based payments.

- Lack of monitoring ← Monitoring technologies as part of the bundle.
- Fragmented management ← Create distributed solutions, and Master Services Agreements (MSAs).
- Conservative environment ← Shift risk from municipalities to the private sector, and reward with risk-adjusted returns.

Lessons from what companies are doing now

- Clearly demonstrate ROI, savings on indirect costs, and improved cost-effectiveness.
- Move from selling technology as a product to selling technology as a service.

Lessons from the energy sector

- Focus on the business case for projects.
- Incentivize performance.
- Decouple water revenues from water sales by increasing water prices or introducing surcharges.

Sensitivity analysis results

- While technology plays a crucial role, awareness and social behavior matter.
- The price of water and the cost of new technologies (Capex and Opex) are the most important factors in determining IRR for stakeholders.

Insights from the model

- There is a business case for water. Significant water savings can be achieved while generating worthwhile IRR values to investors / stakeholders.
- Public-private partnerships, like the EIF model, carry multiple advantages, mainly bringing new capital, shifting risk, and combining knowledge.
- Water prices should gradually increase to reflect real costs. This can also serve to decouple water revenues from water sales.
- Financial agreements between stakeholders matter, and there is room for flexibility and creativity in those agreements. They should be designed to make sure all stakeholders benefit in

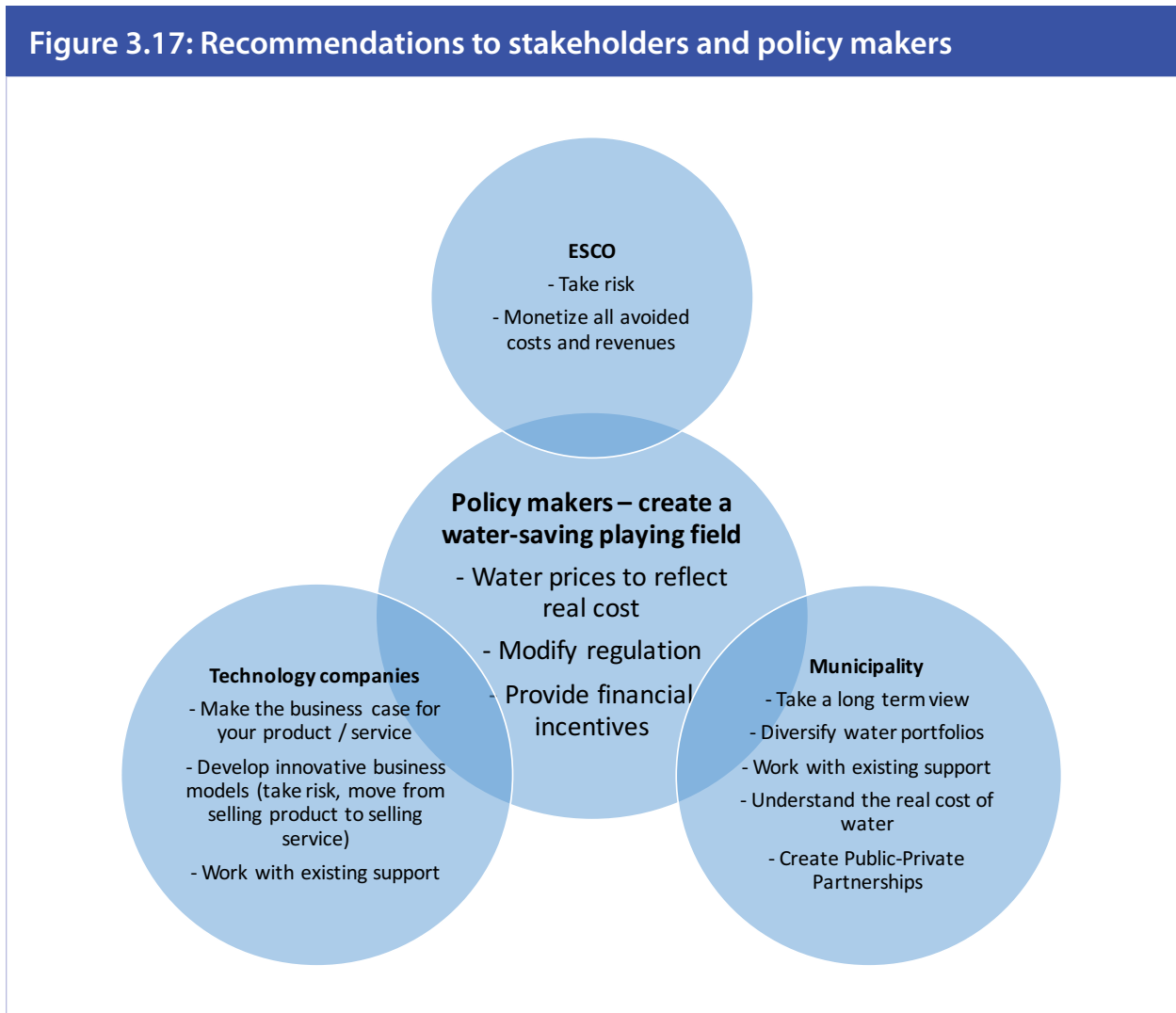
proportion to their risk, and that their breakeven point is feasible.

- Government support is key (e.g., low interest loans for water projects, rebate programs, and support for export activities).
- A long-term view is necessary to analyze costs and benefits and to justify the project's ROI. As part of this, the discount rate has a real impact on project outcomes.
- Scenarios analysis:
 - Future uncertainty matters a lot. However, the business case for water is very much driven by policy—mainly water rebates, assigned discount rates, and lowering water consumption through education and awareness.
 - The cost-effectiveness of technologies is key.

Recommendations to policy makers and stakeholders

Based on the aforementioned lessons and insights, a list of recommendations to policy makers and stakeholders was compiled (figure 3-17). In short, policy should be designed to create a playing field that incentivizes different stakeholders to save water, while stakeholders should be aware of available support mechanisms, other actors with whom they can collaborate, and how to design collaboration agreements to create synergies.

Figure 3.17: Recommendations to stakeholders and policy makers



Source: Milken Innovation Center 2016.

Policy level

1. Israeli government
 - Issue a “technology guarantee” or “technology efficacy insurance” to shift technical risks from companies to the government.
 - Provide subsidized guidance for companies that is tailored for a particular target market.
2. California government
 - Create a playing field that incentivizes water saving:

- Gradually increase water prices to reflect real cost, and compensate for avoided revenues from water savings.
 - Modify regulation to ease and shorten the implementation of innovative technologies.
 - Provide financial incentives to save water to: consumers, municipalities, technology companies, and investors (ESCOs).
 - Some programs already exist, and need to be changed to include water projects or to be better marketed.
 - New mechanisms such as tax credits could be developed or adjusted based on performance-based metrics.
- 3.** Under the Israel-California Memorandum of Understanding (MOU)
- Establish a joint working team focused on implementation of the MOU. This could include:
 - A demonstration site of Israeli water technologies in California.
 - Development of fast-track regulatory approvals; could be done through a Master Services Agreement (MSA).
 - Financial support for initial commercialization of Israeli technologies in California.

Stakeholders

- 1.** Municipalities
- Promote a long-term view and planning approach, and diversify water portfolios.
 - Internalize externalities to make clear the real cost of water at the municipal level.
 - Work with existing financial support.
 - Create Public-Private Partnerships that leverage private investment into creating new water services infrastructure.
- 2.** Companies
- Make the business case for the deployment of water-saving technologies.
 - Demonstrate ROI, savings on indirect costs, and improved cost-effectiveness.
 - Develop innovative business models that will incentivize end-users and/or investors to implement technology.

- Adjust revenue models to allow for performance-based compensation based on successful implementation of technology solutions.
 - Where applicable, move from selling products to selling services.
 - Work with existing financial support.
- 3. Investors (ESCO)**
- Be willing to take calculated risks and to be rewarded with the adjusted return.
 - Monetize avoided costs and revenues, including indirect costs, rebates, and support programs.

General recommendations

Every region has its own political, economic, social, and environmental attributes, including water sources, water prices, government policy and support, regulation, and social awareness, and these particular traits should be taken into the account in the formation of policy. California has the eighth-largest economy in the world, and already has many examples of the ESCO model being used widely in its energy sector. Moreover, the water-energy nexus plays a significant role in California's water supply systems. Finally, water prices in California are relatively low and affected by private water rights. This specific combination is unique to California, which makes the attempt to draw wider implications quite challenging.

However, since the barriers identified for California municipalities are very similar to, and in some cases derived from, global barriers (section 2-1), the solution presented here may well be relevant for municipalities in other regions worldwide, with necessary modifications to be made for each location. Policy recommendations for creating an ecosystem that incentivizes water saving, in addition to recommendations for each stakeholder to focus on the business case for water, could be applied in other regions and hopefully help bring about change.

Moreover, this research study demonstrates the potential contribution of the ESCO model to the water sector, a model that is successfully applied in the Californian energy sector. On a basic level, the research translates a successful practice from one sector to another. Therefore, this study also provides an example of how prominent and complex problems can be addressed with existing means, tools, and practices, after slight modifications. Finally, it demonstrates how finance acts as the fulcrum for projects.

4. Summary

This research study sought to propose a systemic solution to the California water crisis, as a contribution toward tackling the global water problem. It built upon the work done by the Milken Innovation Center and the California-Israel Global Innovation Partnership, and specifically examined innovative financial mechanisms for implementing Israeli water-saving technologies in the California municipal sector. The main goal was to demonstrate that, through the use of innovative financial mechanisms and careful project design, there is a business case to be made for water-saving projects.

Based on an extensive literature review and interviews with key players and stakeholders from both Israel and California, a conceptual model was constructed. The model offers ways to overcome identified barriers using Environmental Impact Financing (EIF) mechanisms, and includes best practices from the Israeli water success story, from the energy sector, and from business methods currently employed by water and technology companies.

The modelling outcomes demonstrated the business case for water-saving technologies: significant water savings can be achieved while generating worthwhile returns to all stakeholders. The model's outcomes also provide a framework for some general recommendations to policy-makers and stakeholders—specifically, the advantages of Public-Private Partnerships (PPPs); the fact that prices must be increased to reflect the true value of water; the importance of government support; and the value of a long-term view. These recommendations are also applicable in other regions worldwide, as they address global barriers to attaining water sustainability.

The main limitation of this study is that the model is conceptual rather than concrete. While it allows for a general solution to be proposed, it is not sufficiently accurate, and contains simplifications, generalizations, and assumptions. Therefore, any practical project must be specifically designed and adjusted to local characteristics.

Bibliography

ADAN Technical and Economic Services. 2013. *Final Report—The Water-Energy Nexus in Israel and Worldwide*.

Ajami, Newsha K., Barton H. Thompson,, and David G. Victor. 2014. *The Path to Water Innovation*. Brookings Institute—Hamilton Project Discussion Paper. Available at: https://woods.stanford.edu/sites/default/files/files/path_to_water_innovation_thompson_paper_final.pdf. (Accessed: June 27, 2016).

Allan, Tony. 1999. "Virtual Water—The Water, Food, and Trade Nexus: Useful Concept or Misleading Metaphor?" *Water International* 28 (1): 106-113.

McIntosh, Arthur. 2003. "Non-Revenue Water." In Arthur McIntosh, *Asian Water Supplies: Reaching the Urban Poor*. Asian Development Bank. Available at: http://www.sswm.info/sites/default/files/reference_attachments/MCINTOSH%202003%20Asian%20Water%20Supply%20Chap%209%20Non%20Revenue%20Water.pdf. (Accessed: July 12, 2016).

Avrahami, T. (Ayyeka). Interview with the author, 2016.

Stock, Stephen, Michael Bott, and Jeremy Carroll. 2015. "Barriers Stand in the Way of Innovation That Could Help Solve California's Water Crisis." *NBC Bay Area* website. Available at: <http://www.nbcbayarea.com/investigations/Bureaucratic-Barriers-Stand-in-the-Way-of-Innovation-That-Could-Help-Solve-Californias-Water-Crisis-346981822.html>. (Accessed: December 14, 2015).

BusinessWire. 2015. "Cambrian Innovation Launches \$30M Fund to Finance Distributed Clean Water Solutions." November 18. Available at: <http://www.businesswire.com/news/home/20151118005219/en/Cambrian-Innovation-Launches-30M-Fund-Finance-Distributed>. (Accessed: July 5, 2016).

California Natural Resources Agency. 2014. *California Water Action Plan*. Available at: http://resources.ca.gov/docs/california_water_action_plan/2014_California_Water_Action_Plan.pdf. (Accessed: July 5, 2016).

California Water Service. 2016. *FAQ: What is WRAM?* Available at: <https://www.calwater.com/help/rate/what-is-wram/>. (Accessed: July 5, 2016).

Cleantech Group and WWF. 2014. *The Global Cleantech Innovation Index 2014*. Available at: <https://wwf.fi/mediabank/6751.pdf>. (Accessed: July 6, 2016).

Cook, J. 2013. *The Future of Electricity Prices in California: Understanding Market Drivers and Forecasting Prices to 2040*. Available at: <http://eec.ucdavis.edu/files/02-06-2014-The-Future-of-Electricity-Prices-in-California-Final-Draft-1.pdf>. (Accessed: July 7, 2016).

CPUC. 2010a. *Embedded Energy in Water Studies Study 1: Statewide and Regional Water-Energy*

Relationship. Available at: <http://www.waterenergyinnovations.com/publication/view/cpuc-embedded-energy-in-water-studies-1-statewide-and-regional-water-energy-relationship/>. (Accessed: July 5, 2016).

CPUC. 2010b. *Embedded Energy in Water Studies Study 2: Water Agency and Function Component Study and Embedded Energy—Water Load Profiles*. Available at: <http://www.waterenergyinnovations.com/publication/view/cpuc-embedded-energy-in-water-studies-2-water-agency-and-function-component-study-and-embedded-energy-water-load-profiles/>. (Accessed: July 5, 2016).

CPUC. 2016. *Water/Energy Nexus Programs*. Available at: http://www.cpuc.ca.gov/nexus_calculator/. (Accessed: July 5, 2016).

Deshmukh, S. (West Basin Municipal Water District). Interview with author, 2016.

Deutsche Bank Research. 2010. *World Water Markets: High Investment Requirements Mixed with Institutional Risks*. Available at: https://www.dbresearch.com/PROD/DBR_INTERNET_EN-PROD/PROD000000000258353/World+water+markets%3A+High+investment+requirements+mixed+with+institutional+risks.pdf. (Accessed: July 5, 2016).

Distel, O. (Israel NewTech). Interview with author, 2016.

Efrat, Z. (Aquarius Spectrum). Interview with author, 2016.

EIA. 2016. *Average Price of Electricity to Ultimate Customers by End-Use Sector*. Available at: https://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a. (Accessed: July 7, 2016).

Ernst & Young. 2013. *The US Water Sector on the Verge of Transformation*. Available at: [http://www.ey.com/Publication/vwLUAssets/Cleantech_Water_Whitepaper/\\$FILE/Cleantech-Water-Whitepaper.pdf](http://www.ey.com/Publication/vwLUAssets/Cleantech_Water_Whitepaper/$FILE/Cleantech-Water-Whitepaper.pdf). (Accessed: July 5, 2016).

Ezekiel, N. H. 2015. "Israeli Water Technology and California: Bridging The Last Mile." *WaterBiz* (October): 15–17.

Famiglietti, J. S., M. Lo, S. L. Ho, J. Bethune, K. J. Anderson, T. H. Syed, S. C. Swenson, C. R. De Linage, and M. Rodell. 2011. "Satellites measure recent rates of groundwater depletion in California's central valley." *Geophysical Research Letters* 38 (3).

Feldman, S. (Takadu). Interview with author, 2016.

Israel Ministry of Economy and Industry: Foreign Trade Administration. 2016. *Industry Support Tools*. Available at: <http://www.economy.gov.il/InternationalAffairs/InternationalProjectsFinancing/Pages/>

default.aspx. (Accessed: July 5, 2016).

Gilmont, M. 2014. "Decoupling Dependence on Natural Water: Reflexivity in the Regulation and Allocation of Water in Israel." *IWA Publishing* 16 (1): 101–79.

Goldfarb, A. (Kando). Interview with author, 2016.

Goldman Sachs. 2013. *Sustainable Growth: Taking a Deep Dive into Water*. Available at: <http://www.goldmansachs.com/our-thinking/clean-technology-and-renewables/cohen/report.pdf>. (Accessed: July 5, 2016).

GAO (Government Accountability Office) Center for Science, Technology, and Engineering. 2016. *Municipal Freshwater Scarcity: Using technology to improve distribution system efficiency and tap nontraditional water sources*. Available at: <http://www.gao.gov/assets/680/676898.pdf>. (Accessed: June 27, 2016).

Greenwald, D. (Israel Water Authority). Interview with author, 2015.

Hanak, Ellen, Brian Gray, Jay Lund, David Mitchell, Caitrin Chappelle, Andrew Fahlund, Katrina Jessoe, Josué MedellínAzuara, Dean Misczynski, James Nachbaur, and Robyn Suddeth. 2014. *Paying for Water in California*. San Francisco: Public Policy Institute of California. Available at: http://www.ppic.org/content/pubs/report/R_314EHR.pdf. (Accessed: June 27, 2016).

Hanak, Ellen, Jay Lund, Barton "Buzz" Thompson, W. Bowman Cutter, Brian Gray, David Houston, Richard Howitt, Katrina Jessoe, Gary Libecap, Josué Medellín-Azuara, Sheila Olmstead, Daniel Sumner, David Sunding, Brian Thomas, Robert Wilkinson. 2012. *Water and the California Economy*. San Francisco: Public Policy Institute of California. Available at: http://www.ppic.org/content/pubs/report/R_512EHR.pdf. (Accessed: June 27, 2016).

Hanak, Ellen, Jay Lund, Ariel Dinar, Brian Gray, Richard Howitt, Jeffrey Mount, Peter Moyle, Barton "Buzz" Thompson. 2011. *Managing California's Water: From Conflict to Reconciliation*. San Francisco: Public Policy Institute of California. Available at: http://www.ppic.org/content/pubs/report/R_211EHR.pdf. (Accessed: June 27, 2016).

Hanak, Ellen, Jeffrey Mount, Caitrin Chappelle, Jay Lund, Josué Medellín-Azuara, Peter Moyle, Nathaniel Seavy, Emma Freeman, Jelena Jedzimirowic, Henry McCann, and Adam Soliman. 2015. *What If California's Drought Continues?* San Francisco: Public Policy Institute of California. Available at: http://www.ppic.org/content/pubs/report/R_815EHR.pdf. (Accessed: July 5, 2016).

Hanak, Ellen, and Elizabeth Stryjewski. 2012. *California's Water Market, By the Numbers: Update 2012*. San Francisco: Public Policy Institute of California. Available at: <http://www.ppic.org/content/pubs/>

report/R_1112EHR.pdf. (Accessed: June 27, 2016).

Hazlett, J. (County of Los Angeles). Interview with author, 2016.

Herman, Jonathan D., Patrick M. Reed, Harrison B. Zeff, and Gregory W. Characklis . 2014. "How Should Robustness Be Defined for Water Systems Planning under Change?" *Journal of Water Resources Planning and Management* 141 (10): 04015012.

Howitt, Richard, Duncan MacEwan, Josué Medellín-Azuara, Jay Lund, and Daniel Sumner. 2015. *Economic Analysis of the 2015 Drought for California Agriculture*. Available at: https://watershed.ucdavis.edu/files/biblio/Final_Drought%20Report_08182015_Full_Report_WithAppendices.pdf. (Accessed: June 27, 2016).

Hubner, D. (ToxSrob). Interview with author, 2015.

IBank. 2016. *California Lending for Energy and Environmental Needs (CLEEN)*. Available at: <http://www.ibank.ca.gov/cleen.htm>. (Accessed: July 5, 2016).

Irving, R. (Emefcy). Interview with author, 2016.

ISO, Standards Institution of Israel, and University of Haifa. 2015. *Economic Inputs for Israeli Water Companies as an Outcome of Regulation*. [In Hebrew.] Available at: http://www.sii.org.il/sip_storage/FILES/9/3419.pdf. (Accessed: July 5, 2016).

Israel Export Institute. 2015. *Export Israel*.

Israel NewTech, Ministry of Economy and Industry. 2015. *NewTech Report*.

IWA. 2015a. *Israel Water Authority, Annual Report 2014*.

IWA. 2015b. *Israeli Water Legislation*. [In Hebrew.] Available at: <http://www.water.gov.il/Hebrew/about-reshut-hamaim/Pages/Legislation.aspx>. (Accessed: July 5, 2016).

IWA. 2016. *Water Tariffs*. [In Hebrew.] Available at: <http://www.water.gov.il/hebrew/rates/pages/rates.aspx>. (Accessed: July 5, 2016).

Larsen, Peter H., Elizabeth Stuart, Charles A. Goldman, and Donald Gilligan. 2014. *Current Policies and Practices related to the Incorporation of Non-Energy Benefits in Energy Saving Performance Contract Projects*. Available at: <http://aceee.org/files/proceedings/2014/data/papers/8-320.pdf>. (Accessed: July 5, 2016).

Legislative Analyst's Office. 2008. *California's Water: An LAO Primer*. Available at: http://www.lao.ca.gov/2008/rsrc/water_primer/water_primer_102208.aspx. (Accessed: July 5, 2016).

Locsin, Aurelio. 2016. "Definition of Master Services Agreement." *Houston Chronicle* website. Available at: <http://smallbusiness.chron.com/definition-master-services-agreement-40141.html>. (Accessed: July 11, 2016).

McKinsey. 2009. *Charting our Water Future*. Available at: <http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/charting-our-water-future>. (Accessed: May 26, 2016).

Mekorot (no date). *General Information*. Available at: <http://www.mekorot.co.il/Eng/newsite/AboutUs/Pages/GeneralInformation.aspx>. (Accessed: July 5, 2016).

Mercer, Thomas, and Jon Christensen. 2013. *Measuring Performance of Water Systems in California*. Woods Institute for the Environment / The Bill Lane Center for the American West / Stanford University. Available at: http://waterinthewest.stanford.edu/sites/default/files/Working_Paper_on_Performance_Measurement_1.pdf. (Accessed: July 7, 2016).

Mercury News. 2015. "California Drought: Farmers' Senior Water Rights Under Siege." Available at: http://www.mercurynews.com/drought/ci_28208027/california-drought-farmers-senior-water-rights-under-siege. (Accessed: July 5, 2016).

Merrill Lynch. 2011. *The Global Water Sector*. Available at: <http://www.ml.com/publish/content/application/pdf/gwmol/global-water-sector.pdf>. (Accessed: July 5, 2016).

Milken Innovation Center. 2016. *Financial Models for Water Sustainability*. Available at: <http://milkeninnovationcenter.org/wp-content/uploads/2016/04/Financial-Models-for-Water-Sustainability-FIL-ENG-2.pdf>. (Accessed: June 27, 2016).

Mount, Jeffrey, Ellen Hanak, Caitrin Chappelle, Brian Gray, Jay Lund, Peter Moyle, and Barton "Buzz" Thompson. 2015. *Policy Priorities for Managing Drought*. San Francisco: Public Policy Institute of California. Available at: http://www.ppic.org/content/pubs/report/R_315EHR.pdf. (Accessed: 5 July 2016).

MWD. 2015a. *Local Resource Program*. Available at: <http://www.mwdh2o.com/AboutYourWater/Planning/Funding-Programs/Local-Resource-Program-Funding>. (Accessed: July 5, 2016).

MWD. 2015b. *Metropolitan's FY 2016/17 and FY 2017/18 proposed budget and water rates and charges*. Available at: <http://www.mwdh2o.com/WhoWeAre/2017-2018-proposed-water-rates-and-charges>. (Accessed: July 5, 2016).

MWD. 2015c. *The Metropolitan Water District of Southern California—An Overview*. Available at: http://www.mwdh2o.com/Who%20We%20Are%20%20Fact%20Sheets/MWD_Overview.pdf. (Accessed: July 7, 2016).

Nahai, D. (David Nahai Consulting Services). Interview with author, 2016.

- Office of Ratepayer Advocates. 2011. *Water Revenue Adjustment Mechanism*. Available at: <http://www.ora.ca.gov/wram.aspx>. (Accessed: July 5, 2016).
- Pacific Institute. 2014a. *New Data Show Residential Per-Capita Water Use across California*. Available at: <http://pacinst.org/new-data-show-residential-per-capita-water-use-across-california/>. (Accessed: July 5, 2016).
- Pacific Institute. 2014b. *The Untapped Potential of California's Water Supply: Efficiency, Reuse, and Stormwater*. Available at: <http://pacinst.org/app/uploads/2014/06/ca-water-capstone.pdf>. (Accessed: July 5, 2016).
- Pogue, Melissa. 2015. *A Discounted Rate? The Impact of Discount Rates on Infrastructure*. Available at: http://martinprosperity.org/media/Infrastructure-Series_MP_Discounted-Rates.pdf. (Accessed: July 7, 2016).
- Posy, P. (Atlantium). Interview with author, 2015.
- PPIC. 2015. *California's Water*. Available at: http://www.ppic.org/content/pubs/report/R_415WPCBKR.pdf. (Accessed: July 5, 2016).
- PPIC. 2016. *California's Future*. Available at: http://www.ppic.org/content/pubs/report/R_116BKR.pdf. (Accessed: July 5, 2016).
- Private Water Law Blog*. 2013. "The Organization of Water Utilities in California." Available at: <https://privatewaterlaw.com/2013/09/25/the-organization-of-water-utilities-in-california/>. (Accessed: July 5, 2016).
- Quesnel, Kim, Newsha K. Ajami, and Noemi Wyss. 2016. *Tapping into Alternative Ways to Fund Innovative and Multi-Purpose Water Projects*. Available at: <http://waterinthewest.stanford.edu/sites/default/files/Woods%20Funding%20Water%20Projects%20Whitepaper%20v09.pdf>. (Accessed: July 5, 2016).
- Sacramento Forecast Project. 2016. *State of California Economic Forecast*. Available at: <http://sacramentoforecastproject.org/ca/CALIF.htm#F>. (Accessed: July 7, 2016).
- Saltelli, Andrea, Marco Ratto, Terry Andres, Francesca Campolongo, Jessica Cariboni, Debora Gatelli, Michaela Saisana, and Stefano Tarantola. 2008. *Global Sensitivity Analysis. The Primer*. Chichester: John Wiley & Sons.
- Shenkar, L. (Artemis Water Strategy). Interview with author, 2016.
- TechTarget. 2016. *What is Software as a Service (SaaS)?* Available at: <http://searchcloudcomputing.techtarget.com/definition/Software-as-a-Service>. (Accessed: July 5, 2016).
- Tietenberg, Thomas H., and Lynne Lewis. 2012. *Environmental and Natural Resource Economics (9th*

edition). New York: Pearson Education.

Tirosh, U. (IDE). Interview with author, 2015.

UNEP. 2011. *Decoupling Natural Resource Use and Environmental Impacts from Economic Growth, A Report of the Working Group on Decoupling to the International Resource Panel*. (Fischer-Kowalski, M., Swilling, M., von Weizsäcker, E.U., Ren, Y., Moriguchi, Y., Crane, W., Krausmann, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero Lankao, P., Siriban Manalang, A., Sewerin, S.). Available at: http://www.unep.org/resourcepanel/decoupling/files/pdf/decoupling_report_english.pdf. (Accessed: July 5, 2016).

UNEP. 2015. *Options for Decoupling Economic Growth from Water Use and Water Pollution. Report of the International Resource Panel Working Group on Sustainable Water Management*. Available at: <http://www.unep.org/resourcepanel/KnowledgeResources/AssessmentAreasReports/Water/tabid/133332/Default.aspx>. (Accessed: June 27, 2016).

Water in the West. 2013. *Water and Energy Nexus: A Literature Review*. Available at: http://waterinthewest.stanford.edu/sites/default/files/Water-Energy_Lit_Review_0.pdf. (Accessed: July 5, 2016).

Water Resources Control Board. 2016. *Financial Assistance Funding — Grants and Loans*. Available at: http://www.waterboards.ca.gov/water_issues/programs/grants_loans/proposition1.shtml. (Accessed: July 5, 2016).

Water Resources Control Board. 2016. *The Water Rights Process*. Available at: http://www.waterboards.ca.gov/waterrights/board_info/water_rights_process.shtml. (Accessed: July 5, 2016).

Weisman, Jamie. (OpTerra Energy Services). Interview with author, 2016.

West Basin Municipal Water District. 2014. *Water Use Report 2013–2014*. Available at: <http://www.westbasin.org/files/waterusereport/wur-2013-2014-web.pdf>. (Accessed: June 27, 2016).

West Basin Municipal Water District. 2015. *Operating Budget Fiscal Year 2015–2016*. Available at: <http://www.westbasin.org/files/finance/wb-budget-2015-2016-web.pdf>. (Accessed: July 5, 2016).

Wiesner, R. (Hutchison Kinrot). Interview with author, 2015.

World Economic Forum. 2015. *Global Risks 2015, 10th edition*. Available at: http://www3.weforum.org/docs/WEF_Global_Risks_2015_Report15.pdf. (Accessed: July 5, 2016).

Appendix A—List of Interviewees

Israel

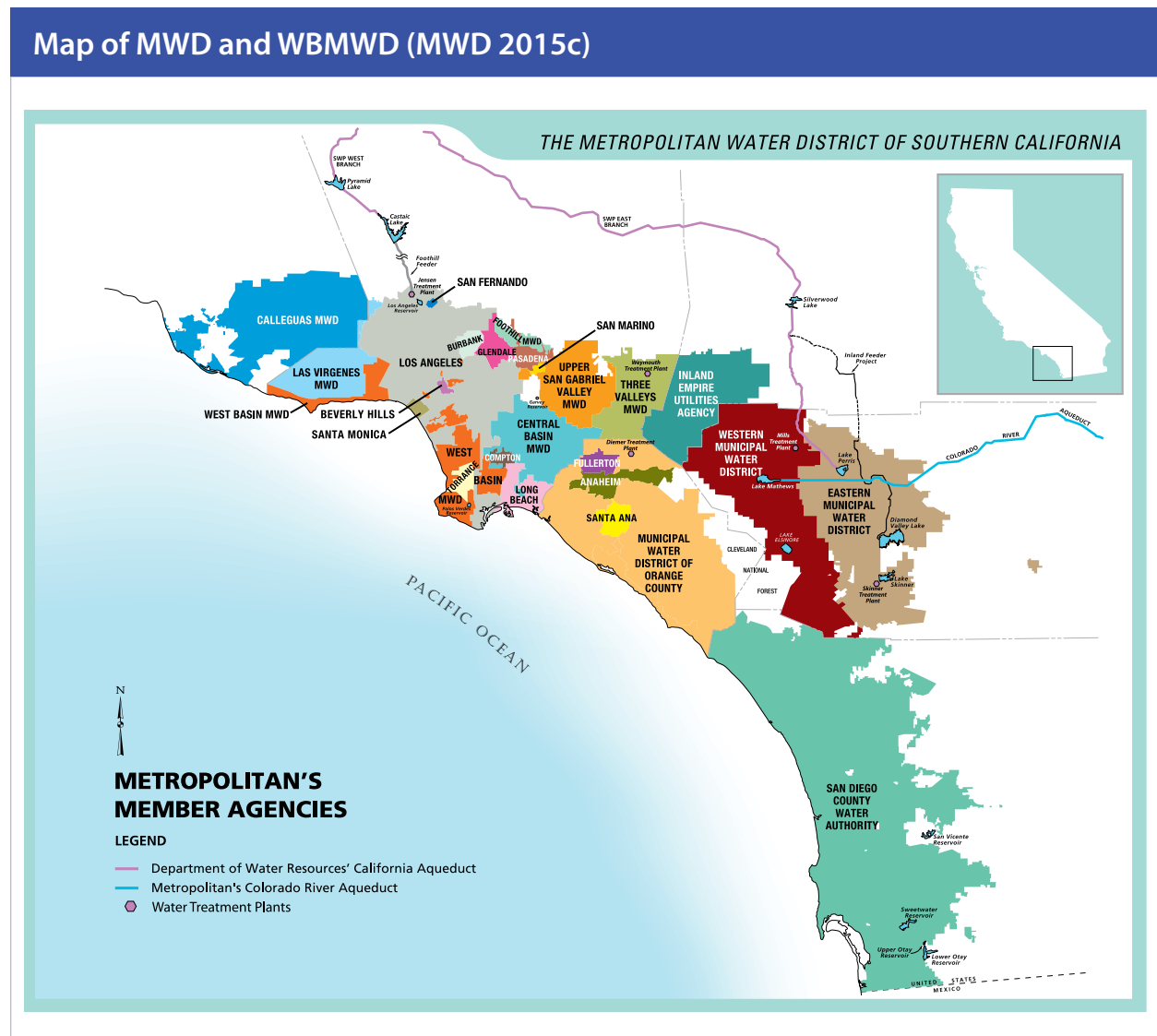
Name	Organization / Company
Astorre Modena	Terra Venture Partners
Phyllis Posy	Atlantium
Avi Feldman	Capital Nature
Danny Greenwald	Israel Water Authority
Hezi Billik	Israel Water Authority
David Arison	Miya
Udi Tirosh	IDE
Gilad Cohen	IDE
Ido Halevi	IDE
Dudy Klein	Ashra—The Israeli Export Credit Agency
Elad Frankel	Aqwise
Eytan Levy	Emefcy
Ronen Berkan	Emefcy
Richard Irving	Emefcy
Gal Joss	Israel Export Institute
Oded Distel	Israel Newtech, Ministry of Economy and Industry
Adi Yefet	Israel Newtech, Ministry of Economy and Industry
Hovav Gilan	WellToDo
Itay Zetlery	Ernst & Young
Jack Levy	Israel Capital Ventures
Ashleigh Talberth	Israel California Greentech Partnership
Joshua Yeres	HaGihon (Jerusalem water utility)
Niv Morag	Blue I Water Technologies

Name	Organization / Company
Naty Barak	Netafim
Nitza Kardish	Trendlines Agtech—Mofet Incubator
Gil Shaki	Office of the Chief Scientist (OCS)
Roy Wiesner	Hutchison Kinrot
Shani Feldman	Takadu
Dana Hubner	ToxSorb and Triple T
Ben Perlman	ToxSorb and Triple T
Zafir Sofer	Palgey Mayim
Meytal Shen Zur	Palgey Mayim
Yossi Yaacoby	Mekorot
Zeev Efrat	Aquarius Spectrum
Ari Goldfarb	Kando
Limor Nakar Vincent	BIRD Foundation
Sivan Cohen	Ayyeka
Tal Avrahami	Ayyeka
Eli Cohen	Ayala
Oran Drach	Defense Lab
Eatay Pomeranz	Amiad
Noam Levy	NeoTop
Sarah Musiker	NeoTop
Paz Itzhar	Startup Nation Central
Jonathan Cohen	MATIMOP, Ministry of Economy and Industry
Hadar Shor	Foreign Trade, Ministry of Economy and Industry

California

Name	Organization / Company
Bob Feyer	Orrick
Scott Houston	West Basin Water District
Shivaji Deshmukh	West Basin Water District
Kristopher Tjernell	Natural Resources Agency
David Nahai	David Nahai Consulting Services, LLC
Jeff Malin	California Governor's Office of Business and Economic Development (GO-BIZ)
Jamie Weisman	OpTerra Energy Services
James Hazlett	County of Los Angeles
Michael Swords	Los Angeles Cleantech Incubator (LACI)
Ben Allen	State Senator, 26th Senate district
Laura Shenkar	Artemis Water Strategy
Michael McGuire	AWWA
Maya Vardi Shoshani	BIRD Foundation
Nadav Efrati	Desalitech
Osher Perry	Desalitech
Martha Amram	WattzOn
Mary Eggert	Global Water Works
Rani Averick	Global Water Works

Appendix B—The Metropolitan Water District (MWD) and West Basin Municipal Water District (WBWMD)



The Metropolitan Water District of Southern California (MWD)

The Metropolitan Water District of Southern California (MWD) is a regional wholesaler that delivers water to 26 member public agencies—14 cities, 11 municipal water districts, and one county water authority—which in turn provide water to more than 19 million people. It was established in 1928 to build and operate the 242-mile Colorado River Aqueduct that would bring water to southern coastal areas.

MWD is the largest distributor of treated drinking water in the United States. To supply the more than

300 cities and unincorporated areas in Southern California with reliable and safe water, it owns and operates an extensive water system, including the Colorado River Aqueduct, 16 hydroelectric facilities, nine reservoirs, 819 miles of large-scale pipes, and five water treatment plants. Four of these treatment plants are among the ten largest plants in the world.

MWD provides more than 50 percent of the region's water through imported supplies and investments in new local projects and conservation. It currently delivers an average of 1.7 billion gallons (6,435,200 cubic meters) of water per day to a 5,200-square-mile service area. To supplement local supplies, MWD imports water from the Feather River in Northern California and the Colorado River. It also helps its member agencies develop water recycling, storage, and other local resource programs to provide additional supplies, and conservation programs to reduce regional demands.

For more information: <http://www.mwdh2o.com>

West Basin Municipal Water District (West Basin)

West Basin Municipal Water District (West Basin) is a public agency that provides drinking and recycled water to its 185-square mile service area. It is the sixth-largest water district in California, serving a population of nearly one million people living in 17 cities in the South Bay. It uses 220,000 acre-feet (271,365,600 cubic meters) of water annually.

West Basin purchases imported water from the Metropolitan Water District of Southern California (MWD) and wholesales the imported water to cities and private companies in southwest Los Angeles County. It also produces recycled water, some of which goes to groundwater recharge in order to protect the groundwater basin from seawater intrusion.

For more information: <http://www.westbasin.org>

Appendix C—Existing Financial Support

1. Israel-US Binational Industrial Research and Development (BIRD) Foundation

<http://www.birdf.com/>

1. The BIRD Foundation's mission is to stimulate, promote and support industrial R&D of mutual benefit to the United States and Israel.
2. BIRD provides both matchmaking services between US and Israeli companies, as well as funding covering up to 50 percent of project development and product commercialization costs.
3. Repayments are due only if commercial revenues are generated as a direct result of the project. If a project fails, BIRD claims no repayments.
4. BIRD supports approximately 20 projects annually. The cumulative sales of products developed through BIRD projects have exceeded \$8 billion.
5. Any pair of companies, one Israeli and one US-based, may apply jointly so long as they can demonstrate the combined capabilities and infrastructure to define, develop, manufacture, sell and support an innovative product based on industrial R&D.
6. BIRD Energy (Adheres to the same rules and procedures as BIRD): Innovation in areas such as: solar power, alternative fuels, advanced vehicle technologies, smart grid, water-energy nexus, wind energy, or any other renewable energy/energy efficiency technology.

2. MATIMOP, Israel-US Innovation Partnerships

http://www.matimop.org.il/RFP_US2014.html

1. MATIMOP is the executive agency, functioning on behalf of the Office of the Chief Scientist in Israel's Ministry of Economy, for facilitating international R&D collaboration between Israeli and foreign companies.
2. Each proposal must include an eligible partner from the United States and Israel (registered Israeli companies in ALL sectors and their US partners).
3. Funding:
 - a. US: Funding opportunities vary on federal or project basis. State level funding / self-funding / other.
 - b. Israel: Up to 50 percent (plus regional incentives, if applicable) of the approved R&D costs.

3. Israeli Foreign Trade Programs, for Israeli Companies

<http://www.moital.gov.il/NR/exeres/A5E90C0B-C1F0-475C-BC35-436C87A9E0DF.htm>

1. Support the export efforts of Israeli companies.
2. Programs are competitive, and companies must apply for support.
3. Relevant programs:
 - a. The “Support in International Projects and Tenders” fund
 - ii. Support for a feasibility survey / first commercial installation / tender application.
 - iii. Funding of up to 50 percent of project costs.
 - b. The “Infrastructure Bundle” program
 - i. Supporting the establishment, operation and marketing of a commercial demonstration site in the destination country.
 - ii. A bundle of at least 5 companies.
 - iii. Funding of up to 50 percent of project costs.
4. Governor Brown press release for existing support mechanisms: link
5. IBANK’s CLEEN Center – SWEEP Program
<http://www.ibank.ca.gov/cleen.htm>
 1. IBank established the California Lending for Energy and Environmental Needs (CLEEN) Center to encourage public and private investments.
 2. IBank’s primary role in SWEEP is to provide direct financing in a senior or subordinate lien position, or as a credit enhancement provider.
 3. Statewide Energy Efficiency Program (SWEEP)
 - a. The first and only currently approved lending program, for small and large scale energy efficiency projects, for MUSH (municipalities, universities, schools and hospitals).
 - b. Provides capital for direct financing and credit enhancement.

Appendix D—List of Existing Israeli Water Projects in California

- **Netafim**—precise drip irrigation
 - Offices at Fresno, California
 - Hundreds of projects throughout the state
- **IDE**—desalination
 - Carlsbad desalination plant north of San Diego
 - Construction-renewal of existing Santa-Barbara desalination plant
- **Amiad**—filtration solutions
 - Working with various clients in all sectors (agriculture, industry and municipalities), with hundreds of projects throughout the state
 - Offices at Oxnard, California
 - Standout projects in California: Owens Lake, West Basin Ocean Water Desalination Demonstration, Bakersfield, Boswell Farms
- **Arad (Master Meter)**—water metering
 - Sales of their technology and products through their daughter company in United States—Master Meter
- **Aqwise**—wastewater treatment
 - Several facilities in California
- **Galcon**—analyzers and control systems for irrigation solutions
 - Offices in southern California
- **RWL Water**—water and wastewater treatment
 - Headquarters in New York and various offices across the US
 - Wastewater treatment aeration systems at Laguna Niguel Regional Park in Southern California
- **Atlantium**—water disinfection
 - Dozens of projects with the food and beverage industry

- **ToxSorb**—filtration systems
 - Recently finished a pilot in Indio Water Authority for perchlorate removal
- **Utilis**—Satellite based leak detection
 - Conducted a successful pilot with East Bay Municipal Utility District, which led to an annual contract that includes providing periodic potable water leak network reports
- **IOSight**—Infrastructure Facility Management
 - Dozens of projects throughout the US
 - One System installed at the Carlsbad desalination plant, and one system in tests at the Santa Barbara desalination plant
- **Yevul Mayim**—rainwater capture
 - A beta pilot program to bring rain harvesting barrels from Israel to three public schools—City Heights, Pacific Beach, and Encinitas
- Israel-California GreenTech partnership
 - First industry-driven initiative to build off of the Memorandum of Understanding (MOU) signed between California and Israel in 2014
 - Recently launched a program with the LA Cleantech Incubator (LACI), to bring innovative and promising cleantech startups to California
- The companies on the following list recently began operating in California:
 - **Ayyeka**—water management
 - **Takadu**—water network monitoring
 - **Emefcy**—distributed wastewater treatment
 - **Blue I Water Technologies**—water quality analyzers and controllers
 - **Aquarius Spectrum**—leak detection
 - **Ayala**—natural biological systems for water treatment
 - **Triple T**—wastewater treatment
 - **NeoTop**—covering reservoirs

- **EZPack**—water storage, distribution and mobility
- **Aqua-Rimat**—smart water management and leak protection
- **Reali Technologies**—water management
- **CQM**—water treatment and disinfection
- **Odis Filtering**—water and wastewater treatment



The Jerusalem Institute for Israel Studies
Milken Innovation Center
20 Radak St. Jerusalem 9218604
Office: 02-5630175 (Ext. 34)

www.jiis.org.il

www.milkeninnovationcenter.org