RECLAMATION

Managing Water in the West

Cataloguing Commercial, Industrial, and Institutional Customer Classes

Water and Energy Efficiency Program for Commercial, Industrial, and Institutional Customer Classes in Southern California

Volume 2 of 5

U.S. Department of the Interior
Bureau of Reclamation

April 2009

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1.0 Introduction

For many years, programs in southern California have promoted water efficiency or energy efficiency within the broad categories of commercial, industrial, and institutional (CII) customers. Although these programs have been relatively successful, current regional water and energy projections indicate there is an urgent need to examine water and energy efficiency in an integrated manner. The Bureau of Reclamation, in partnership with the California Energy Commission (CEC), and the Metropolitan Water District of Southern California (MWD), commissioned an innovative study in 2007 to develop an integrated water and energy efficiency program.

The results of the study are presented in a multi-volume report called the *Water and Energy Efficiency Program (WEEP) for Commercial, Industrial and Institutional Customer Classes in Southern California*.

1.1 Volume Summary

Volume 2 presents data on regional water and energy use trends and savings potentials, and summarizes the methodology and results for identifying CII customer classes selected for WEEP. Key findings include the following:

- Regional forecasts for CII water and energy use and savings potentials in southern California show a growing demand for water and energy in the region, even with the implementation of existing conservation programs.

- CII customer classes should be defined by applying three-digit North American Industry Classification System (NAICS) codes that can be linked to account data and described by names that are common to water districts and energy utilities.

- Cost-benefit analyses should include all available resource savings and incentives rather than those provided by individual water districts and energy utilities.

1.2 Volume Organization

This Volume is organized as follows:

- Section 2.0 presents data on regional water and energy use and savings that support the purpose and scope of WEEP.

- Section 3.0 covers approaches that have been used to characterize customers and presents three principles of defining customers for WEEP.
- Section 4.0 outlines the methodology and results for selecting customers for WEEP.
- Section 5.0 summarizes the savings potentials associated with customer classes selected for WEEP.
- Section 6.0 outlines an analytical framework for evaluating the financial impacts of water and energy efficiency incentives.
- The Appendices includes data tables, detailed information on savings potentials, a list of acronyms, a glossary of key terms, and a bibliography.

2.0 Regional Water and Energy Use and Savings Potentials

Regional forecasts for CII water and energy use and savings potentials in southern California show a growing demand for water and energy in the region, even with the implementation of existing conservation programs. This increases the burden on resource management and reinforces the need for efficiency measures focused on CII customer classes. This section of the WEEP study presents data in a series of figures and tables extracted from CEC and MWD reports on non-residential water and energy use.

2.1 Regional Water and Energy Use Forecasts

Water and energy use is expected to increase within the broad category of CII in southern California as illustrated in the three figures below. These forecasts are based on factors such as general population growth but do not specifically include future conservation programs.

Figure 2.1 shows a steady and slightly increasing demand for electricity consumption within the commercial and industrial sectors and all non-residential sectors for the years 2007 to 2018. This forecast:[1]

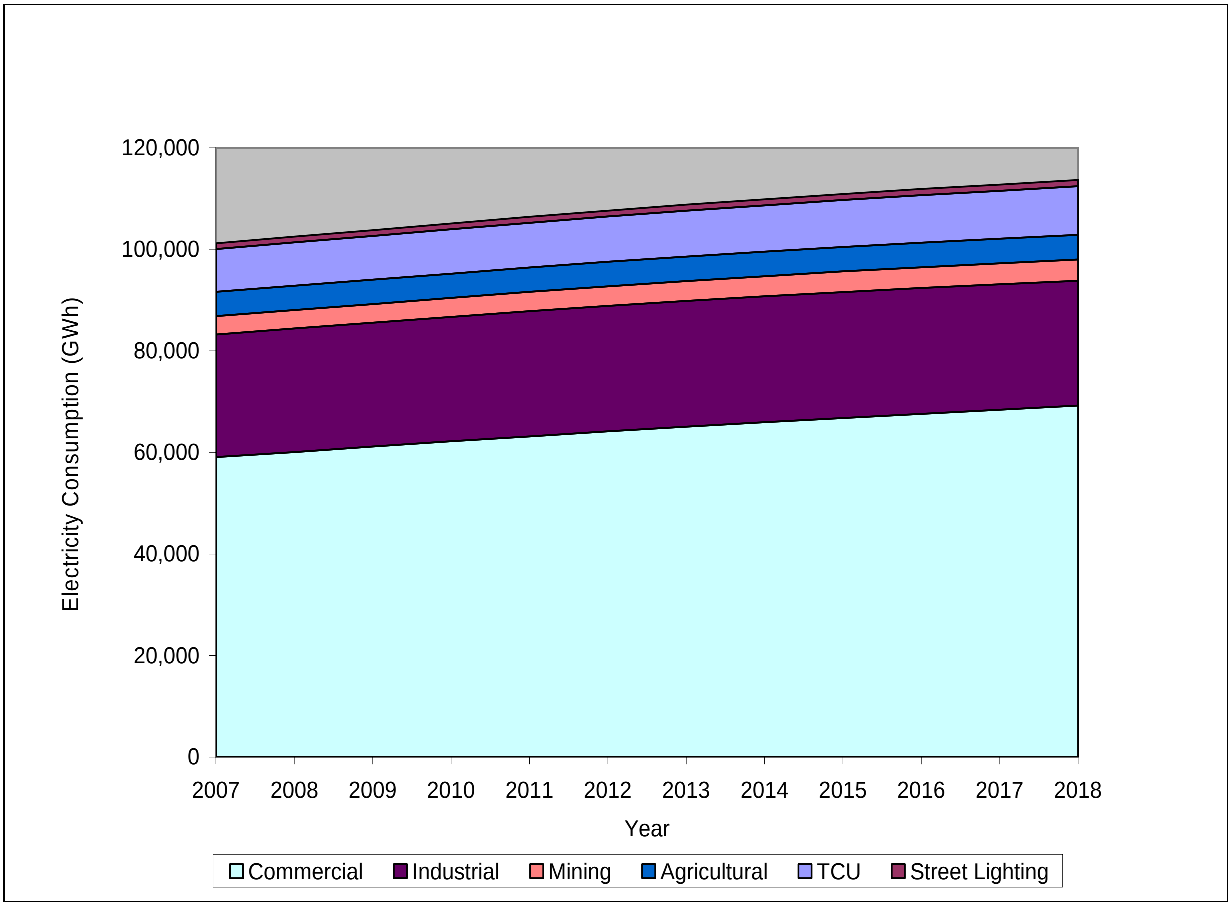
- Includes aggregate data from three suppliers that provide the majority of the region's electricity: Los Angeles Department of Water and Power (LADWP), Southern California Edison (SCE), and San Diego Gas and Electric Company (SDG&E).

- Was based on changes in population, personal income, employment, and industrial growth. In particular, increased population growth is a key driver for increasing energy use within the commercial sector, resulting in greater demands on water pumping and other energy consuming services.

- Uses future real electricity prices held constant at their current levels.

[1] The data for this figure were extracted from CEC's Energy Forecast 2018, from the Form 1.1 Tables, "California Energy Demand 2008-2018 Staff Revised Forecast," November 2007.

Figure 2.1: Projected Electricity Use within LADWP, SCE, and SDG&E Service Areas[2]



[2] The data sets used for the forecasts define southern California in terms the service areas for SCE, LADWP, and SDG&E. The acronym "TCU" stands for transportation, communications, and utilities. The mining sector includes oil and gas extraction. GWh is the unit of energy equal to that expended in one hour at a rate of one billion watts. One GWh equals 1,000 megawatt-hours.

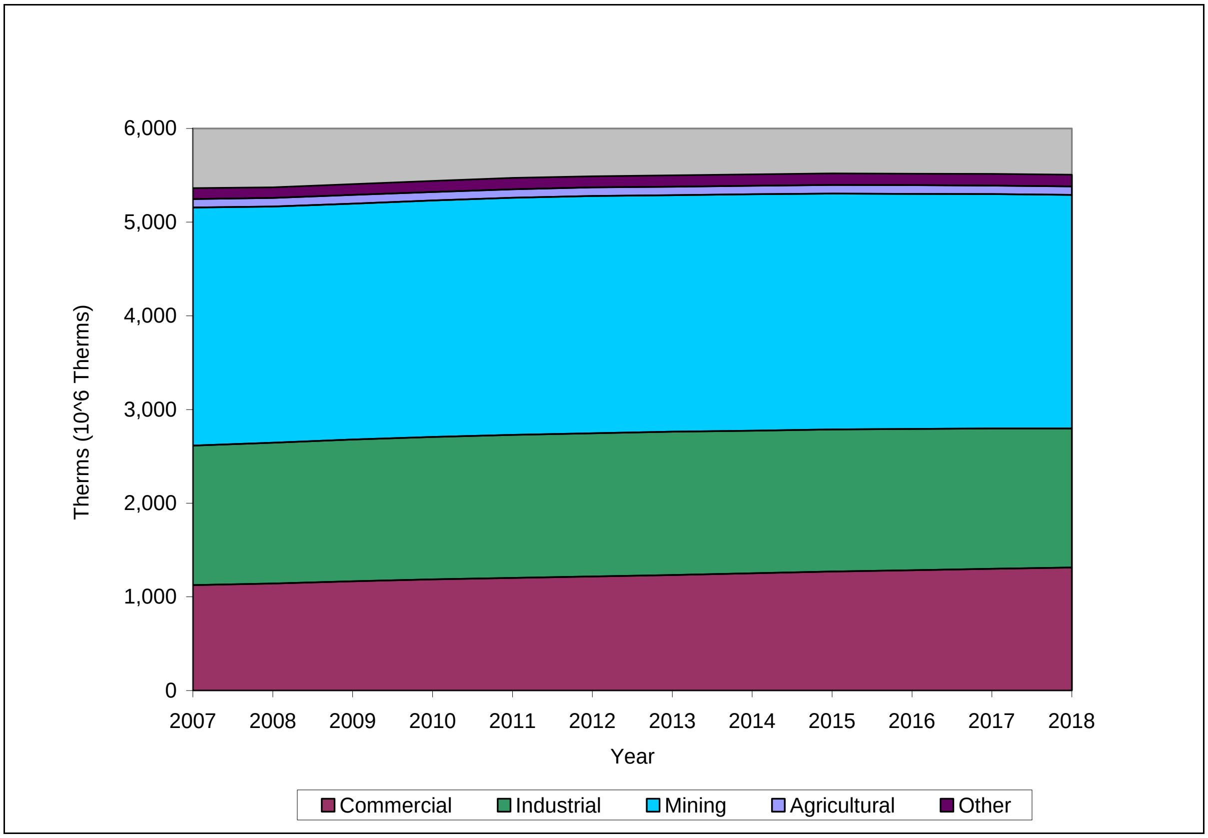
Figure 2.2 shows a similar demand trend for natural gas consumption for all non-residential sectors for the years 2007 to 2018. This forecast:[3]

- Includes aggregate data from two southern California suppliers that provide the majority of the region's natural gas: Southern California Gas (SoCalGas) and SDG&E.

- Uses population and natural gas price projections in addition to data on actual consumption.

- Does not include natural gas used for electric generation or cogeneration.

Figure 2.2: Projected Natural Gas Use within SoCalGas and SDG&E Service Areas[4]

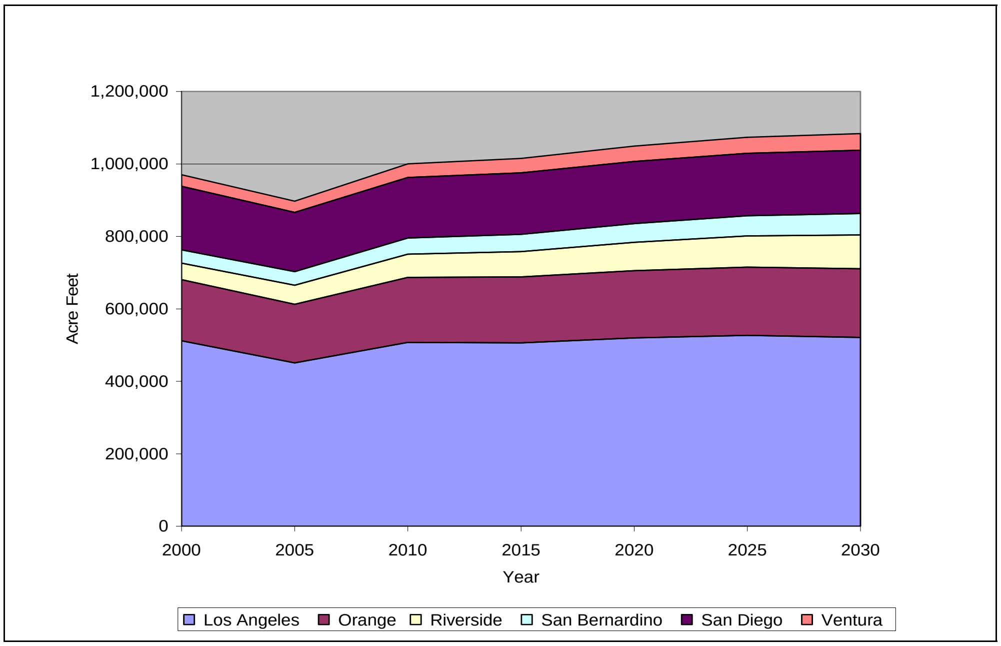


[3] The data for this figure were extracted from CEC's Energy Demand 2008-2018, November 2007.
[4] The higher forecast for natural gas use in every energy utility service area is a result of the general trend to use natural gas instead of electricity for cooking, water heating, and space heating. The category "other" includes natural gas use for transportation, communication and utilities, and street lighting. The mining sector includes oil and gas extraction.

Figure 2.3 includes actual and projected retail water use among CII sectors for the years 2000 to 2030.[5]

- The projected demand shows an increase without any adjustments associated with savings from future conservation programs.
- The year 2000 figures are model estimates, and other years are projected average year demands.
- MWD territory covers 13% of land area of southern California counties, but 87% of its population.

Figure 2.3: MWD Retail Water Demand Forecast



2.2 Electricity, Natural Gas, and Water Savings

A number of studies have been conducted indicating that water and energy demands can be reduced through programs such as WEEP. The figures and tables that follow highlight this inference by depicting potential savings that can be achieved when efficiency measures are implemented within CII.

Figure 2.4 projects electricity savings for the years 2007 to 2018. The graph includes commercial sectors only and is based on aggregate data from three southern California suppliers that provide most of the region's electricity:

[5] The data for this figure were extracted from MWD's Regional Urban Water Management Plan, November 2005, Table A.1-10.

LADWP, SCE, and SDG&E.[6]

- The graph is based on savings from a price effect from conservation programs (Cons Prog), and savings from the installation of energy efficiency appliances (Appl. Stds.) and building standards requiring the use of energy efficient equipment such as lighting (Bldg. Stds.).

- Electricity savings associated with building and appliance standards and market and price effects were modeled in the residential and commercial demand forecast models. Fuel prices are a significant driver for the savings; higher fuel prices lower program savings and lower fuel prices increase program savings. In other words, as fuel prices increase, the value of the program savings decreases because the customer is paying more for the same level of savings.

Figure 2.4: Projected Electricity Savings within LADWP, SCE, SDG&E Service Areas

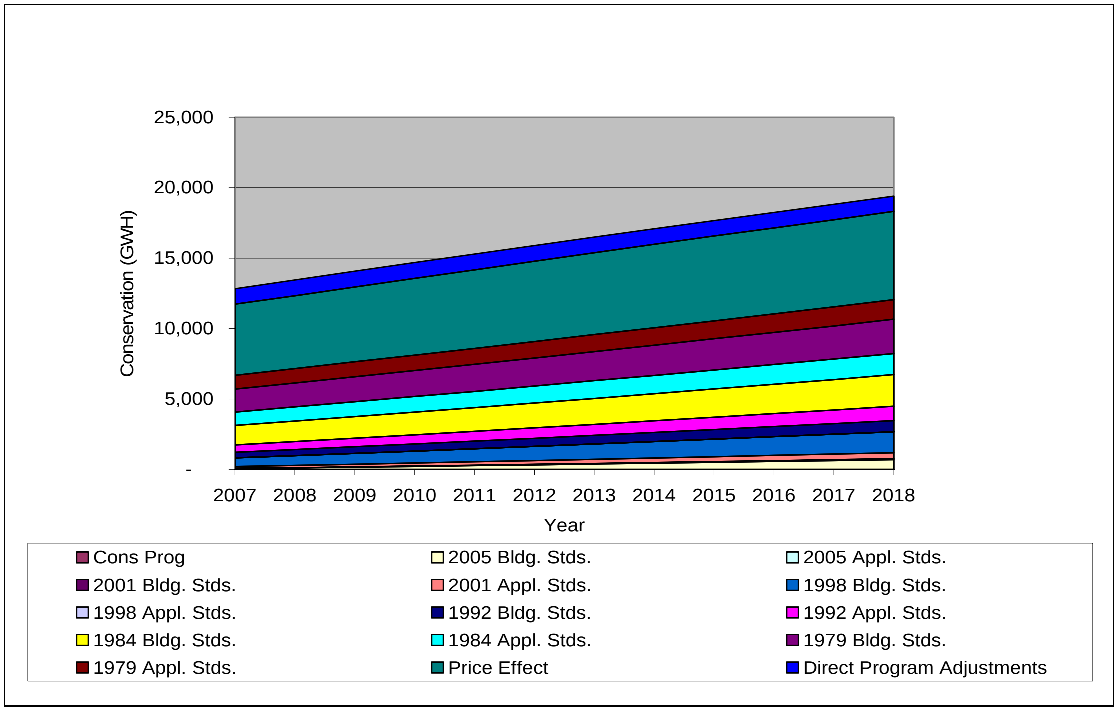


Figure 2.5 projects natural gas savings for the years 2007 to 2018. The graph includes commercial sectors only and is based on aggregate data from the two

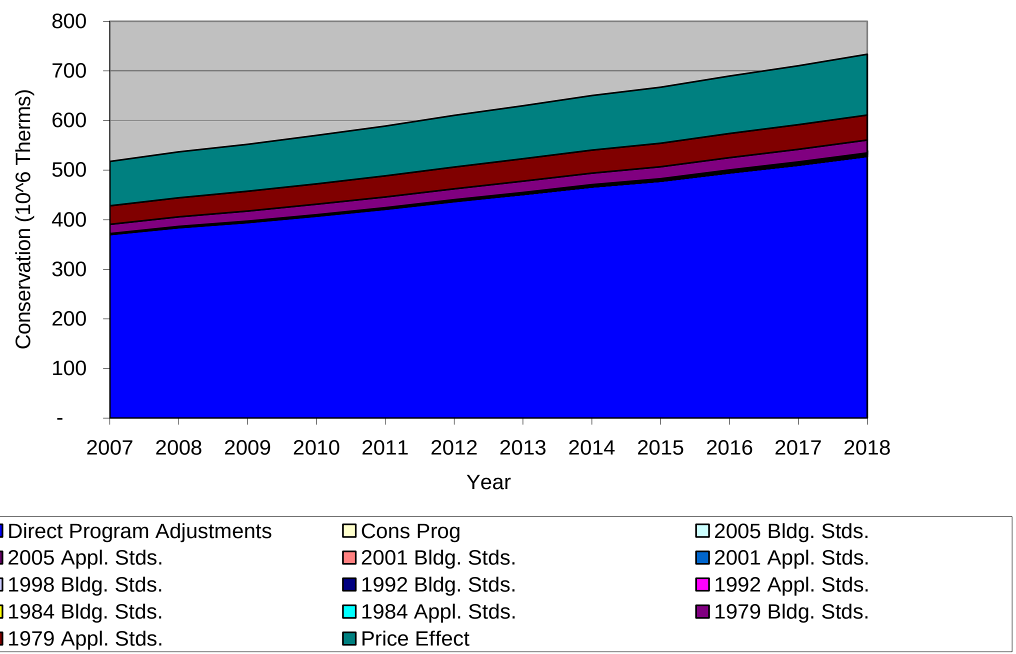
[6] See Footnote #1, "California Energy Demand 2008-2018 Staff Revised Forecast," November 2007. The data for this figure were extracted from Table 42: Electricity Conservation Impacts by Sector (commercial) and planning area (utility service area).

southern California suppliers that provide most of the region's natural gas: SoCalGas and SDG&E.[7]

- The savings are related to the use of energy efficient equipment and building standards requiring installation of energy efficient fixtures.

- Natural gas savings associated with building and appliance standards and market and price effects were modeled in the residential and commercial demand forecast models. Fuel prices are a significant driver for the savings; higher fuel prices lower program savings and lower fuel prices increase program savings.

Figure 2.5: Projected Natural Gas Savings within SoCalGas and SDG&E Service Areas



Since estimates of water savings specific to CII customers in southern California are not available, a series of figures projecting water savings in southern California and the state are shown to estimate the potential.

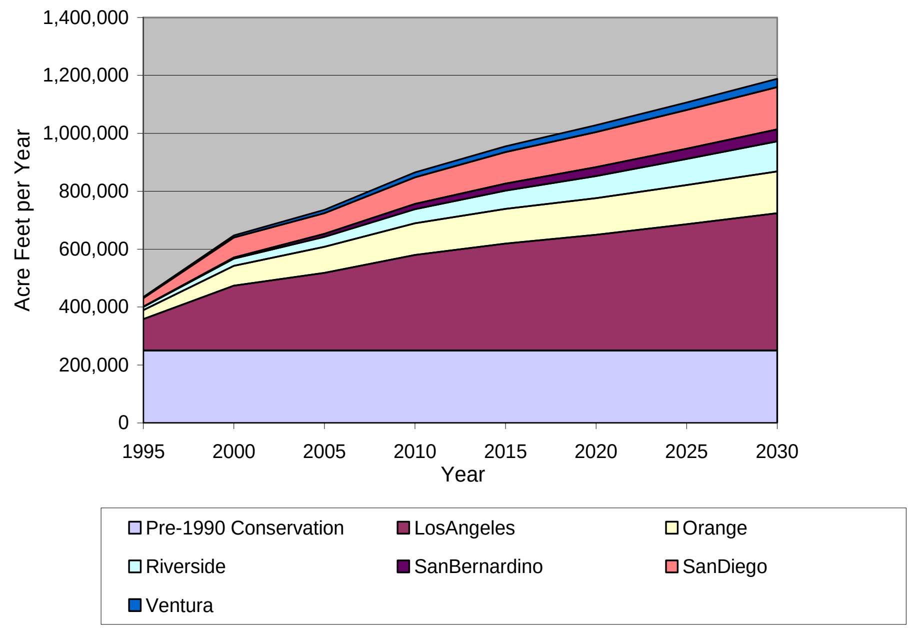
[7] See Footnote #1, "California Energy Demand 2008-2018 Staff Revised Forecast," November 2007. The data for this figure were extracted from Table 43: Natural Gas Conservation Impacts by Impacts by Sector (commercial) and planning area (utility service area).

Figure 2.6 shows actual and projected water use in southern California counties for the years 2000 to 2030. The water conservation forecasts include all sectors such as CII and residential.[8]

- The forecasts are based on existing conservation program data, the effects associated with rising water prices, and plumbing codes requirements mandating the use of water efficient equipment.

- Total retail demand in southern California is projected to be 4,914,000 acre feet per year (afy) in 2030, and CII retail demand is projected to be 1,084,000 afy as a function of program savings related to existing conservation programs, price effects, and plumbing code requirements.

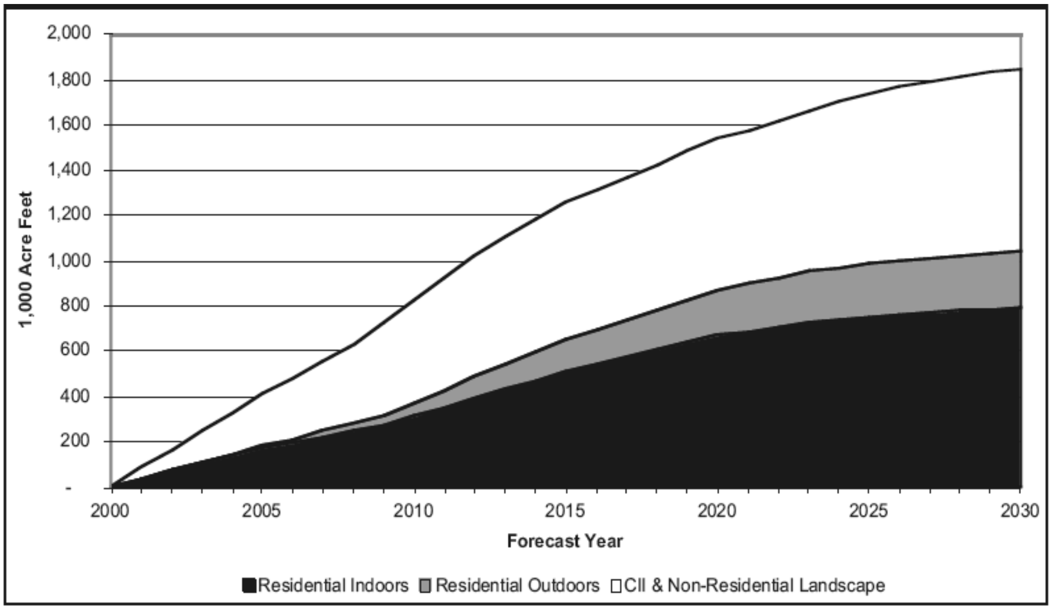
Figure 2.6: Projected Water Savings within MWD Area



[8] The data for this figure were extracted from MWD's Regional Urban Water Management Plan, Table A.1-12, November 2005.

Figure 2.7 shows the projected savings associated with statewide efficiency codes and regionally cost-effective conservation by type of use.[9] CII data are included in the projection for the grouping called "CII and non-residential landscape."

Figure 2.7: Statewide Water Savings



[9] The figure was extracted from the CALFED Water Use Efficiency Comprehensive Evaluation completed for the CALFED Bay-Delta Program Water Use Efficiency Element in August 2006, Figure 3.31.

Table 2.1 shows the savings potential from existing conservation measures by hydrologic region for a variety sectors including CII and residential.[10] These data illustrate that the projected savings from cost-effective efficiency measures are greatest within southern California.

Table 2.1: Water Savings Potential by Hydrologic Region[11]

Water Savings Potential of Regionally Cost-Effective Conservation Measures (1,000 acre feet [AF])				
Hydrologic Region	**2005**	**2010**	**2020**	**2030**
Central Coast	4	8	30	47
Colorado River	28	38	52	70
North Coast	2	5	9	13
North Lahontan	0	1	2	15
Sacramento River	1	1	2	15
San Francisco Bay	41	89	148	156
San Joaquin River	6	8	11	15
South Coast	174	330	501	509
South Lahontan	4	8	13	14
Tulare Lake	2	4	6	8
State	262	492	773	881

[10] The figure was extracted from the CALFED Water Use Efficiency Comprehensive Evaluation completed for the CALFED Bay-Delta Program Water Use Efficiency Element in August 2006, Table 3.13.
[11] Preliminary forecasts associated with California's 2020 program indicate similar trends.

3.0 Identifying Water and Energy Customers for WEEP

3.1 Purpose and Scope

One of the primary objectives of the WEEP study is to identify CII customer classes in southern California to target for an integrated program composed of water and energy incentives, audits, and marketing and outreach activities, and retrofits.

The approaches used to define customers by water agencies, energy utilities, and wastewater sanitation agencies vary and do not fully align with Project Advisory Committee (PAC) guidance to target the WEEP Study on CII customers that are large water, wastewater, and energy users with multiple accounts in southern California.[12] To establish a process for defining customer classes for WEEP, various approaches to categorize CII customers were analyzed. The results are summarized below, including a proposed set of principles for defining customers for WEEP.

3.2 Approaches for Categorizing Customers

Water districts and energy utilities categorize customers with varying methods for planning and reporting purposes. Customers may be classified by the customer sector, business and industry categories, end-uses, or by efficiency technologies and measures. Customer sector generally denotes a top-level category, such as commercial, industrial, and institutional, while the business and industry categories are more specific and indicate a business subsector, like educational institutions. More specific are the end use categories which describe processes and activities that take place at facilities (e.g., rinsing and cooling) and the efficiency technologies and measures which indicate specific types of actions taken to reduce water and energy use. Energy utilities and water districts may also categorize customers by physical units or accounting units (e.g., meters or billing locations).

[12] PAC Design Subcommittee Meeting, April 2008. The PAC was formed to provide input on the WEEP Study and feedback on the report, and is comprised of representatives from southern California water districts, energy utilities, wastewater districts, and federal, state, and local agencies.

3.2.1 Customer Sectors

Customer sectors, defined as top-level broad customer classifications, are used by energy utilities and water districts for rate making, rate categories, or other financial planning purposes. Examples of these top-level customer categories include commercial, industrial, institutional, and for water districts, landscape sectors. Sample customer sectors used by water and energy organizational entities are summarized below.

3.2.1.1 Water Customer Sectors

Definitions for water customer sectors in the state of California differ among the California Urban Water Conservation Council (CUWCC), the California Department of Water Resources (DWR), and the Urban Water Management Planning Act. These are the three main sources in California for defining water customer sectors.

The CUWCC categorizes CII water customer sectors.[13] Commercial accounts include water users that provide or distribute a product or service, such as hotels, restaurants, office buildings, commercial businesses or other places of commerce; however, commercial accounts exclude multi-family residences and agricultural users. Industrial accounts consist of water users that are primarily manufacturers or processors of materials. Institutional accounts are water-using establishments dedicated to public service, including schools, courts, churches, hospitals, and government facilities. Appendix A contains the detailed CUWCC definitions of these three broad categories.

The Water Use Efficiency and Transfers unit of DWR categorizes water customers based on the customer class production data reported in a yearly survey of public water agencies in California (the Public Water System Survey). The data are used by DWR to update the California Water Plan (Bulletin 160), and the Urban Water Use in California (Bulletin 166). Customer classes include residential (single-family and multi-family), commercial and institutional, industrial, landscape irrigation, agricultural irrigation and other. The data also indicate whether the customer site or activity is metered or unmetered, or if the site uses recycled water.[14]

The California Urban Water Management Planning Act[15] requires urban water suppliers to describe and evaluate sources of water supply, efficient uses of water, demand management measures, implementation strategy and schedules, and other

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[13] CUWCC Best Management Practice 9, Conservation Programs for CII, 1999.
[14] http://www.landwateruse.water.ca.gov/basicdata/urbanwateruse/prodsurvey.cfm.
[15] Water Code Sections, 10610-10656, 1983.

relevant information and programs. The water use sectors include:[16]

- Multi-family
- Commercial
- Industrial
- Institutional and governmental
- Landscape
- Sales to other agencies
- Saline water intrusion barriers, groundwater recharge, or conjunctive use, or any combination thereof
- Agricultural

3.2.1.2 Energy Customer Sectors

Energy customer sectors are defined by demand forecasts developed by the CEC and are reported on in detail in biannual CEC energy policy reports. The demand forecasts produced by CEC include sector energy forecasts for electricity and natural gas. For the industrial sector, the 2003 forecast uses the Industrial End Use Forecasting Model developed by the Electric Power Research Institute. The broad-level sectors outlined in these forecasts include: residential, commercial, industrial, agriculture and water pumping, and transportation, communication, and utilities.[17]

CEC's 2007 Integrated Energy Policy Report includes more specific categories for the natural gas and electricity energy demand sectors:[18]

- Natural Gas:
  - Residential
  - Commercial
  - Industrial
  - Electric Generation
  - Transportation
- Electricity:
  - Residential
  - Commercial

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[16] Guidebook to Assist Water Suppliers in the Preparation of a 2005 Urban Water Management Plan, January 18, 2005.

[17] CEC's Energy Demand 2003-2013 Forecast, August 2003. This report presents electricity and end-user natural gas consumption and peak electricity demand data for the state and for utility planning areas and climate zones within the state. This analysis supports the data and recommendations presented in the CEC's integrated energy policy reports.

[18] CEC's 2007 Integrated Energy Policy Report, December 2007. CEC is required by law to prepare an integrated assessment of major energy trends and issues facing the state's electricity, natural gas, and transportation fuel sectors and provides policy recommendations to: conserve resources; protect the environment; ensure reliable, secure, and diverse energy supplies; enhance the state's economy; and protect public health and safety.

- Industrial
- Mining
- Agricultural
- Transportation, Communication, Utilities
- Street Lighting

3.2.2 Business and Industry Categories

Business and industry categories are used in commerce to define a customer relative to a business or industry subsector, and are traditionally based on classification code systems like the NAICS and the Standard Industrial Classification (SIC) systems.

NAICS codes consist of a six-digit, business-type indicator, though some codes may consist of four or less digits. Table 3.1 provides an example of 2002 four-digit NAICS codes and associated descriptions.

Table 3.1: Examples of 2002 NAICS Codes and Descriptions

NAICS Codes	Description
3369	Other Transportation Equipment Manufacturing
3371	Household and Institutional Furniture and Kitchen Cabinet Manufacturing
3372	Office Furniture (including Fixtures) Manufacturing
3379	Other Furniture Related Product Manufacturing
3391	Medical Equipment and Supplies Manufacturing
3399	Other Miscellaneous Manufacturing
4231	Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers
4232	Furniture and Home Furnishing Merchant Wholesalers
4233	Lumber and Other Construction Materials Merchant Wholesalers

NAICS codes can be used in many applications, but are commonly used in Urban Water Management Plans (UWMPS) and in Quarterly Fuel and Energy Reporting (QFER) reports. For example, the Golden State Water Company used NAICS codes to separate their commercial, industrial and institutional customers when developing their UWMPS.[19] Since NAICS codes do not differentiate landscape,

[19] 2005 Urban Water Management Plan – Culver City, Golden State Water Company, December 2005.

fire, pools, or construction meters, these customers were assigned non-NAICS codes.

CEC regulations for QFER require electricity retailers to provide monthly reports that show electricity sales and deliveries by NAICS code in Form 1306A. Natural gas retailers are required to report sales by NAICS code in Form 1308B. Both forms contain special instructions for assigning a non-standard extension of a NAICS code to indicate:

- Residential;
- Street lighting;
- Water pumping, municipal water supply;
- Water pumping, agriculture irrigation; and
- Unclassified.

Prior to the development of NAICS, SIC codes were the primary industry category system. SIC codes have a lower level of definition than NAICS codes. Table 3.2 compares a few sample SIC codes to their respective NAICS codes.

Table 3.2: Examples of NAICS and SIC Codes

2002 NAICS Codes	Description	1987 SIC Codes	Description
311223	Other Oilseed Processing	2076	Vegetable Oil Mills, Except Corn, Cottonseed, and Soybean (oilseed processing)
311225	Fats and Oils Refining and Blending	2076	Vegetable Oil Mills, Except Corn, Cottonseed, and Soybean (processing purchased vegetable and oilseed oils)
311613	Rendering and Meat Byproduct Processing	2077	Animal and Marine Fats and Oils (animal fats and oils)
311711	Seafood Canning	2077	Animal and Marine Fats and Oils (canned marine fats and oils)
311712	Fresh and Frozen Seafood Processing	2077	Animal and Marine Fats and Oils (fresh and frozen marine fats and oils)
311222	Soybean Processing	2079	Shortening, Table Oils, Margarine, and Other Edible Fats and Oils, Not Elsewhere Classified (processing soybean oil into edible cooking oils from soybeans crushed in the same establishment)

Although developed for land use planning and tax purposes, county land use codes can be informative for utility planning. For example, the Los Angeles County Assessor assigns a four-digit alphanumeric “use code” to each identified parcel. Each digit placeholder has significance indicated in the use code table.

Table 3.3 shows an example that includes the county land use code, the mean area of parcels (sq. ft.) frequency, and the significance of the four digits. By associating parcels to water or energy meters, information is collected about water and energy customers, when other sources are not available. Use codes that indicate tall buildings or shopping centers can also be used to identify customers that have cooling towers and other equipment typically found at these facilities.

Table 3.3: Examples of Assessor Land Use Codes

Use Code	First Digit	Second Digit	Third Digit	Fourth Digit
1016	Commercial	Commercial	Miscellaneous Commercial	Six Stories
1108	Commercial	Store		Eight Stories
1214	Commercial	Store Combination	Store & Residential	Four Stories
1300	Commercial	Department Store		One Story
1302	Commercial	Department Store		Two Stories
1310	Commercial	Department Store	Discounted Department Store	One Story
131T	Commercial	Department Store	Discounted Department Store	Wireless Commercial Tower
1320	Commercial	Department Store	Building Supplies	One Story
1350	Commercial	Department Store	Warehouse Store	One Story
135T	Commercial	Department Store	Warehouse Store	Wireless Commercial Tower

3.2.3 End Uses

Water and energy conservation plans and studies use categories of end-use processes that may be present in one or more business and industry sectors. Examples of end uses include rinsing and cleaning, heating and cooling, painting and dying, plating and metal finishing, food preparation, and domestic sanitary uses.

End-use categories commonly used in water and energy efficiency guides are shown in Tables 3.4 and 3.5.

Table 3.4: Industrial Water Efficiency End Use Categories[20]

Category	End Use Sub-Category
Cooling and Heating Systems	Boilers, Hot Water, and Steam Evaporative Cooling Systems Single-Pass Cooling Water Use Equipment Cooling
Process and Equipment Use	All Applications Rinsing and Cleaning Plating and Metal Finishing Painting Photo and X-Ray Processing Dyeing Applying Degraded Water
Sanitary, Kitchen, and Domestic Use	Faucets Showerheads Toilets Kitchens
Medical Care Facilities	Miscellaneous
Maintenance Operations	Miscellaneous
Landscaping Irrigation	Miscellaneous

[20] Adapted from list in "Water Efficiency Guide for Businesses Managers and Facility Engineers," California Department of Water Resources, October 1994.

Table 3.5: Commercial Energy End-Use and Fuel Type Classifications[21]

End-Use	Description	Electricity	Natural Gas
Space Heat	Combinations of packaged and system space heat	√	√
Space Cooling	Combinations of packaged and system cooling	√	√
Ventilation	Ventilation systems	√	
Water Heating	Water heaters and system boilers	√	√
Cooking	Major cooking appliances	√	√
Refrigeration	Major refrigeration systems and stand alone units	√	√
Indoor Lighting	Lighting systems, does not include desktop lamps	√	
Outdoor Lighting	Lighting systems	√	
Office Equipment	Faxes, computers, copiers	√	
Miscellaneous Equipment	Miscellaneous plug load, including small refrigerators, desktop lamps, and other non-system energy using equipment.	√	√

3.2.4 Efficiency Technologies and Measures

A variety of technologies and measures are used to define the types of actions or efficiency improvements that can be taken to reduce process water or energy use. Efficiency technologies and measures "customer" categories include water, electricity, natural gas, and wastewater.[22] Some examples of efficiency technologies and measures used to define customers include:

- *Water:* Using clean water for third and final rinses before discharge, or recycled water for production related activities.

- *Electricity:* Using variable speed pumps or parallel pumps to conserve energy.

- *Natural Gas:* Using double-insulated tanks and insulated hot water pipes to conserve energy.

- *Wastewater:* Employing efficiency technologies that can reduce the volume, constituents, or concentrations in wastewater.[23]

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[21] Reproduced from California Energy Demand 2003-2013 Forecast, CEC, August 2003.
[22] Defining customers by efficiency technologies and measures is not typical but has been used within California.
[23] Counter examples are possible for reducing water volume and increasing concentration.

3.2.5 Physical Unit Customer Categorizations

Water districts and energy utilities frequently define a customer in terms of physical or accounting units. Physical units may be defined by the meter for water, electricity, or natural gas; the wastewater line; or the site. On the other hand, accounting units are defined by the billing party, the meter size, or the company.

3.3 Principles for Defining CII Customer Classes for WEEP

The approaches summarized above suggest that economic categories are used to categorize water and energy customers alike. It was decided for the WEEP Study that analysis at the NAICS and SIC code levels are the most useful. Auxiliary categorization may be needed for selected water and customers[24] that are not defined by these codes. It is important to note that few water utilities have identified customers by NAICS or SIC codes.

Furthermore, both the energy and water industries use various broad and narrow category sets for commercial, industrial, and institutional customers. The most common categorization across water, electricity, and natural gas occurs at the sector level where customers are identified as commercial or industrial.

However, a number of data challenges arise when merging data sets from different utilities. In certain data sets, customer-type identifiers may not exist, and when they do exist, category definitions may not always match. Additionally, account number systems across energy and water suppliers vary widely.

Therefore, to evaluate water, wastewater, and energy savings on a comparable basis, the study team developed a common approach for defining customers and recording usage data. This approach is based on three principles.

- First, customer classes should be based upon data from the meter-level, to best assess resource use patterns and measure the effectiveness of efficiency measures.

- Second, to facilitate ease in understanding and adoption, the use names and common sector categorizations should be familiar to water districts and energy utilities, and based on existing categories in NAICS, SIC, and billing codes.

[24] For example, water customers are defined as landscaping and pools; street lighting and water pumping characterizations are used for energy customers.

- Third, customer classes suitable for joint marketing should be grouped in order to market WEEP and develop common technologies and measures for efficiencies.

4.0 Selecting CII Customer Classes for WEEP

4.1 Introduction

Applying the first principle of using account data to identify CII customer classes for WEEP, CEC and several water and wastewater districts provided the study team with electricity, natural gas, water, and wastewater data. From these data, categories of customers were ranked according to their relative use of water and energy and by their number of accounts. The information was merged to identify categories that are large users of electricity and water, electricity and natural gas, and water and wastewater, and have a high number of accounts or presence in southern California.[25]

This section describes:

- The specific data used to select CII customer classes for WEEP.
- The caveats associated with the data analysis.
- The data processing efforts.
- The results of the data processing and ranking performed by PAC members.

4.2 Data Sources

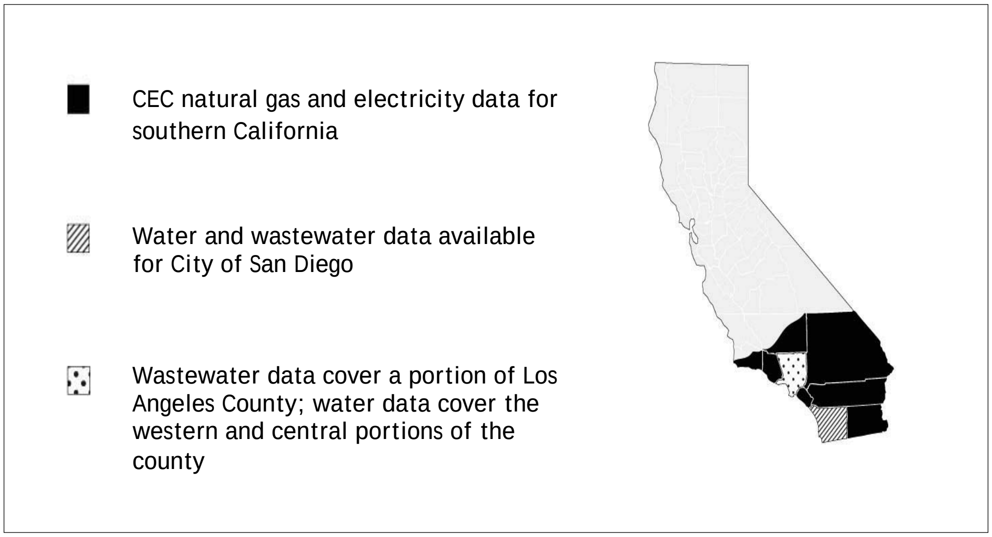
The data collection effort was designed to gather the best possible information that was reasonably accessible. The data sources used for the analysis were:

- CEC Quarterly Report Data (electricity, natural gas).
- West Basin Municipal Water District and Central Basin Municipal Water District data (water).
- Sanitation Districts of Los Angeles County (LACSD) (wastewater).
- City of San Diego (water, wastewater).

[25] This methodology was developed in consultation with PAC members.

Figure 4.1 presents a vicinity map for the data used in this analysis.[26]

Figure 4.1: Data Vicinity Map



Data received from the organizations referenced above were categorized by one of the following classification systems:

- NAICS codes: 1997, 2002, 2007 versions presented as two-digit to six-digit classification codes.

- SIC codes: 1972, 1987 versions presented as two-digit to four-digit codes.

The data were converted into three-digit 2002 NAICS codes.

4.3 Caveats Pertinent to the Understanding the Analysis

The analysis outlined herein is based on an innovative use of data sources that were originally prepared for other purposes. Consequently, using these data sources to develop joint electricity, natural gas, water, and wastewater rankings by category is subject to important caveats:

- Data on electricity and natural gas sales from the CEC cover the same territory in southern California. However, water data on CII customers was provided by agencies whose geographic coverage includes western and central Los Angeles County and the entire City of San Diego. Wastewater data covers all of the City of San Diego and portions of Los

[26] The map is intended to provide an overview of the area covered in the analysis. However, the account information did not always cover the entire county, as summarized in the descriptions of the data sets received.

Angeles County. The ranking presented in this section are valid to the extent that water and wastewater CII customers in Los Angels County and the City of San Diego are representative of such customers in southern California.

- In some cases, data were provided with SIC code classifications. The SIC codes were converted to NAICS codes using one of several methods, depending on the quality of the input data. This was done by using well-established concordance tables published by the U.S. Census Bureau, the National Bureau of Economic Research (NBER), and the U.S. Department of Labor, Bureau of Labor Statistics, Current Employment (SCE) Statistics.[27] In a few cases NAICS codes were looked up manually for their official definitions. Although there is a NAICS code for each SIC category, the conversion rarely is one-to-one, so the concordance tables provide either a weighted division or dominant assignment.

- When comparing results across electricity, natural gas, water and wastewater resources, results are presented strictly by rank rather than absolute value. This presentation is designed to prevent apples-and-oranges assessments that show physical units of more than one resource side-by-side where they are not necessarily the same facilities or do not necessarily have the same geographic coverage. The water and wastewater results can be generalized for southern California to the extent that the customers included in these service areas are representative of the region as a whole.

- The NAICS or SIC codes were assigned by the reporting agencies using their own processes, thus definitional differences are likely to some extent.

- NAICS and SIC codes are not designed for natural resource planning purposes. Thus, there are categorical distinctions that neither NAICS nor SIC are able to make and that natural resource agencies must negotiate. For example, knowing that a water account is a dedicated irrigation meter is more important for water conservation planning than knowing the industrial sector to which that landscape is assigned. In the CEC Quarterly Reports, electricity for street lighting is a designated category rather than a NAICS code. Therefore, it represents a different type of customer for CEC reporting purposes.

[27] http://www.census.gov/epcd/ec97brdg; http://www.nber.org/nberces; http://www.osha.gov/pls/imis/sic_manual.html.

4.4 Data Processing

The data processing effort consisted of the following steps:

- Converting to common units.
- Ranking use data by NAICS codes.
- Aggregating use data by NAICS codes.
- Sorting by high use.
- Sorting by high account and use.

Each of these steps is detailed below.

4.4.1 Converting to Common Units

Some of the customer use data were received in full six-digit NAICS codes; other data were either four-digit NAICS or SIC codes. Converting from SIC codes yielded NAICS code matches that ranged from two-digit to six-digit NAICS codes. The common denominator that allowed conversion and that most practically provided a detailed set of categories was at the three-digit 2002 NAICS code. The results in this study are presented at the 2002 three-digit NAICS code level.

Specific NAICS and SIC data processing tasks included the following:

- ***LACSD Data:*** These wastewater data were categorized by the 1972 version SIC codes. The first step was to convert 1972 SIC to 1987 SIC codes with the NBER concordance table and assemble a single list of 1987 SIC codes. The SIC codes were then validated against the 1987 SIC definitions at the four-, three-, and two-digit levels to maintain the maximum information value. Next, the SIC codes were then converted to 2002 NAICS codes with CES tables that allocate a share of each SIC code to its respective NAICS code. For SIC codes not included in the CES tables, the Census Bureau concordance tables were used. Finally, groundwater remediation permits were identified using the U.S. Environmental Protection Agency (EPA) permit code and included with the data coded to the NAICS 5629 to indicate remediation.

- ***City of San Diego Water and Wastewater Data:*** Multi-family residential categories were removed from the data provided so that the data consisted of only non-residential CII customers. SIC classifications matched 1987 SIC codes at the two-, three-, or four-digit levels. Because of the low success rate in matching two-digit and three-digit SIC codes with NAICS classifications in the concordance tables, the SIC codes were assigned to NAICS codes by looking up keywords in the official NAICS descriptions. The concordance tables were used to assign four-digit NAICS when four-digit SIC codes were provided.

- ***CEC Data:*** Electric and gas data was based on 1997 NAICS codes and converted to 2002 NAICS code numbers. The electricity data were provided as four-digit NAICS codes and converted into three-digit codes. The number of natural gas accounts by NAICS code was not provided by CEC due to concerns about revealing proprietary information. The concern was that some of the data "cells" contain a small number of businesses of a particular NAICS code and revealing the number of customers in that cell would be indicative of operations. However, natural gas sales data were provided for all NAICS codes.

- ***Central Basin and West Basin Data:*** The data were provided in four-digit NAICS codes and converted into three-digit 2002 NAICS codes.

4.4.2 Ranking Use Data by NAICS Code

The collected empirical data on electricity, natural gas, water, and wastewater among CII customer classes in southern California were also ranked using a weighted percent of total market volume. Table 4.1 provides the top ranked NAICS codes for electricity, natural gas, water and wastewater. A complete set of results for all 111 NAICS code categories is provided in Appendix B.

Table 4.1: Top Ranked NAICS Codes for Electricity, Natural Gas, Water, and Wastewater Use[28]

NAICS Code and Description		Electricity % Ranking	NAICS Code and Description		Natural Gas % Ranking	NAICS Code and Description		Water % Ranking	NAICS Code and Description		Waste-water % Ranking
531	Real Estate	9.7	722	Food Services and Drinking Places	20.5	324	Petroleum and Coal Products Manufacturing	9.8	324	Petroleum and Coal Products Manufacturing	12.6
722	Food Services and Drinking Places	5.5	221	Utilities	7.5	611	Educational Services	6.3	313	Textile Mills	7.7
221	Utilities	5.4	812	Personal and Laundry Services	6.0	221	Utilities	5.5	311	Food Manufacturing	7.6
445	Food and Beverage Stores	5.0	721	Accommodation	5.4	531	Real Estate	5.2	322	Paper Manufacturing	4.4
611	Educational Services	4.7	611	Educational Services	5.3	721	Accommodation	5.0	721	Accommodation	4.4
622	Hospitals	2.8	311	Food Manufacturing	4.3	722	Food Services and Drinking Places	4.0	562	Waste Management and Remediation Services	4.3
334	Computer and Electronic Product Manufacturing	2.5	111	Crop Production	2.8	561	Administrative and Support Services	3.8	211	Oil and Gas Extraction	3.7
721	Accommodation	2.5	541	Professional, Scientific, and Technical Services	2.7	928	National Security and International Affairs	3.6	922	Justice, Pubic Order, and Safety Activities	3.5
452	General Merchandise Stores	2.5	531	Real Estate	2.5	713	Amusement, Gambling, and Recreation Industries	3.1	541	Professional, Scientific, and Technical Services	3.1
541	Professional, Scientific, and Technical Services	2.4	332	Fabricated Metal Product Manufacturing	2.1	812	Personal and Laundry Services	3.1	622	Hospitals	3.0
332	Fabricated Metal Product Manufacturing	2.2	623	Nursing and Residential Care Facilities	2.1	313	Textile Mills	2.8	325	Chemical Manufacturing	2.8
325	Chemical Manufacturing	2.0	447	Gasoline Stations	1.7	423	Merchant Wholesalers, Durable Goods	2.7	332	Fabricated Metal Product Manufacturing	**2.8**
999	Unassigned	2.0	813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	1.6	311	Food Manufacturing	2.5	312	Beverage, Tobacco, Product Manufacturing	2.6
713	Amusement, Gambling, and Recreation Industries	2.0	325	Chemical Manufacturing	1.5	813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	2.2	722	Food Services and Drinking Places	2.4
311	Food Manufacturing	1.9	713	Amusement, Gambling, and Recreation Industries	1.4	325	Chemical Manufacturing	1.8	611	Educational Services	2.4
336	Transportation Equipment Manufacturing	1.9	622	Hospitals	1.4	512	Motion Picture and Sound Recording Industries	1.5	551	Management of Companies and Enterprises	1.9

[28] Top rank refers to NAICS code accounts that have the highest weighted percent of total market volume in southern California.

4.4.3 Aggregating Use Data by NAICS Codes

The collected empirical data on electricity, natural gas, water, and wastewater use and accounts among CII customer classes in southern California were aggregated. Table 4.2 provides an example of the aggregated account and usage data by NAICS code.

A complete set of results for electricity, natural gas, water, and wastewater customer accounts, use, and NAICS codes are in Appendix B. The reader is encouraged not to compare the use tables for electricity and natural gas side-by-side with those for water and wastewater as the geographic coverage areas are not the same.

Table 4.2: Example Electricity Use by NAICS Code

NAICS Code	Description	Megawatt hour (MWh)	Number of Accounts	MWh/ Account
531	Real Estate	8,648,124	136,167	64
221	Utilities	4,811,110	14,999	321
445	Food and Beverage Stores	4,410,416	17,777	248
611	Educational Services	4,110,028	16,886	243
721	Accommodation	2,184,573	8,084	270
622	Hospitals	2,497,987	1,585	1,576
722	Food Services and Drinking Places	4,828,456	47,054	103

4.4.4 Sorting by High Use

To determine the customer categories with high energy and water use, the NAICS codes were sorted into four quadrants. This method provides a means to group customer categories in accordance with PAC guidance, which was to focus on CII customer classes that are high water and energy users with multiple accounts in southern California.[29] The four quadrant approach is illustrated in Figure 4.2. Moving clockwise in this figure:

- The upper right quadrant contains NAICS account codes that rank high in electricity use and water use.

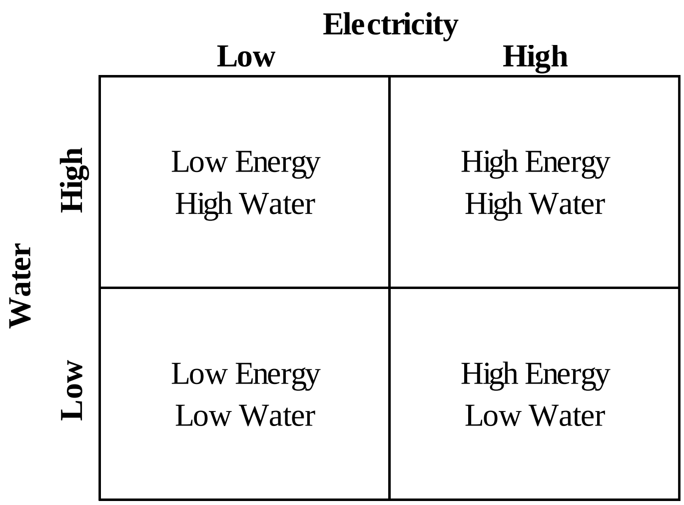
[29] This methodology was developed in consultation with PAC members.

- The lower right quadrant contains NAICS account codes that rank high in electricity use and low in water use.

- The lower left quadrant contains NAICS account codes that rank low in electricity and water use.

- The upper left quadrant contains NAICS account codes that rank low in electricity use and high in water use.

Figure 4.2: 2x2 Matrix



A series of tables was generated that list the NAICS codes in each of the four quadrants. A summary of the High Electricity-High Water Use, High Electricity-High Natural Gas Use, and High Water-High Wastewater Use NAICS codes are summarized in Table 4.3. Appendix B contains a complete set of tables that include all four quadrants.

There are several important points to keep in mind when interpreting Table 4.3. The columns are sorted by the ranking of the high NAICS account codes. For example, the High Electricity, High Water column contains all the NAICS account codes that ranked in the top half of both electricity and water use, and the NAICS account data are sorted by those that ranked high for electricity use.

Table 4.3: Examples of Customer Sorting by NAICS Code and High Use

NAICS Code/High Electricity, High Water		NAICS Code/High Electricity, High Natural Gas		NAICS Code/High Water, High Wastewater	
531	Real Estate	722	Food Services and Drinking Places	324	Petroleum and Coal Products Manufacturing
722	Food Services and Drinking Places	221	Utilities	611	Educational Services
221	Utilities	812	Personal and Laundry Services	221	Utilities
445	Food and Beverage Stores	721	Accommodation	531	Real Estate
611	Educational Services	611	Educational Services	721	Accommodation
622	Hospitals	311	Food Manufacturing	722	Food Services and Drinking Places
334	Computer and Electronic Product Manufacturing	111	Crop Production	561	Administrative and Support Services
721	Accommodation	541	Professional, Scientific, and Technical Services	928	National Security and International Affairs
452	General Merchandise Stores	531	Real Estate	713	Amusement, Gambling, and Recreation Industries
541	Professional, Scientific, and Technical Services	332	Fabricated Metal Product Manufacturing	812	Personal and Laundry Services
332	Fabricated Metal Product Manufacturing	623	Nursing and Residential Care Facilities	313	Textile Mills
325	Chemical Manufacturing	447	Gasoline Stations	423	Merchant Wholesalers, Durable Goods
999	Unassigned	813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	311	Food Manufacturing
713	Amusement, Gambling, and Recreation Industries	325	Chemical Manufacturing	813	Religious, Grantmaking, Civic, Professional, and Similar Organizations
311	Food Manufacturing	713	Amusement, Gambling, and Recreation Industries	325	Chemical Manufacturing
336	Transportation Equipment Manufacturing	622	Hospitals	512	Motion Picture and Sound Recording Industries
326	Plastics and Rubber Products Manufacturing	621	Ambulatory Health Care Services	622	Hospitals
423	Merchant Wholesalers, Durable Goods	334	Computer and Electronic Product Manufacturing	445	Food and Beverage Stores
621	Ambulatory Health Care Services	424	Merchant Wholesalers, Nondurable Goods	621	Ambulatory Health Care Services
928	National Security and International Affairs	999	Unassigned	453	Miscellaneous Store Retailers
922	Justice, Public Order, and Safety Activities	331	Primary Metal Manufacturing	424	Merchant Wholesalers, Nondurable Goods
424	Merchant Wholesalers, Nondurable Goods	333	Machinery Manufacturing	712	Museums, Historical Sites, and Similar Institutions
327	Nonmetallic Mineral Product Manufacturing	922	Justice, Public Order, and Safety Activities	811	Repair and Maintenance
813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	339	Miscellaneous Manufacturing	312	Beverage and Tobacco Product Manufacturing
921	Executive, Legislative, and Other General Government Support	336	Transportation Equipment Manufacturing	922	Justice, Public Order, and Safety Activities

4.4.5 Sorting by High Account and Use

The data were then sorted to reflect NAISC codes that have a high weighted percent of total market volume in southern California (see Table 4.1) and represent customers that are high users of water, energy, and wastewater. The results are summarized in Table 4.4.

Table 4.4: NAICS Codes with Accounts that Rank High in Energy, Water, Wastewater Use and Weighted Percent of Total Market Volume

NAICS Code	Customer Class
531	Real Estate
722	Food Services and Drinking Places
221	Utilities
445	Food and Beverage Stores
611	Educational Services
622	Hospitals
334	Computer and Electronic Product Manufacturing
721	Accommodation
452	General Merchandise Stores
541	Professional, Scientific, and Technical Services
332	Fabricated Metal Product Manufacturing
313	Textile Mills
325	Chemical Manufacturing
999	Unassigned
713	Amusement, Gambling, and Recreation Industries
311	Food Manufacturing
336	Transportation Equipment Manufacturing
326	Plastics and Rubber Products Manufacturing
423	Merchant Wholesalers, Durable Goods
621	Ambulatory Health Care Services
928	National Security and International Affairs
922	Justice, Public Order, and Safety Activities
424	Merchant Wholesalers, Nondurable Goods
327	Nonmetallic Mineral Product Manufacturing
813	Religious, Grantmaking, Civic, Professional, and Similar Organizations
921	Executive, Legislative, and Other General Government Support
324	Petroleum and Coal Products Manufacturing
561	Administrative and Support Services
441	Motor Vehicle and Parts Dealers
812	Personal and Laundry Services
448	Clothing and Clothing Accessories Stores
333	Machinery Manufacturing
512	Motion Picture and Sound Recording Industries
339	Miscellaneous Manufacturing
331	Primary Metal Manufacturing
453	Miscellaneous Store Retailers
623	Nursing and Residential Care Facilities
488	Support Activities for Transportation
811	Repair and Maintenance
493	Warehousing and Storage
451	Sporting Goods, Hobby, Book, and Music Stores
111	Crop Production
312	Beverage and Tobacco Product Manufacturing
624	Social Assistance

4.5 Selecting CII Customer Classes for WEEP

Using the categories in Table 4.4, PAC members were asked to prioritize the CII customer classes for WEEP. Table 4.5 presents the results. The selected customer classes were considered by PAC members as viable candidates for an integrated program involving water and energy incentives, audits, marketing and outreach activities, and retrofits in southern California.

Table 4.5: CII Customer Class Prioritization

Customer Class
Accommodation
Amusement, Gambling, and Recreation Industries
Chemical Manufacturing
Computer and Electronic Product Manufacturing
Educational Services
Fabricated Metal Product Manufacturing
Food Manufacturing
Food Services and Drinking Places
Hospitals
Personal and Laundry Services
Petroleum and Coal Products Manufacturing
Professional, Scientific, and Technical Services
Real Estate
Textile Mills
Utilities

4.6 Data Processing Recommendations

As revealed through the data collection and processing activities, customers are defined differently by water agencies, energy utilities, and wastewater sanitation agencies. To evaluate water, wastewater, and energy savings on a comparable basis, a common approach for defining customers and recording usage data is needed for WEEP.

Based on the data processing efforts undertaken for this study, a recommended approach for defining customers is for the water districts, energy utilities, and wastewater sanitation agencies to converge on the use of similar NAICS codes by applying the principles outlined in Section 3.0, and align these customer categories with metering data.

5.0 CII Customer Class Water and Energy Savings Potentials

5.1 Introduction

To guide the combined audit development in Volume 3 and identify areas that could be targeted for marketing and outreach activities in Volume 4, examples of water and energy savings potentials associated with each of the CII customer classes selected for WEEP were gathered (see Table 4.5). Table 5.1 is an illustrative example and indicates that there are potential savings associated with CII customer classes selected for WEEP.

Table 5.1: Example Water and Energy Savings Potentials Table

Water and Energy Savings Potential for CII Customer Class - Accommodation*			
Item	**Water**	**Electricity**	**Natural Gas**
Swimming Pools	30%	50% to 70%	50% to 70%
Laundry[1]	10% to 90%	45% to 80%	45% to 90%
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Cooling	20% to 30%	20% to 30%	
Landscape	20% to 50%		
Food Service	10% to 30%	10% to 30%	10% to 30%

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

5.2. Appendix C Summary Tables

Appendix C contains a series of tables summarizing savings potentials for the fifteen CII customer classes selected for WEEP.

For each of the "items" listed in a table, the source of the data is provided as well as an explanation of the savings potentials related to water, electricity, and natural gas.

6.0 Analytical Framework

6.1 Introduction

This section presents an analytical framework for evaluating the costs and benefits associated with water and energy efficiency projects. The framework discusses five primary elements of a cost-benefit analysis:

- Determining the perspective of the analysis.
- Identifying the costs and benefits including, but not limited to, capital expenditures, cost of routine maintenance, and reduced benefits costs associated with energy and water demands.
- Discounting future costs and benefits to reflect their present values.
- Calculating the net present value or using other measures such as, benefit-cost ratios, cost-effectiveness ratios, and internal rates of return, to generate an evaluation measure.
- Analyzing the uncertainty associated with the available information to evaluate whether the conclusions are sensitive to the underlying assumptions.

This section also includes an example spreadsheet to illustrate how the analytical framework can be applied to evaluate potential water and energy efficiency improvements at CII customer class sites from the perspective of the customer. The spreadsheet also provides an approach for summarizing estimated and actual savings in a service area or region.

6.2 Determining the Perspective of the Analysis

A cost-benefits analysis of water and energy efficiency measures can be applied from three perspectives: the customer (or ratepayer), the water district or energy utility, and society as a whole. Ideally analyses should be conducted from all three perspectives. By undertaking the analyses from differing perspectives, information is generated that can be used by customers in making decisions to implement efficiency measures, and by water districts and energy utilities in evaluating the efficacy of water and energy improvements region-wide. Each perspective is briefly described below.

6.2.1 Customer Perspective

Customer-level cost-benefit analyses identify each change in equipment or process and estimate the impact of the change on water and energy use for the customer. When the customer-level analysis is used, the customer obtains information that can be compared and contrasted with various efficiency opportunities, and the water districts and energy utilities obtain information necessary to identify the assistance or incentives required to encourage the customer to implement efficiency measures.

6.2.2 Water District or Energy Utility Perspective

A cost-benefit analysis from the water district or energy utility perspective estimates the value of an efficiency project for the district or utility. It may result in an outcome that differs from an analysis undertaken from the customer perspective. For example, a water district or energy utility may need to achieve explicit efficiency goals in order to comply with state or other public objectives. Thus, it may value efficiency gains over and above the savings available to the customer because the efficiency measures help it achieve these goals. Because of this, the value of potential efficiency measures may be positive for the water district or energy utility even though it might be zero or negative for the customer.

6.2.3 Social Perspective

Cost-benefit analyses from the social perspective weigh the aggregate costs and benefits of the efficiency project or program to the greater community as well as to customers, ratepayers, districts, and utilities. An analysis at this level is the widest in scope. It captures all costs and benefits to society, including externalities or impacts on parties not directly involved in the program. This type of analysis is useful for high-level policy-making since it allows for comparisons of efficiency programs and projects at the macro level.

Analysis from the social perspective is more likely to include costs and benefits that are difficult to quantify. Measuring and valuing the environmental, security, and social benefits of reduced water and energy use is complex and often associated with great uncertainty. Further, this analysis does not distinguish the net effects for each party involved. Some parties may have costs that outweigh benefits, even if society as a whole is better off with the program. In addition, there may be social or political reasons for treating the costs or benefits differently to various parties.

6.3 Identifying Costs and Benefits

6.3.1 Identifying and Measuring Costs and Benefits

It is crucial that a cost-benefit analysis, regardless of its perspective, include all potential costs and benefits, which are traditionally quantified as monetary costs and benefits. For energy utilities, water districts, and customers, costs incurred by implementing conservation measures include capital expenditures, labor, power, water, routine maintenance, and forgone revenue. Benefits include reduced expenditures on water and energy and avoided costs.

Some costs and benefits cannot be quantified or their monetary value may be unknown. For example, the impact of a conservation program on the local control of resources may be important but difficult to value. However, to undertake a comprehensive cost-benefit analysis, non-monetary benefits should be identified and assigned qualitative measures to reflect their importance and to assess their impact on the bottom line. In addition, incremental costs and benefits resulting from the project should be included in the cost-benefit analysis.

6.3.2 Costs and Benefits by Perspective

6.3.2.1 Customer Perspective

The quantifiable benefits that should be reflected in the cost-benefits analysis from the customer perspective typically include the following:

- Reductions in the customer's utility bills, beyond those that would have occurred without participation in the efficiency project, due to reduced use of water, wastewater, electricity, or natural gas.
- Reductions in operations and maintenance (O&M) costs.
- Incentives or tax credits received.

Other potential benefits that are important to consider, but may be difficult to quantify, are increased productivity, enhanced green image, and increased morale of employees who value improved efficiency.

The costs that should be included in the customer perspective analysis are:

- Incremental one-time costs to purchase and install equipment. That is, the additional costs of the efficient equipment should be included in the analysis if less efficient equipment would have been installed absent the program.
- Additional O&M costs.
- The value of time the customer spends organizing and managing the project.
- Any increases in the customer's utility bills. For example, reduced water use may lead to higher contaminant concentrations in wastewater and higher rates paid for wastewater treatment.

These example costs and benefits are consistent with the guidelines established by CPUC and CEC as well as by CUWCC for economic evaluations at the customer level.[30]

6.3.2.2 Water District and Energy Utility Perspectives

The costs and benefits of an efficiency project or program from the water district or energy utility perspective are calculated by evaluating changes in revenues and operating costs.

Typical benefits that should be considered as part of this analysis include:

- Avoided costs of acquiring water and energy sources, including purchases, or generation.
- Avoided water storage costs.
- Avoided costs of treating water and wastewater.
- Avoided transmission and distribution costs.
- Rate increases, incentives, tax credits, or revenue from sales of conserved water to other customers.

The costs to the water district or energy utility that should be considered include:

- Costs of administering the project or program.
- Incentives paid to customers.
- Any additional source, storage, treatment, or transmission and distribution costs.
- Forgone revenue.

The CUWCC does not consider changes in revenues for the water district or energy utility as costs or benefits since they will result in rate changes. Typically, a loss in revenues will be recovered through increases in rates; there will be no net loss to the water district or energy utility. This framework accounts for revenue changes, but since they are included as both benefits and costs, revenue changes may not result in net benefits.

The non-revenue costs and benefits presented above are consistent with the CPUC and CEC and CUWCC guidelines for conducting a cost-benefit analysis from the district or utility perspective (e.g., CPUC and CEC Program Administrator Test

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[30] See CPUC and CEC, "California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects," October 2001 and CUWCC, "Guidelines to Conduct Cost Effectiveness Analysis of Best Management Practices for Urban Water Conservation," 1996.

and CUWCC Supplier Perspective[31]). For additional guidance on calculating avoided costs for water and wastewater, see the CUWCC/American Water Works Research Foundation Direct Utility Avoided Cost Model.[32]

6.3.2.3 Social Perspective

The social perspective sums the total costs and benefits of a project across society as a whole. An analysis from this perspective includes the effects of the efficiency project to the customer, the district or utility, and the greater community. The benefits include:

- Supply, storage, treatment, and transmission and distribution costs avoided by the district or utility serving the customer.
- Costs incurred by other districts or utilities providing water and energy but avoided by the district or utility serving the customer.
- Environmental benefits created through reduced water and energy use. These include improved air and water quality, reduced greenhouse gas emissions, and improved ecological habitats.
- Avoided costs of expanding the transmission and distribution networks for water, electricity, natural gas, and wastewater by the district or utility serving the customer.
- Potentially more stable demand, increased system reliability, and reduced price volatility.

The social costs of an efficiency project include:

- Incremental one-time costs incurred by the customer to purchase and install new or replacement equipment.
- Additional O&M costs for the customer.
- The administrative costs incurred by the district or utility and by the customer to implement the project.
- Any external costs to the environment.

Taxes and incentives are not counted as costs or benefits since they are considered transfer payments. Interest paid on financing is also considered a transfer payment. The approach presented above is similar to the Societal Test outlined by

[31] "Supplier" refers to the water supplier (or water agency) implementing a BMP or conservation program. Thus, the CUWCC "Supplier Perspective" can be adapted for analyses at the water agency or energy utility level. See CUWCC CEA guidelines, 1996.
[32] Instructions and the model can be downloaded at: http://www.cuwcc.org/direct-utility-avoided-costs-environmental-benefits-models.aspx.

the CPUC and CEC guidelines, as well as the Total Social Perspective guidelines set by the CUWCC.

Though difficult to quantify, a variety of resources can be used for valuing the positive externalities associated with water and energy conservation.[33] The CPUC identifies a variety of "adders," or positive externalities, resulting from reduced energy generation. The Environmental Benefits (EB) Model developed for the CUWCC allows for valuation of the environmental benefits of reduced water use.

6.4 Discounting Future Costs and Benefits

6.4.1 Purpose of Discounting

The costs and benefits of water and energy efficiency projects may occur over many years. For example, companies may purchase water- and energy-efficient equipment today that will produce water and energy savings for many years. Future costs and benefits must be discounted to compare them to present values for two reasons. First, most people would place higher values on current costs or benefits than future costs or benefits due to the time value of money. For example, most people would choose to receive $100 today rather than in one year because (in principle) they could invest the $100 they receive today and have more than $100 next year. Second, there is a risk that future costs and benefits will not occur. Discounting adjusts future costs and benefits in order to reflect their present value (i.e., what they are worth today). The higher the discount rate applied for discounting, the lower the present value of future costs and benefits.

The following equation is used to calculate the present value of future costs or benefits:

$$PV = \frac{FV}{(1+r)^t}$$

where *PV* is the present value, *FV* is the future value, *r* is the annual discount rate, and *t* is the number years until the future cost or benefit occurs. The discount rate can be in nominal or real (i.e., inflation-adjusted) terms. It can be risk free or adjusted for risk, depending on the needs of the analysis.

[33] See CPUC and CEC, *California Standard Practice Manual: Economic Analysis Of Demand-Side Programs And Projects*, October 2001 and CUWCC (2007c), *Environmental Benefits Model*, April 2007.

6.4.2 Determining the Discount Rate

Careful consideration should be given to choosing a discount rate since the rate can influence the outcome of the cost-benefit analysis. For example, the present value of $1,000 dollars saved in 10 years at a discount rate of 5 percent is nearly $614. In contrast, a discount rate of 10 percent yields a present value of less than $386.

$$PV = \frac{\$1{,}000}{(1+.05)^{10}} = \$614 \qquad PV = \frac{\$1{,}000}{(1+.10)^{10}} = \$386$$

The appropriate discount rate to apply depends on the perspective of the analysis. If the analysis is conducted at the customer level, the analysis should utilize the market rate of return for private investments or the customer's weighted average cost of capital. Similarly, analyses at the district or utility level should use the water district's or energy utility's cost of capital.

Analyses conducted from the social perspective will typically apply lower discount rates than those used in analyses conducted at the customer, district, or utility level. This difference is due, in part, to the role of risk. Individual customers usually pay a risk premium when they borrow funds. The risk premium is a transfer payment and its value is negligible from society's perspective. Further, some economists have argued that the social discount rate is below the risk-free market rate because of imperfections in capital markets.[34] The CUWCC cost-effectiveness guidelines recommend using the discount rates published by the Executive Office of the President, Office of Management and Budget (OMB) Circular No. A-94 for the social discount rate.[35] These rates are based on the U.S. Treasury borrowing rate on marketable securities. The rate with a maturity comparable to the length of analysis should be used. The OMB discount rates for 2009 are indicated in Table 6.1.

[34] See Rosen and Gayer, 2008.
[35] See Office of Management and Budget, Circular No. A-94, "Benefit-Cost Analysis of Federal Programs: Guidelines and Discounts," Appendix C, Washington, D.C., revised December 2008. Available at: http://www.whitehouse.gov/omb/assets/agencyinformation_circulars_pdf/m09-07.pdf.

Table 6.1: Interest Percent Rates on Treasury Notes and Bonds of Specified Maturities [36]

Year/Rate	3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
Nominal Interest Rates	2.7	3.3	3.7	4.2	4.7	4.5
Real Interest Rates	0.9	1.6	1.9	2.4	2.9	2.7

If the costs and benefits are to be expressed in real terms, then the real discount rate should be applied rather than the nominal discount rate. The real discount rate is calculated from the nominal discount rate using the following equation:

$$r = (d - i) + (1 + i)$$

where r is the real discount rate, d is the nominal discount rate, and i is the expected inflation rate.

6.5 Calculating the Value of the Proposed Activity

The best approach for completing a cost-benefit analysis is to calculate the net present value (NPV) of the water and energy efficiency measures. While NPV is the best measure, there are times when it is appropriate to use other measures. These others include benefit-cost ratios, cost-effectiveness ratios, and internal rates of return. It is also important to consider payback periods for efficiency projects, since customers often use this metric when making decisions about infrastructure investments. The framework includes a description of these measures, guidance on how they are calculated, and a discussion of the advantages and disadvantages compared to net present value.

6.5.1 Net Present Value

NPV enables streams of costs and benefits over time to be expressed in their equivalent present day value and compared to one another. NPV sums the discounted value of net benefits, which are accrued over a specified period of time. An NPV above zero indicates that the benefits outweigh the costs of the project. A project is considered admissible if its net present value is greater than zero. Among admissible projects, the preferred project is the one with the highest net present value.

[36] Circular No. A-94, “Benefit-Cost Analysis of Federal Programs: Guidelines and Discounts,” Appendix C, Office of Management and Budget, Washington, D.C., revised December 2008.

The NPV is calculated using the following equation:

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t}$$

where B_t are the benefits in year *t*, C_t are the costs in year *t*, *r* is the discount rate, and *n* is the period of years in the analysis. The period of the analysis, *n*, is typically equal to the expected life of the new or replacement equipment installed as part of the efficiency project.

The advantage of using NPV is that it calculates the total value of the project. Since NPV reflects the actual net benefits that will be earned over time, it allows direct comparisons between the values of alternative projects. NPV does not however, reveal the relative advantage of investing a given amount of money in one efficiency project over another. Another disadvantage of using NPV is that it may not adequately capture all the factors that play a role in decision making. NPV does not indicate when benefits begin to outweigh costs, a particularly important consideration for customers.

6.5.2 Benefit-Cost Ratio

The benefit-cost ratio is the ratio of the sum of discounted benefits to the sum of discounted costs of a program over time. A benefit-cost ratio above one indicates that the total benefits of the project are greater than the costs.

The benefit-cost ratio is calculated using the following equation:

$$B/C = {\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}} \Big/ {\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}}$$

where B_t are the benefits in year *t*, C_t are the costs in year *t*, *r* is the discount rate, and *n* is the period of years in the analysis.

The advantage of using a benefit-cost ratio is that it allows a quick comparison of the benefits relative to the costs. It also provides a general rate of return for the project, which enables comparisons between the returns of alternative investments. The disadvantage of using a benefit-cost ratio is that it does not indicate the magnitude of the total value of the project. A project may have a very large benefit-cost ratio, but a small NPV compared to alternative projects.

6.5.3 Cost-Effectiveness Ratio

The cost-effectiveness (CE) ratio provides a measure of the costs associated with saving a specified amount of water or energy. Just as monetary values can be discounted, so can units of energy and water. The cost-effectiveness ratio is the sum of discounted costs over the sum of the discounted water, electricity, natural gas, or wastewater saved (as measured in gallons, kilowatt hour [kWh], therms) through an efficiency program over time.

CE is calculated using the following equation:

$$CE = \left. \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} \middle/ \sum_{t=1}^{n} \frac{U_t}{(1+r)^t} \right.$$

where C_t are the costs in year *t*, U_t are the units of water or energy saved, *r* is the discount rate, and *n* is the period of years in the analysis.

The cost-effectiveness ratio is a good measure to identify the lowest cost option for reducing resource use. The alternative with the lowest costs per unit of water, electricity, natural gas, or wastewater saved can be identified. The cost-effectiveness ratio does not allow comparisons of the total resource savings for each of the alternatives, nor does it include the overall benefits associated with efficiency projects.

6.5.4 Internal Rates of Return

The internal rate of return calculates the discount rate that would make the net present value of the project equal to zero. It is calculated through an iterative process where different discount rates are applied to the NPV equation until the NPV is zero. If market interest rates are less than the internal rate of return, then the project is beneficial.

The internal rate of return finds the value of *r* that satisfies the following equation:

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t} = 0$$

where B_t are the benefits in year *t*, C_t are the costs in year *t*, *r* is the discount rate, and *n* is the period of years in the analysis.

The advantage of calculating an internal rate of return is that it allows the returns from the efficiency project to be compared with the returns of other investment alternatives. Like the benefit-cost ratio and the cost-effectiveness ratio, the internal rate of return does not provide the total value of the project.

6.5.5 Simple Payback (SP) Period

The simple payback period equals the number of years before a project's cumulative benefits exceed its cumulative costs. The shorter the payback, the more attractive the project is, particularly for customers that have limited funding for capital investment.

The SP period is the *n* that satisfies the following equation:

$$IC = \sum_{t=1}^{n} B_t - AC_t$$

where *IC* are the initial capital costs (e.g., purchasing and installing equipment), B_t are the benefits in year *t*, AC_t are the annual costs in year *t* (e.g., operations and maintenance), and *n* is the period of years.

If the annual net benefits ($B_t - AC_t$) are the same every year, then the following equation is used to calculate the SP period:

$$SP = \frac{IC}{B - AC}$$

where *IC* are the initial capital costs (e.g., purchasing and installing equipment), *B* are the benefits received every year, and *AC* are the annual costs.

The CPUC and CEC cost-effectiveness guidelines call for a discounted payback, which requires discounting future costs and benefits. A discounted payback more accurately reflects the value of future costs and benefits, though the simple payback is the method commonly used by many water districts and customers.

The discounted payback is the *n* that satisfies the following equation:

$$IC = \sum_{t=1}^{n} \frac{B_t - AC_t}{(1+r)^t}$$

where *IC* are the initial capital costs (e.g., purchasing and installing equipment), B_t are the benefits in year *t*, AC_t are the annual costs in year *t* (e.g., operations and maintenance), *r* is the discount rate, and *n* is the period of years.

6.5.6 Qualitative Measures

Some benefits of water- and energy-efficiency measures are intangible. These benefits might be increased local control over resources, for example, or helping to create a cleaner environment. It may not be possible to place a dollar value on these benefits, but they can be discussed qualitatively. The analysis should indicate whether they exist, and may also describe their magnitude in qualitative terms. Ultimately, the value of these intangible benefits is subjective. The goal of the analysis is to provide enough information for decision makers to determine their relative importance.

6.6 Analyzing Uncertainty

Cost-benefit analyses often require a great deal of information, some of which may not be available. Some future costs may not be known. The amount of water or energy that can be saved may depend on future conditions, which are unknown. Analysts may be able to estimate the cost of capital, but it may vary over some range. With additional time and resources, the missing information may be developed. Lacking those resources, the analyst may need to make assumptions about costs, benefits, and discount rates in order to evaluate a project. Even full-scale analyses conducted over many years lack perfect information. Therefore, cost-benefit analyses need to evaluate the impact of uncertainty on their results. These analyses are known as “sensitivity analyses” because they evaluate whether the conclusions are sensitive to the underlying assumptions. The analysis should look at the following assumptions.

- **Costs**. Many cost-benefit analyses have access to realistic cost data. The cost of new equipment is often known, and companies may have useful information about current and future labor costs. If there is uncertainty about the cost of a project, the analysis should include estimates of the NPV and other measures of project effectiveness over the range of possible costs.

- **Benefits**. Benefits are often more uncertain. For example, the amount of energy that a device can save may depend on usage rates and maintenance, which can vary over time. In other cases, benefits may not be easily quantified. The analysis may use assumptions about the dollar value of these measures. As with costs, the analysis should include estimates of the NPV and other measures of project effectiveness over a range of possible benefits.

- **Discount rates**. The cost of capital for a specific company may not be available. There also may not be a consensus on the value of the social discount rate. The discount rate is a critical value in the analysis and can have a substantial impact on the results. NPV should be calculated over a reasonable range of discount rates.

Given the best information available about costs and benefits, and given an agreed-upon discount rate, the NPV of a project may be positive and indicate that it is a better choice than alternative projects. But a sensitivity analysis may indicate that the project’s NPV may be negative under some circumstances. This situation may indicate where additional information is needed to better inform the analysis. It may also illustrate the risks inherent in the project that water districts and energy utilities might be able to address with financial incentives.

6.7 Example Evaluation

A relatively simple cost-benefit analysis of a water- and energy-efficiency project is presented in this section to demonstrate project evaluation from the customer perspective. This method was determined to be the most valuable for WEEP. It uses the method outlined in the framework and is implemented in an Excel spreadsheet that is contained on the compact disc in Volume 1 of the WEEP Study. The hypothetical project is at a food production facility (Food Example). The primary focus of the analysis is the NPV and simple payback period of a project to reuse process rinse water, which will reduce water, wastewater, and natural gas use at the facility. The project includes the installation of recycle clean-in-place (CIP) process water equipment, a timer to reduce rinse times, and a high temperature short time steam condensate reclaim tank, pump, and piping. This example can be modified to provide a rough estimate of the value of other efficiency projects.

6.7.1 Example Project Inputs

The costs and benefits associated with each type of efficiency equipment are entered into the example spreadsheet on the project specification worksheet. Costs are broken down into annual costs such as O&M and one-time costs such as capital costs. Benefits are the annual water, wastewater, natural gas, and electricity savings. While the example spreadsheet model is not currently designed to include additional benefits, it could be expanded to do so. (see Figure 6.1)

Figure 6.1: Example Project Specifications Worksheet

Conservation Action	Capital and other One-Time Costs	O&M and other Annual Costs	Annual Water Savings (1000 gallons)	Annual Wastewater Savings (1000 gallons)	Annual Natural Gas Savings (Therms)	Annual Electricity Savings (kWh)
Recycle Clean-in-Place (CIP) Process Water	30,000	500	2,000	2,000	0	0
Re-program Timer to Reduce Rinse Times	500	0	300	300	0	0
Install an HTST Steam Condensate Reclaim Tank, Pump, and Piping	10,500	500	400	400	5,000	0
Total	41,000	1,000	2,700	2,700	5,000	0

Water, wastewater, natural gas, and electricity rates, or charges, are input into the "Rates" sheet so that the water and energy savings can be valued. The example allows fixed and variable charges to be differentiated. It is also possible to vary or escalate the annual water and energy savings, rates charged for water and energy, and annual O&M costs over time. For example, water rates can be increased by a certain percentage each year. If the model is used to evaluate a project in real terms, the rates used to adjust resource savings and charges should reflect only increases beyond those that would occur with inflation. An evaluation in real terms often is easier because it does not require the estimation of inflation rates. In some cases, customers may be interested in nominal cash flow; in those cases, the nominal discount rate should be used. The discount rate applied for the analysis is also input into the "Rates" sheet. (See Figure 6.2)

Figure 6.2: Example Rates Worksheet

Customer Water and Energy Costs (Rates)

	Water	Wastewater	Natural Gas	Electricity	Reclaim
Unit	1000 gallons	1000 gallons	Therms	kWh	1000 gallons
Cost/Unit	1.5	1.4	0.6	0.08	0
Fixed Cost	0	0	0	0	0

Discount Rate

	Rate
Private Cost of Capital	0.075

Resource Savings Ramp-up and Benefit Escalation Rates

	Water	Wastewater	Natural Gas	Electricity
Savings Ramp Up	0	0	0	0
Resource Rates	0.03	0	0	0
Incentives	0	0	0	0

Cost Escalation rates
(Increase in Costs per Year)

	Rates
Capital	0
O&M	0

6.7.2 Incentives

Incentives provided to the customer by water districts, wastewater districts, natural gas utilities, and electricity utilities are entered into the "Incentives" worksheet of the example. The spreadsheet distinguishes between incentives that the districts and utilities provide up-front and those that they provide annually. Limits can also be set for each incentive received based on the length or total value of the incentives. For example, some incentives may be capped based on the total capital costs of the project, while others may be paid for a limited number of years. (See Figure 6.3)

Figure 6.3: Example Conservation Incentives Worksheet

Incentive Type		Water	Wastewater	Natural Gas	Electric
Rate (Number)	Upfront payments	0	0	0	0
	Annual payments	3	0	0.6	0.08
Unit	Upfront payments	1000 gallons	1000 gallons	Therms	kWh
	Annual payments	1000 gallons	1000 gallons	Therms	kWh
Limit (Years)	Upfront payments	None	None	None	None
	Annual payments	1	None	None	1
Limit (Value)	Upfront payments	None	None	None	None
	Annual payments	41000	None	20500	20500

6.7.3 Calculations and NPV Scenarios

The "Calculations" worksheet demonstrates the costs, benefits, and incentives for each year of the analysis. They are distinguished for water, wastewater, natural gas, and electricity. The NPV, benefit-cost ratio, cost-effectiveness, and internal rate of return are calculated based on all variables input in the "Food Project" and "Rates" worksheets. Alternatively, the annual costs and benefits can be input manually into the "Calculations" worksheet. (See Figure 6.4)

Figure 6.4: Example Calculations Worksheet[37]

Year	Costs to Customer: Direct Costs ($)		Benefits to Customer: Water and Energy Savings				Reduced Costs (Dollars)				Incentives ($)			
	Capital Costs	O&M Costs	Water	Wastewater	Natural Gas	Electric	Water	Wastewater	Natural Gas	Electric	Water	Wastewater	Natural Gas	Electric
1	41,000	1,000	2,700	2,700	5,000	0	4,050	3,780	3,000	0	8,100	0	3,000	0
2	0	1,000	2,700	2,700	5,000	0	4,172	3,780	3,000	0	0	0	3,000	0
3	0	1,000	2,700	2,700	5,000	0	4,297	3,780	3,000	0	0	0	3,000	0
4	0	1,000	2,700	2,700	5,000	0	4,426	3,780	3,000	0	0	0	3,000	0
5	0	1,000	2,700	2,700	5,000	0	4,558	3,780	3,000	0	0	0	3,000	0
6	0	1,000	2,700	2,700	5,000	0	4,695	3,780	3,000	0	0	0	3,000	0
7	0	1,000	2,700	2,700	5,000	0	4,836	3,780	3,000	0	0	0	2,500	0
8	0	1,000	2,700	2,700	5,000	0	4,981	3,780	3,000	0	0	0	0	0
9	0	1,000	2,700	2,700	5,000	0	5,130	3,780	3,000	0	0	0	0	0
10	0	1,000	2,700	2,700	5,000	0	5,284	3,780	3,000	0	0	0	0	0
11	0	1,000	2,700	2,700	5,000	0	5,443	3,780	3,000	0	0	0	0	0
12	0	1,000	2,700	2,700	5,000	0	5,606	3,780	3,000	0	0	0	0	0
13	0	1,000	2,700	2,700	5,000	0	5,774	3,780	3,000	0	0	0	0	0
14	0	1,000	2,700	2,700	5,000	0	5,948	3,780	3,000	0	0	0	0	0
15	0	1,000	2,700	2,700	5,000	0	6,126	3,780	3,000	0	0	0	0	0
16	0	1,000	2,700	2,700	5,000	0	6,310	3,780	3,000	0	0	0	0	0
17	0	1,000	2,700	2,700	5,000	0	6,499	3,780	3,000	0	0	0	0	0
18	0	1,000	2,700	2,700	5,000	0	6,694	3,780	3,000	0	0	0	0	0
19	0	1,000	2,700	2,700	5,000	0	6,895	3,780	3,000	0	0	0	0	0
20	0	1,000	2,700	2,700	5,000	0	7,102	3,780	3,000	0	0	0	0	0
Total	41,000	20,000	54,000	54,000	100,000	0	108,825	75,600	60,000	0	8,100	0	20,500	0
Present Value														
10-Year	41,000	7,379	19,923	19,923	36,894	0	33,663	27,892	22,137	0	8,100	0	16,758	0
20-Year	41,000	10,959	29,590	29,590	54,795	0	55,614	41,425	32,877	0	8,100	0	16,758	0
Benefit/Cost Ratio														
10-Year														
20-Year														
Cost-effectiveness														
10-Year			2.43	2.43	1.31	0.00								
20-Year			1.76	1.76	0.95	0.00								
Internal Rate of Return														
10-Year														
20-Year														

Year	Net Benefit	Cumulative Net Present Value	Net Benefit: Water	Add Waste-water	Add Natural Gas	Add Electric	Add Incentive	Cumulative Net Benefit: Water	Add Waste-water	Add Natural Gas	Add Electric	Add Incentive
1	-20,070	-20,070	-37,950	-34,170	-31,170	-31,170	-20,070	-37,950	-34,170	-31,170	-31,170	-20,070
2	12,952	-8,022	3,172	6,952	9,952	9,952	12,952	-34,779	-27,219	-21,219	-21,219	-7,119
3	13,077	3,294	3,297	7,077	10,077	10,077	13,077	-31,482	-20,142	-11,142	-11,142	5,958
4	13,206	13,923	3,426	7,206	10,206	10,206	13,206	-28,056	-12,936	-936	-936	19,164
5	13,338	23,911	3,558	7,338	10,338	10,338	13,338	-24,498	-5,598	9,402	9,402	32,502
6	13,475	33,297	3,695	7,475	10,475	10,475	13,475	-20,803	1,877	19,877	19,877	45,977
7	13,116	41,796	3,836	7,616	10,616	10,616	13,116	-16,967	9,493	30,493	30,493	59,093
8	10,761	48,282	3,981	7,761	10,761	10,761	10,761	-12,986	17,254	41,254	41,254	69,854
9	10,910	54,400	4,130	7,910	10,910	10,910	10,910	-8,856	25,164	52,164	52,164	80,764
10	11,064	60,171	4,284	8,064	11,064	11,064	11,064	-4,571	33,229	63,229	63,229	91,829
11	11,223	65,616	4,443	8,223	11,223	11,223	11,223	-128	41,452	74,452	74,452	103,052
12	11,386	70,755	4,606	8,386	11,386	11,386	11,386	4,478	49,838	85,838	85,838	114,438
13	11,554	75,606	4,774	8,554	11,554	11,554	11,554	9,252	58,392	97,392	97,392	125,992
14	11,728	80,187	4,948	8,728	11,728	11,728	11,728	14,200	67,120	109,120	109,120	137,720
15	11,906	84,512	5,126	8,906	11,906	11,906	11,906	19,326	76,026	121,026	121,026	149,626
16	12,090	88,598	5,310	9,090	12,090	12,090	12,090	24,635	85,115	133,115	133,115	161,715
17	12,279	92,458	5,499	9,279	12,279	12,279	12,279	30,134	94,394	145,394	145,394	173,994
18	12,474	96,106	5,694	9,474	12,474	12,474	12,474	35,828	103,868	157,868	157,868	186,468
19	12,675	99,555	5,895	9,675	12,675	12,675	12,675	41,723	113,543	170,543	170,543	199,143
20	12,882	102,815	6,102	9,882	12,882	12,882	12,882	47,825	123,425	183,425	183,425	212,025
Total	212,025		47,825	123,425	183,425	183,425	212,025	6,326	800,126	1,430,126	1,430,126	1,942,126
Present Value												
10-Year	60,171		-14,716	13,176	35,313	35,313	60,171	-179,134	-42,224	66,435	66,435	223,829
20-Year	102,815		3,655	45,080	77,957	77,957	102,815	-108,992	229,677	498,462	498,462	758,250
Benefit/Cost Ratio												
10-Year	2.24		0.65	1.18	1.61	1.61	2.09	2.09	2.09	3.25	3.25	3.90
20-Year	2.98		1.07	1.87	2.50	2.50	2.98	2.98	2.98	4.96	4.96	7.40
Cost-effectiveness												
10-Year												
20-Year												
Internal Rate of Return												
10-Year	64%		-2%	16%	30%	30%	64%	0%	-2%	20%	20%	62%
20-Year	65%		9%	22%	33%	33%	65%	0%	19%	32%	32%	65%

The "NPV Scenarios" worksheet summarizes the simple payback and the NPV of the project under various scenarios. NPV is calculated for 10 years and 20 years. Both NPV and the simple payback can be calculated to identify water savings only; water and wastewater savings; water, wastewater, and energy savings; and all resource savings and incentives. The Food Example shows that water savings alone do not provide a positive NPV after 10 years. The more resources and incentives included, the greater the NPV and the shorter the project's payback period. Cost-benefit analyses under WEEP should include all available resource savings and incentives rather than those provided by individual water districts and energy utilities, which is a common practice. The "NPV Scenarios" worksheet also allows qualitative measures to be identified. While the value of these measures are not calculated, it is important to recognize that a project may provide additional non-monetary benefits, such as enhanced green image and reduced greenhouse gas emissions. (See Figure 6.5)

[37] See the Excel Spreadsheet on the compact disc in Volume 1 to view the details of the Calculations Worksheet.

Figure 6.5: Example NPV Scenarios Worksheet

	Water Savings Only	Water and Sewer Savings	Water, Sewer, and Energy Savings	Add Incentives
		Customer Perspective		
Simple Payback (Years)	12.0	6.0	5.0	3.0
Net Present Value for 10 Years ($)	-14,716	13,176	35,313	60,171
Net Present Value for 20 Years ($)	3,655	45,080	77,957	102,815

Qualitative Measures

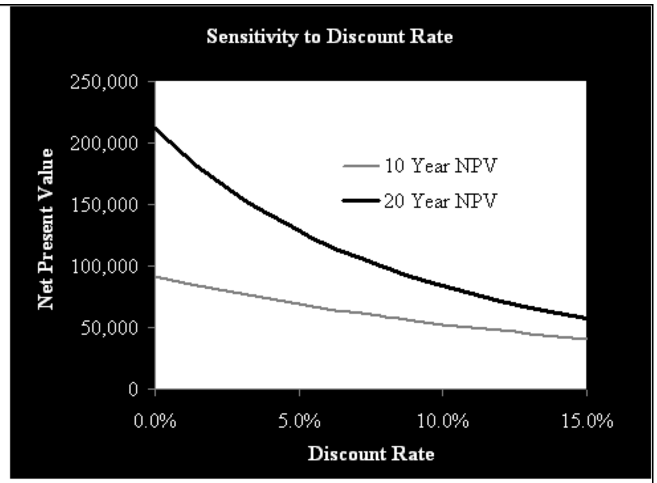
	Water Savings Only	Water and Sewer Savings	Water, Sewer, and Energy Savings	Add Incentives
		Customer Perspective		
Increased Green Image	X	X	X	X
Reduced GHG Emissions			X	X

6.7.4 Sensitivity Analysis

The "Sensitivity" worksheet shows the sensitivity of the NPV calculations to two important project assumptions: capital costs and the discount rate. Estimated project costs will often vary from actual costs. The spreadsheet shows the effect varying costs have on the overall value of a project. For the Food Example, the NPV will be positive even if project costs are much higher than initially assumed. The sensitivity of NPV to the discount rate is also shown on the "Sensitivity" sheet. The example project illustrates that a change in the discount rate can have a large impact on the project's value. The spreadsheet can be expanded to include additional sensitivity analyses. (See Figure 6.6)

Figure 6.6: Example Sensitivity Analysis Worksheet

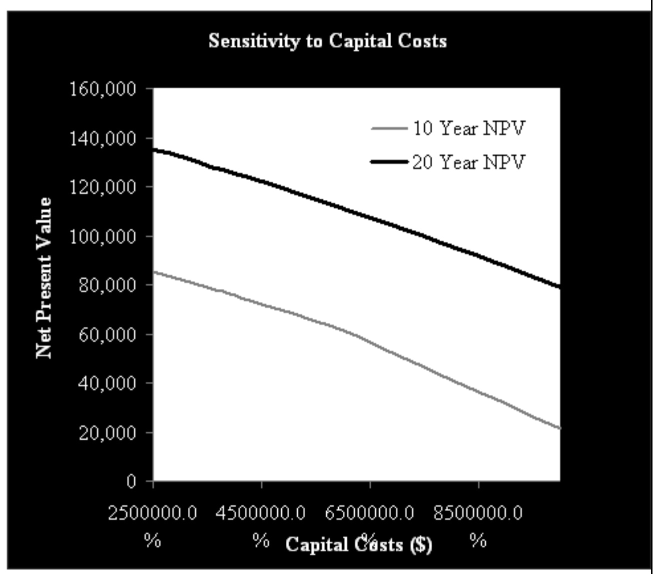
Discount Rate	10 Year NPV	20 Year NPV
0.0%	91,829	212,025
1.0%	86,613	190,572
2.0%	81,752	171,869
3.0%	77,217	155,504
4.0%	72,979	141,136
5.0%	69,016	128,477
6.0%	65,306	117,286
7.0%	61,828	107,359
7.5%	60,171	102,815
8.0%	58,565	98,524
9.0%	55,500	90,636
10.0%	52,618	83,570
11.0%	49,905	77,221
12.0%	47,350	71,499
13.0%	44,940	66,326
14.0%	42,665	61,636
15.0%	40,516	57,372



Capital Cost Sensitivity Analysis*

Capital Costs ($)	10 Year NPV	20 Year NPV
2500000.0%	85,347	135,151
3000000.0%	82,219	132,023
3500000.0%	78,960	128,765
4000000.0%	75,605	125,409
4100000.0%	74,928	124,733
4500000.0%	72,157	121,961
5000000.0%	68,621	118,426
5500000.0%	65,004	114,808
6000000.0%	61,308	111,112
6500000.0%	56,308	107,325
7000000.0%	51,308	103,470
7500000.0%	46,308	99,551
8000000.0%	41,308	95,572
8500000.0%	36,308	91,534
9000000.0%	31,308	87,443
9500000.0%	26,308	83,288
10000000.0%	21,308	79,085

* This table will not automatically update if any project inputs are adjusted.



6.7.5 Database

The "Database" worksheet collects key information about the project so it can be exported to a project database. The information collected includes customer costs, incentives, and projected water and energy savings. It also includes fields for realized water and energy savings, which may be completed through future evaluations of the project. (See Figure 6.7)

Figure 6.7: Example Database Tracking Worksheet

Facility	Project Description	Direct Costs		Incentives ($ per savings)				Projected Water and Energy Savings				Realized Water and Energy Savings			
		Capital Costs	O&M Costs	Water	Sewer	Natural Gas	Electric	Water (1000 gallons)	Sewer (1000 gallons)	Natural Gas (therms)	Electric (kWh)	Water	Sewer	Natural Gas	Electric
ID001	Recycle Clean-in-Place (CIP) Process Water	41,000	1,000	3	0	0.06	0.08	2,700	2,700	5,000	0				

6.8 Conclusions

Cost-benefit analysis is a powerful tool that can help inform water- and energy-efficiency investment decisions. Complete analyses will include:

- All relevant costs and benefits, accurately reflect the timing of the project and discount future costs and benefits appropriately; and
- A sensitivity analysis so water districts, energy utilities, and their customers can understand the impact of any assumptions they make about costs, benefits, or the discount rate.

The analysis can provide useful information for the individual customer considering efficiency measures. It also can provide information that the water district or energy utility can use to inform decisions on whether to provide incentives to encourage customers to take action, and on the type and value of possible incentives.

6.9 Categories of Potential Equipment Rebates

The largest cost customers may incur when implementing water- and energy-efficiency measures is the cost of new equipment. Table 6.2 summarizes the types of equipment customers may install to improve water and energy efficiency. Many energy utilities and water districts provide rebates and other financial incentives for this equipment.

Table 6.2: Example Rebates Categories

Cooling Towers
- Cooling tower controllers
- pH cooling tower controllers
- Cooling tower retrofits

Heating, Ventilation, and Air Conditioning (HVAC)
- Advanced evaporative cooler
- Natural gas furnaces
- Adjustable frequency drives
- Reflective window film
- Packaged terminal air conditioners
- Thermal energy storage
- Chillers for space air conditioning
- Air cooled versus water cooled equipment
- Ceiling fans
- Cool roofs

Hospitals
- X-ray processors
- Dialysis machines
- Dry vacuum pumps
- Steam sterilizer retrofits

Large Scale or Long Term Retrofit Incentive Programs
- Standard Performance Contracts
- Business Energy/Water Efficiency Programs
- Savings by Design
- California Solar Initiative
- Self Generation Program
- Grants Program
- Energy Net Metering Program

Irrigation and Landscaping Activities
- Synthetic turf
- Low water consuming plants
- Weather based irrigation scheduling
- Smart irrigation controllers
- High efficiency nozzles
- Rotating nozzles

Lavatories
- High efficiency toilets
- Ultra low flush toilets
- Zero water urinals
- High efficiency urinals

Laundry Operations
- High efficiency commercial washers
- ENERGY STAR clothes washers

Motors and Pumps
- High efficiency motors

Office Equipment/Plug Load
- Sleep mode for computer software
- Plug load occupancy sensors

Kitchen Services
- Connectionless steam cookers
- Pre-rinse spray valves
- Energy efficient dishwashers
- High efficiency ventilation systems
- ENERGY STAR commercial dishwashers
- High efficiency commercial fryers
- High efficiency commercial griddles
- High efficiency commercial electric combination ovens
- High efficiency commercial gas combination ovens
- High efficiency commercial electric convection ovens
- High efficiency commercial gas convection ovens
- ENERGY STAR commercial ice machines
- ENERGY STAR commercial pressureless steam cookers
- ENERGY STAR solid door refrigerators and freezers
- Double rack/single rack ovens
- Commercial insulated hot food holding cabinets
- Night covers for open vertical and horizontal display cases
- High efficiency refrigeration display case with special doors
- High efficiency vending machine controllers
- High efficiency evaporative fan motors
- Refrigerator door gaskets and anti-sweat devices
- Auto-closers for main cooler or freezer doors
- Ice machines (air and water cooled)

Lighting
- Fluorescent lamps
- Fluorescent tubes and magnetic ballasts
- High intensity discharge (HID) lamps and high-bay fluorescent fixtures
- Occupancy sensors
- Light emitting diodes (LED)

Process Heating
- Insulation

Site-Wide Water and Energy Use Activities and Equipment
- Car washing
- Fire suppression systems
- Laboratories
- Conveyor systems
- Battery charging operations
- Pool covers
- Commercial pool heaters
- Storage water heaters
- Instantaneous hot water heaters
- Pressurized waterbrooms
- Backup generators
- Plumbing fixtures

Steam Equipment
- Steam traps
- High efficiency boilers

Appendices

Appendix A CUWCC Categories[38]

The following paragraphs contain category definitions used by CUWCC in categorizing customers.

- Commercial Accounts: any water use that provides or distributes a product or service, such as hotels, restaurants, office buildings, commercial businesses or other places of commerce. These do not include multi-family residences, agricultural users, or customers that fall within the industrial or institutional classifications.

- Industrial Accounts: any water users that are primarily manufacturers or processors of materials as defined by the SIC code numbers 2000 through 3999.

- Institutional Accounts: any water-using establishment dedicated to public service. This includes schools, courts, churches, hospitals, and government facilities. All facilities serving these functions are to be considered institutions regardless of ownership.

[38] See CUWCC BMP Conservation Programs for CII Sectors, 1999.

Appendix B Use by NAICS Codes and Customer Categories

This appendix contains the complete set of results of the analysis of customer categories by 2002 NAICS codes for electricity, natural gas, water, and wastewater.[39]

Table B.1: Weighted Percent Rank of Total Market Volume for Each Resource by 2002 NAICS Code in Southern California

Three-Digit NAICS Code	Description	Electricity % Ranking	Natural Gas % Ranking	Water % Ranking	Wastewater % Ranking
531	Real Estate	9.80	2.47	5.19	1.84
722	Food Services and Drinking Places	5.47	20.53	4.00	2.38
221	Utilities	5.45	7.54	5.54	7.57
445	Food and Beverage Stores	5.00	0.80	1.39	0.56
611	Educational Services	4.66	5.34	6.28	2.37
622	Hospitals	2.83	1.39	1.43	3.00
334	Computer and Electronic Product Manufacturing	2.49	1.14	0.72	0.50
721	Accommodation	2.47	5.44	5.04	4.42
541	Professional, Scientific, and Technical Services	2.46	2.69	5.50	3.14
452	General Merchandise Stores	2.45	0.24	0.38	0.22
332	Fabricated Metal Product Manufacturing	2.21	2.12	0.63	2.80
325	Chemical Manufacturing	2.01	1.49	1.83	2.83
999	Unassigned	1.99	1.04	0.69	0.13
713	Amusement, Gambling, and Recreation Industries	1.96	1.42	3.13	1.23

[39] For more information about a specific NAICS code, please see www.census.gov/eos/www/naics.

Three-Digit NAICS Code	Description	Electricity % Ranking	Natural Gas % Ranking	Water % Ranking	Wastewater % Ranking
517	Telecommunications	1.93	0.04	0.20	0.10
311	Food Manufacturing	1.92	4.31	2.47	7.15
336	Transportation Equipment Manufacturing	1.87	0.89	0.61	0.85
326	Plastics and Rubber Products Manufacturing	1.71	0.83	0.45	0.29
423	Merchant Wholesalers, Durable Goods	1.66	0.72	2.69	0.11
621	Ambulatory Health Care Services	1.61	1.17	1.21	0.60
928	National Security and International Affairs	1.58	0.76	3.57	0.82
922	Justice, Public Order, and Safety Activities	1.49	0.90	0.83	3.50
424	Merchant Wholesalers, Nondurable Goods	1.45	1.13	1.18	0.81
211	Oil and Gas Extraction	1.34	0.27	0.05	3.72
522	Credit Intermediation and Related Activities	1.27	0.35	0.23	0.01
327	Nonmetallic Mineral Product Manufacturing	1.26	0.87	0.41	0.36
813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	1.19	1.57	2.22	0.24
921	Executive, Legislative, and Other General Government Support	1.18	0.78	2.43	0.01
324	Petroleum and Coal Products Manufacturing	1.17	0.75	9.76	12.62
561	Administrative and Support Services	1.16	0.85	3.76	1.70
441	Motor Vehicle and Parts Dealers	1.14	0.40	0.83	0.51
812	Personal and Laundry Services	0.98	6.05	3.05	3.82
448	Clothing and Clothing Accessories Stores	0.93	0.19	0.36	0.05
333	Machinery Manufacturing	0.92	0.91	0.37	0.09

Three-Digit NAICS Code	Description	Electricity % Ranking	Natural Gas % Ranking	Water % Ranking	Wastewater % Ranking
512	Motion Picture and Sound Recording Industries	0.90	0.54	1.51	1.60
339	Miscellaneous Manufacturing	0.80	0.89	0.67	0.20
322	Paper Manufacturing	0.80	0.51	0.26	4.43
331	Primary Metal Manufacturing	0.78	1.02	0.32	1.59
453	Miscellaneous Store Retailers	0.75	0.11	1.20	0.65
623	Nursing and Residential Care Facilities	0.73	2.06	0.74	0.38
444	Building Material and Garden Equipment and Supplies Dealers	0.72	0.49	0.26	0.20
447	Gasoline Stations	0.70	1.75	0.15	0.04
488	Support Activities for Transportation	0.69	0.53	0.35	0.03
811	Repair and Maintenance	0.69	0.54	0.91	0.67
446	Health and Personal Care Stores	0.63	0.12	0.09	0.00
323	Printing and Related Support Activities	0.61	0.41	0.21	0.25
515	Broadcasting (except Internet)	0.60	0.07	0.01	-
442	Furniture and Home Furnishings Stores	0.54	0.11	0.13	0.05
493	Warehousing and Storage	0.54	0.27	0.60	0.23
451	Sporting Goods, Hobby, Book, and Music Stores	0.52	0.08	0.59	-
111	Crop Production	0.50	2.75	0.58	0.07
486	Pipeline Transportation	0.49	0.10	0.03	0.10
312	Beverage and Tobacco Product Manufacturing	0.48	0.31	0.86	2.55
624	Social Assistance	0.45	0.58	0.39	0.00
443	Electronics and Appliance Stores	0.42	0.07	0.07	0.00
524	Insurance Carriers and Related Activities	0.41	0.12	0.09	0.04
335	Electrical Equipment, Appliance, and Component Manufacturing	0.40	0.31	0.38	0.23

Three-Digit NAICS Code	Description	Electricity % Ranking	Natural Gas % Ranking	Water % Ranking	Wastewater % Ranking
511	Publishing Industries (except Internet)	0.39	0.11	0.08	0.01
485	Transit and Ground Passenger Transportation	0.36	0.09	0.07	0.08
337	Furniture and Related Product Manufacturing	0.36	0.43	0.12	0.02
238	Specialty Trade Contractors	0.34	0.20	0.40	0.04
711	Performing Arts, Spectator Sports, and Related Industries	0.33	2.06	0.33	0.20
237	Heavy and Civil Engineering Construction	0.33	0.14	1.63	0.00
212	Mining (except Oil and Gas)	0.30	0.11	0.00	-
532	Rental and Leasing Services	0.29	0.12	0.15	0.04
484	Truck Transportation	0.29	0.03	0.24	0.07
491	Postal Service	0.28	0.04	0.12	0.05
315	Apparel Manufacturing	0.28	0.24	0.47	0.03
236	Construction of Buildings	0.26	0.22	0.48	0.03
519	Other Information Services	0.23	0.14	0.05	0.00
712	Museums, Historical Sites, and Similar Institutions	0.22	0.29	0.93	0.42
518	Internet Service Providers, Web Search Portals, and Data Processing Services	0.21	0.04	0.02	0.00
562	Waste Management and Remediation Services	0.21	0.46	0.43	4.28
112	Animal Production	0.20	0.67	0.03	-
313	Textile Mills	0.19	1.89	2.82	7.71
926	Administration of Economic Programs	0.16	0.07	0.18	0.00
115	Support Activities for Agriculture and Forestry	0.15	0.37	0.02	0.02

Three-Digit NAICS Code	Description	Electricity % Ranking	Natural Gas % Ranking	Water % Ranking	Wastewater % Ranking
454	Nonstore Retailers	0.15	0.17	0.10	0.03
525	Funds, Trusts, and Other Financial Vehicles	0.15	0.12	0.16	0.00
492	Couriers and Messengers	0.14	0.05	0.02	0.00
321	Wood Product Manufacturing	0.14	0.05	0.02	-
923	Administration of Human Resource Programs	0.12	0.11	0.08	-
314	Textile Product Mills	0.12	0.14	0.47	0.79
482	Rail Transportation	0.09	0.03	0.02	0.11
523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	0.09	0.11	0.21	-
551	Management of Companies and Enterprises	0.07	0.01	0.09	1.91
924	Administration of Environmental Quality Programs	0.07	0.21	0.81	0.07
483	Water Transportation	0.07	0.01	0.06	0.03
316	Leather and Allied Product Manufacturing	0.07	0.02	0.02	0.00
925	Administration of Housing Programs, Urban Planning, and Community Development	0.05	0.06	0.13	-
213	Support Activities for Mining	0.04	0.02	0.03	0.00
521	Monetary Authorities - Central Bank	0.03	0.02	0.00	-
114	Fishing, Hunting and Trapping	0.02	-	-	-
481	Air Transportation	0.02	0.02	0.06	0.04
487	Scenic and Sightseeing Transportation	0.01	0.00	0.32	0.17

Three-Digit NAICS Code	Description	Electricity % Ranking	Natural Gas % Ranking	Water % Ranking	Wastewater % Ranking
533	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	0.01	0.00	0.00	-
425	Wholesale Electronic Markets and Agents and Brokers	0.00	0.00	0.00	0.05
516	Internet Publishing and Broadcasting	-	0.01	-	0.00
927	Space Research and Technology	-	0.00	0.00	0.12

Table B.2: Electricity Use by 2002 NAICS Code in Southern California[40]

Three-Digit NAICS Code	Description	MWh	Number of Accounts	MWh/ Account
531	Real Estate	8,648,124	136,167	64
722	Food Services and Drinking Places	4,828,456	47,054	103
221	Utilities	4,811,110	14,999	321
445	Food and Beverage Stores	4,410,416	17,777	248
611	Educational Services	4,110,028	16,886	243
622	Hospitals	2,497,987	1,585	1,576
334	Computer and Electronic Product Manufacturing	2,199,871	4,325	509
721	Accommodation	2,184,573	8,084	270
541	Professional, Scientific, and Technical Services	2,172,754	30,459	71
452	General Merchandise Stores	2,165,525	4,648	466
332	Fabricated Metal Product Manufacturing	1,949,632	9,633	202
325	Chemical Manufacturing	1,770,885	2,130	831
999	Unassigned	1,759,078	152,306	12
713	Amusement, Gambling, and Recreation Industries	1,732,373	11,333	153
517	Telecommunications	1,706,179	12,940	132
311	Food Manufacturing	1,690,967	3,208	527
336	Transportation Equipment Manufacturing	1,647,050	3,618	455
326	Plastics and Rubber Products Manufacturing	1,506,463	1,966	766
423	Merchant Wholesalers, Durable Goods	1,461,471	19,541	75
621	Ambulatory Health Care Services	1,419,990	30,647	46
928	National Security and International Affairs	1,391,796	613	2,271
922	Justice, Public Order, and Safety Activities	1,314,881	42,781	31
424	Merchant Wholesalers, Nondurable Goods	1,282,291	10,870	118
211	Oil and Gas Extraction	1,184,416	921	1,286
522	Credit Intermediation and Related Activities	1,123,885	10,555	106
327	Nonmetallic Mineral Product Manufacturing	1,109,999	1,916	579

[40] Table B.2 gives the complete ranking of three-digit 2002 NAICS codes by MWh of electricity. One megawatt-hour is equal to 1,000 kilowatt-hours or 1 million watt-hours. The MWh/Account is the MWh for the NAICS code divided by the number of accounts.

Three-Digit NAICS Code	Description	MWh	Number of Accounts	MWh/ Account
813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	1,047,552	24,352	43
921	Executive, Legislative, and Other General Government Support	1,040,241	6,067	171
324	Petroleum and Coal Products Manufacturing	1,028,813	239	4,305
561	Administrative and Support Services	1,022,316	33,661	30
441	Motor Vehicle and Parts Dealers	1,007,711	10,950	92
812	Personal and Laundry Services	862,665	37,359	23
448	Clothing and Clothing Accessories Stores	824,062	14,636	56
333	Machinery Manufacturing	814,555	5,345	152
512	Motion Picture and Sound Recording Industries	795,331	3,648	218
339	Miscellaneous Manufacturing	708,028	4,808	147
322	Paper Manufacturing	704,614	710	992
331	Primary Metal Manufacturing	692,382	837	827
453	Miscellaneous Store Retailers	658,828	15,091	44
623	Nursing and Residential Care Facilities	645,544	2,245	288
444	Building Material and Garden Equipment and Supplies Dealers	635,612	5,616	113
447	Gasoline Stations	619,387	4,112	151
488	Support Activities for Transportation	610,027	3,893	157
811	Repair and Maintenance	606,753	27,051	22
446	Health and Personal Care Stores	553,142	4,533	122
323	Printing and Related Support Activities	535,025	4,925	109
515	Broadcasting (except Internet)	533,105	24,273	22
442	Furniture and Home Furnishings Stores	479,533	9,003	53
493	Warehousing and Storage	474,479	3,779	126
451	Sporting Goods, Hobby, Book, and Music Stores	460,552	7,265	63
111	Crop Production	445,671	7,276	61
486	Pipeline Transportation	432,520	473	915
312	Beverage and Tobacco Product Manufacturing	422,426	387	1,092

Three-Digit NAICS Code	Description	MWh	Number of Accounts	MWh/ Account
624	Social Assistance	393,830	7,536	52
443	Electronics and Appliance Stores	373,170	5,786	64
524	Insurance Carriers and Related Activities	359,339	5,641	64
335	Electrical Equipment, Appliance, and Component Manufacturing	356,195	1,394	256
511	Publishing Industries (except Internet)	347,862	1,651	211
485	Transit and Ground Passenger Transportation	321,377	1,170	275
337	Furniture and Related Product Manufacturing	320,225	4,269	75
238	Specialty Trade Contractors	299,933	12,298	24
711	Performing Arts, Spectator Sports, and Related Industries	292,775	1,898	154
237	Heavy and Civil Engineering Construction	287,044	11,002	26
212	Mining (except Oil and Gas)	267,437	315	849
532	Rental and Leasing Services	259,786	5,047	51
484	Truck Transportation	255,505	2,205	116
491	Postal Service	245,727	849	289
315	Apparel Manufacturing	243,830	3,208	76
236	Construction of Buildings	229,031	7,193	32
519	Other Information Services	207,108	893	232
712	Museums, Historical Sites, and Similar Institutions	196,036	1,102	178
518	Internet Service Providers, Web Search Portals, and Data Processing Services	187,325	362	517
562	Waste Management and Remediation Services	185,521	1,006	184
112	Animal Production	174,031	2,132	82
313	Textile Mills	170,349	564	302
926	Administration of Economic Programs	143,645	1,681	85
115	Support Activities for Agriculture and Forestry	131,782	931	142
454	Nonstore Retailers	130,865	1,619	81
525	Funds, Trusts, and Other Financial Vehicles	128,934	627	206
492	Couriers and Messengers	126,603	529	239

Three-Digit NAICS Code	Description	MWh	Number of Accounts	MWh/ Account
321	Wood Product Manufacturing	126,033	1,118	113
923	Administration of Human Resource Programs	109,951	361	304
314	Textile Product Mills	105,851	1,130	94
482	Rail Transportation	79,096	2,016	39
523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	78,587	1,583	50
551	Management of Companies and Enterprises	64,057	193	332
924	Administration of Environmental Quality Programs	63,626	550	116
483	Water Transportation	63,124	70	899
316	Leather and Allied Product Manufacturing	63,029	299	211
925	Administration of Housing Programs, Urban Planning, and Community Development	45,061	1,324	34
213	Support Activities for Mining	35,422	178	199
521	Monetary Authorities - Central Bank	25,104	67	376
114	Fishing, Hunting and Trapping	16,102	107	150
481	Air Transportation	13,907	169	82
487	Scenic and Sightseeing Transportation	6,950	54	128
533	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	4,911	32	152
425	Wholesale Electronic Markets and Agents and Brokers	1,297	17	76

Table B.3: Natural Gas Use by 2002 NAICS Code in Southern California[41]

Three-Digit NAICS Code	Description	Therms
722	Food Services and Drinking Places	261,712,811
221	Utilities	96,113,578
812	Personal and Laundry Services	77,099,939
721	Accommodation	69,332,303
611	Educational Services	68,126,435
311	Food Manufacturing	54,936,762
111	Crop Production	35,095,267
541	Professional, Scientific, and Technical Services	34,356,986
531	Real Estate	31,493,530
332	Fabricated Metal Product Manufacturing	27,041,029
711	Performing Arts, Spectator Sports, and Related Industries	26,296,347
623	Nursing and Residential Care Facilities	26,227,432
313	Textile Mills	24,032,315
447	Gasoline Stations	22,251,753
813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	20,016,890
325	Chemical Manufacturing	18,941,999
713	Amusement, Gambling, and Recreation Industries	18,166,603
622	Hospitals	17,757,429
621	Ambulatory Health Care Services	14,863,435
334	Computer and Electronic Product Manufacturing	14,470,772
424	Merchant Wholesalers, Nondurable Goods	14,436,471
999	Unassigned	13,277,345
331	Primary Metal Manufacturing	12,952,233
333	Machinery Manufacturing	11,568,212
922	Justice, Public Order, and Safety Activities	11,513,338
339	Miscellaneous Manufacturing	11,345,635
336	Transportation Equipment Manufacturing	11,298,526
327	Nonmetallic Mineral Product Manufacturing	11,094,628
561	Administrative and Support Services	10,813,992
326	Plastics and Rubber Products Manufacturing	10,622,733
445	Food and Beverage Stores	10,140,786
921	Executive, Legislative, and Other General Government Support	9,906,600
928	National Security and International Affairs	9,647,338
324	Petroleum and Coal Products Manufacturing	9,596,168
423	Merchant Wholesalers, Durable Goods	9,182,415
112	Animal Production	8,510,105
624	Social Assistance	7,438,920
512	Motion Picture and Sound Recording Industries	6,886,674
811	Repair and Maintenance	6,857,608
488	Support Activities for Transportation	6,740,989
322	Paper Manufacturing	6,518,390

41 Table B.3 provides the therms per three-digit 2002 NAICS code in southern California. Specific account information is not provided due to confidentiality issues. Therms refer to a unit of heat equal to 100,000 British thermal units (1.054×10^8 joules).

Three-Digit NAICS Code	Description	Therms
444	Building Material and Garden Equipment and Supplies Dealers	6,201,889
562	Waste Management and Remediation Services	5,844,904
337	Furniture and Related Product Manufacturing	5,495,776
323	Printing and Related Support Activities	5,282,959
441	Motor Vehicle and Parts Dealers	5,104,711
115	Support Activities for Agriculture and Forestry	4,668,093
522	Credit Intermediation and Related Activities	4,426,487
335	Electrical Equipment, Appliance, and Component Manufacturing	3,983,639
312	Beverage and Tobacco Product Manufacturing	3,917,929
712	Museums, Historical Sites, and Similar Institutions	3,706,637
211	Oil and Gas Extraction	3,491,082
493	Warehousing and Storage	3,400,591
315	Apparel Manufacturing	3,043,222
452	General Merchandise Stores	3,004,869
236	Construction of Buildings	2,852,775
924	Administration of Environmental Quality Programs	2,653,317
238	Specialty Trade Contractors	2,513,647
448	Clothing and Clothing Accessories Stores	2,472,489
454	Nonstore Retailers	2,123,458
237	Heavy and Civil Engineering Construction	1,847,531
519	Other Information Services	1,762,663
314	Textile Product Mills	1,738,942
525	Funds, Trusts, and Other Financial Vehicles	1,583,702
524	Insurance Carriers and Related Activities	1,582,192
446	Health and Personal Care Stores	1,557,832
532	Rental and Leasing Services	1,517,559
523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	1,463,701
442	Furniture and Home Furnishings Stores	1,455,728
923	Administration of Human Resource Programs	1,392,589
453	Miscellaneous Store Retailers	1,361,875
212	Mining (except Oil and Gas)	1,352,546
511	Publishing Industries (except Internet)	1,351,885
486	Pipeline Transportation	1,333,275
485	Transit and Ground Passenger Transportation	1,206,870
451	Sporting Goods, Hobby, Book, and Music Stores	1,038,828
926	Administration of Economic Programs	939,217
515	Broadcasting (except Internet)	857,261
443	Electronics and Appliance Stores	844,951
925	Administration of Housing Programs, Urban Planning, and Community Development	704,413
321	Wood Product Manufacturing	700,539
492	Couriers and Messengers	612,584
491	Postal Service	511,619
518	Internet Service Providers, Web Search Portals, and Data Processing Services	475,444
517	Telecommunications	454,729
484	Truck Transportation	444,634
482	Rail Transportation	359,067

Three-Digit NAICS Code	Description	Therms
481	Air Transportation	313,861
521	Monetary Authorities - Central Bank	289,497
316	Leather and Allied Product Manufacturing	289,109
213	Support Activities for Mining	211,729
483	Water Transportation	154,623
516	Internet Publishing and Broadcasting	87,020
551	Management of Companies and Enterprises	77,312
533	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	62,911
425	Wholesale Electronic Markets and Agents and Brokers	56,564
927	Space Research and Technology	10,624
487	Scenic and Sightseeing Transportation	8,533

Table B.4: Water Use by 2002 NAICS Code in Parts of Los Angeles County and in the City of San Diego[42]

Three-Digit NAICS Code	Description	Hundred Cubic Feet (HCF) / Year	Number of Accounts	HCF / Account
324	Petroleum and Coal Products Manufacturing	6,694,376	113	59,242
611	Educational Services	4,306,601	1,445	2,980
221	Utilities	3,801,577	632	6,015
541	Professional, Scientific, and Technical Services	3,771,465	3,819	988
531	Real Estate	3,558,281	2,644	1,346
721	Accommodation	3,459,403	763	4,534
722	Food Services and Drinking Places	2,741,170	2,948	930
561	Administrative and Support Services	2,578,670	2,272	1,135
928	National Security and International Affairs	2,450,931	117	20,948
713	Amusement, Gambling, and Recreation Industries	2,147,824	546	3,934
812	Personal and Laundry Services	2,095,089	1,205	1,739
313	Textile Mills	1,934,658	166	11,655
423	Merchant Wholesalers, Durable Goods	1,847,762	2,980	620
311	Food Manufacturing	1,691,701	412	4,106
921	Executive, Legislative, and Other General Government Support	1,668,596	523	3,190
813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	1,524,073	1,837	830
325	Chemical Manufacturing	1,255,518	381	3,295
237	Heavy and Civil Engineering Construction	1,119,092	424	2,639
512	Motion Picture and Sound Recording Industries	1,038,134	899	1,155
622	Hospitals	984,348	136	7,238
445	Food and Beverage Stores	955,158	709	1,347
621	Ambulatory Health Care Services	828,449	1,236	670
453	Miscellaneous Store Retailers	825,562	1,584	521
424	Merchant Wholesalers, Nondurable Goods	806,440	994	811
712	Museums, Historical Sites, and Similar Institutions	634,826	122	5,203
811	Repair and Maintenance	625,715	1,068	586
312	Beverage and Tobacco Product Manufacturing	588,276	42	14,007
922	Justice, Public Order, and Safety Activities	570,902	493	1,158
441	Motor Vehicle and Parts Dealers	568,178	1,560	364

[42] Table B.4 provides information on water use by three-digit 2002 NAICS code and account data in portions of southern California. 1 HCF= 748 gallons. 1 AF = 325,851 gallons. HCF/Account is the HCF for the NAICS code divided by the number of accounts.

Three-Digit NAICS Code	Description	Hundred Cubic Feet (HCF) / Year	Number of Accounts	HCF / Account
924	Administration of Environmental Quality Programs	553,014	290	1,907
623	Nursing and Residential Care Facilities	511,067	154	3,319
334	Computer and Electronic Product Manufacturing	494,439	205	2,412
999	Unassigned	475,796	927	513
339	Miscellaneous Manufacturing	459,080	1,150	399
332	Fabricated Metal Product Manufacturing	430,959	428	1,007
336	Transportation Equipment Manufacturing	421,139	216	1,950
493	Warehousing and Storage	410,002	279	1,470
451	Sporting Goods, Hobby, Book, and Music Stores	401,660	247	1,626
111	Crop Production	400,697	195	2,055
236	Construction of Buildings	326,113	289	1,128
314	Textile Product Mills	322,087	50	6,442
315	Apparel Manufacturing	319,583	187	1,709
326	Plastics and Rubber Products Manufacturing	306,048	89	3,439
562	Waste Management and Remediation Services	296,609	239	1,241
327	Nonmetallic Mineral Product Manufacturing	279,265	195	1,432
238	Specialty Trade Contractors	277,293	392	707
624	Social Assistance	269,268	191	1,410
335	Electrical Equipment, Appliance, and Component Manufacturing	261,515	196	1,334
452	General Merchandise Stores	259,762	406	640
333	Machinery Manufacturing	255,319	304	840
448	Clothing and Clothing Accessories Stores	247,950	466	532
488	Support Activities for Transportation	242,537	209	1,160
711	Performing Arts, Spectator Sports, and Related Industries	228,462	180	1,269
331	Primary Metal Manufacturing	220,984	151	1,463
487	Scenic and Sightseeing Transportation	220,712	344	642
444	Building Material and Garden Equipment and Supplies Dealers	179,587	300	599
322	Paper Manufacturing	179,105	33	5,427
484	Truck Transportation	163,429	162	1,009
522	Credit Intermediation and Related Activities	157,258	198	794
523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	146,181	205	713
323	Printing and Related Support Activities	141,115	205	688
517	Telecommunications	136,346	135	1,010
926	Administration of Economic Programs	120,904	27	4,478

Three-Digit NAICS Code	Description	Hundred Cubic Feet (HCF) / Year	Number of Accounts	HCF / Account
525	Funds, Trusts, and Other Financial Vehicles	109,948	108	1,018
447	Gasoline Stations	105,352	170	620
532	Rental and Leasing Services	103,958	779	133
925	Administration of Housing Programs, Urban Planning, and Community Development	91,637	9	10,182
442	Furniture and Home Furnishings Stores	90,264	351	257
491	Postal Service	81,301	72	1,129
337	Furniture and Related Product Manufacturing	80,653	220	367
454	Nonstore Retailers	66,058	162	408
524	Insurance Carriers and Related Activities	59,558	117	509
551	Management of Companies and Enterprises	59,267	29	2,044
446	Health and Personal Care Stores	59,197	286	207
923	Administration of Human Resource Programs	57,784	76	760
511	Publishing Industries (except Internet)	53,352	63	847
443	Electronics and Appliance Stores	51,093	142	360
485	Transit and Ground Passenger Transportation	46,451	232	200
481	Air Transportation	43,405	20	2,170
483	Water Transportation	37,881	33	1,148
519	Other Information Services	37,460	72	520
211	Oil and Gas Extraction	31,308	89	352
112	Animal Production	22,592	18	1,255
486	Pipeline Transportation	22,573	5	4,515
213	Support Activities for Mining	19,374	4	4,844
518	Internet Service Providers, Web Search Portals, and Data Processing Services	16,816	28	601
321	Wood Product Manufacturing	14,634	153	96
492	Couriers and Messengers	13,581	39	348
482	Rail Transportation	12,628	10	1,263
115	Support Activities for Agriculture and Forestry	11,897	13	915
316	Leather and Allied Product Manufacturing	10,464	32	327
515	Broadcasting (except Internet)	5,826	55	106
927	Space Research and Technology	2,739	4	685
212	Mining (except Oil and Gas)	1,252	4	313
533	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	1,101	3	367
521	Monetary Authorities - Central Bank	233	3	78
425	Wholesale Electronic Markets and Agents and Brokers	71	7	10

Table B.5: Wastewater Use by 2002 NAICS Code in parts of Los Angeles County and in the City of San Diego[43]

Three-Digit NAICS Code	Description	Annual Flow (Gallons)	Number of Accounts	Gallons / Account
324	Petroleum and Coal Products Manufacturing	4,820,498,023	26	182,242,084
313	Textile Mills	2,943,350,331	56	52,865,034
221	Utilities	2,892,185,059	522	5,544,749
311	Food Manufacturing	2,731,617,176	341	8,008,842
322	Paper Manufacturing	1,693,569,027	43	39,620,629
721	Accommodation	1,688,882,011	475	3,555,541
562	Waste Management and Remediation Services	1,633,108,545	122	13,372,406
812	Personal and Laundry Services	1,460,310,948	521	2,804,617
211	Oil and Gas Extraction	1,420,457,601	52	27,175,068
922	Justice, Public Order, and Safety Activities	1,337,091,742	150	8,913,945
541	Professional, Scientific, and Technical Services	1,199,363,246	2,217	541,072
622	Hospitals	1,147,227,471	102	11,300,440
325	Chemical Manufacturing	1,082,824,229	184	5,871,291
332	Fabricated Metal Product Manufacturing	1,068,686,838	290	3,686,390
312	Beverage and Tobacco Product Manufacturing	974,802,647	44	22,079,007
722	Food Services and Drinking Places	908,708,691	1,529	594,456
611	Educational Services	903,470,540	562	1,606,984
551	Management of Companies and Enterprises	727,817,613	31	23,741,603
531	Real Estate	701,276,215	1,708	410,583
561	Administrative and Support Services	647,574,884	1,708	379,225
512	Motion Picture and Sound Recording Industries	612,806,822	755	811,595
331	Primary Metal Manufacturing	607,339,275	96	6,321,369
713	Amusement, Gambling, and Recreation Industries	470,560,945	260	1,808,086
336	Transportation Equipment Manufacturing	323,403,678	85	3,801,659
928	National Security and International Affairs	314,739,017	31	10,152,872
424	Merchant Wholesalers, Nondurable Goods	311,138,198	140	2,224,966
314	Textile Product Mills	301,740,728	4	71,318,916
811	Repair and Maintenance	254,144,233	214	1,186,928
453	Miscellaneous Store Retailers	249,919,219	875	285,491

[43] Table B.5 provides wastewater use by three-digit 2002 NAICS code and account data in portions of Los Angeles County and the City of San Diego. Gallons/Account is the annual flow for the NAICS code divided by the number of accounts.

Three-Digit NAICS Code	Description	Annual Flow (Gallons)	Number of Accounts	Gallons / Account
621	Ambulatory Health Care Services	230,262,344	451	510,560
445	Food and Beverage Stores	214,160,712	206	1,040,269
441	Motor Vehicle and Parts Dealers	196,333,464	1,076	182,423
334	Computer and Electronic Product Manufacturing	192,616,780	67	2,883,133
712	Museums, Historical Sites, and Similar Institutions	159,667,782	37	4,299,420
623	Nursing and Residential Care Facilities	144,172,074	46	3,134,119
327	Nonmetallic Mineral Product Manufacturing	139,095,916	35	3,923,873
326	Plastics and Rubber Products Manufacturing	111,074,847	50	2,228,343
323	Printing and Related Support Activities	93,625,621	148	634,313
813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	91,652,067	527	173,913
493	Warehousing and Storage	88,669,099	115	773,650
335	Electrical Equipment, Appliance, and Component Manufacturing	88,121,058	117	753,840
452	General Merchandise Stores	82,695,187	266	310,870
444	Building Material and Garden Equipment and Supplies Dealers	78,247,765	78	1,007,765
339	Miscellaneous Manufacturing	77,491,197	130	597,476
711	Performing Arts, Spectator Sports, and Related Industries	77,037,647	18	4,370,587
487	Scenic and Sightseeing Transportation	64,238,612	344	186,578
999	Unassigned	49,932,575	49	1,019,032
927	Space Research and Technology	46,664,800	1	46,664,800
423	Merchant Wholesalers, Durable Goods	42,265,669	157	269,725
482	Rail Transportation	41,781,369	8	5,273,585
517	Telecommunications	40,084,361	54	742,303
486	Pipeline Transportation	38,274,600	2	19,137,300
333	Machinery Manufacturing	33,597,222	40	836,848
485	Transit and Ground Passenger Transportation	28,946,032	60	483,233
111	Crop Production	27,305,600	14	1,950,400
924	Administration of Environmental Quality Programs	26,732,160	3	8,910,720
484	Truck Transportation	26,210,031	11	2,294,510
442	Furniture and Home Furnishings Stores	20,789,244	138	150,372
491	Postal Service	20,367,222	30	678,907
448	Clothing and Clothing Accessories Stores	20,147,327	103	195,338

Three-Digit NAICS Code	Description	Annual Flow (Gallons)	Number of Accounts	Gallons / Account
425	Wholesale Electronic Markets and Agents and Brokers	19,996,225	6	3,317,708
524	Insurance Carriers and Related Activities	15,028,200	3	5,419,633
238	Specialty Trade Contractors	14,574,679	9	1,614,067
481	Air Transportation	14,130,700	12	1,177,558
447	Gasoline Stations	13,948,480	7	1,972,283
532	Rental and Leasing Services	13,497,125	7	1,803,606
454	Nonstore Retailers	12,975,792	3	4,246,216
236	Construction of Buildings	11,739,557	70	167,424
315	Apparel Manufacturing	11,430,613	20	584,972
488	Support Activities for Transportation	10,186,038	12	853,979
483	Water Transportation	9,746,639	26	374,349
115	Support Activities for Agriculture and Forestry	8,923,200	1	8,923,200
337	Furniture and Related Product Manufacturing	8,847,870	50	177,347
511	Publishing Industries (except Internet)	4,832,567	6	834,132
921	Executive, Legislative, and Other General Government Support	2,506,400	5	501,280
522	Credit Intermediation and Related Activities	2,031,805	1[44]	2,031,805
492	Couriers and Messengers	914,687	2	468,997
213	Support Activities for Mining	611,455	1	611,455
446	Health and Personal Care Stores	512,855	1	512,855
525	Funds, Trusts, and Other Financial Vehicles	278,300	1	278,300
237	Heavy and Civil Engineering Construction	257,062	2	114,642
926	Administration of Economic Programs	136,240	1	136,240
624	Social Assistance	51,335	1	51,335
316	Leather and Allied Product Manufacturing	40,214	1	40,214
519	Other Information Services	30,459	1	30,459
518	Internet Service Providers, Web Search Portals, and Data Processing Services	25,287	1	25,287
516	Internet Publishing and Broadcasting	17,816	1	17,816
443	Electronics and Appliance Stores	17,566	1	17,566

[44] Due to conversion issues a few of the NAICS data sets resulted in fractional accounts. These were counted as 1. The gallons/account data reflects this conversion issue.

Table B.6: 2002 NAICS Codes: Southern California Electricity and Water Accounts Sorted by Use[45]

	Bottom Half of Electricity Use	Top Half of Electricity Use
Top Half of Water Use	Crop Production	Real Estate
	Beverage and Tobacco Product Manufacturing	Food Services and Drinking Places
	Social Assistance	Utilities
	Electrical Equipment, Appliance, and Component Manufacturing	Food and Beverage Stores
	Specialty Trade Contractors	Educational Services
	Heavy and Civil Engineering Construction	Hospitals
	Apparel Manufacturing	Computer and Electronic Product Manufacturing
	Construction of Buildings	Accommodation
	Museums, Historical Sites, and Similar Institutions	Professional, Scientific, and Technical Services
	Waste Management and Remediation Services	General Merchandise Stores
	Textile Mills	Fabricated Metal Product Manufacturing
	Textile Product Mills	Chemical Manufacturing
	Administration of Environmental Quality Programs	Unassigned
		Amusement, Gambling, and Recreation Industries
		Food Manufacturing
		Transportation Equipment Manufacturing
		Plastics and Rubber Products Manufacturing
		Merchant Wholesalers, Durable Goods
		Ambulatory Health Care Services
		National Security and International Affairs
		Justice, Public Order, and Safety Activities
		Merchant Wholesalers, Nondurable Goods
		Nonmetallic Mineral Product Manufacturing
		Religious, Grantmaking, Civic, Professional, and Similar Organizations
		Executive, Legislative, and Other General Government Support
		Petroleum and Coal Products Manufacturing
		Administrative and Support Services
		Motor Vehicle and Parts Dealers
		Personal and Laundry Services
		Machinery Manufacturing
		Motion Picture and Sound Recording Industries
		Miscellaneous Manufacturing
		Miscellaneous Store Retailers
		Nursing and Residential Care Facilities
		Repair and Maintenance
		Warehousing and Storage
		Sporting Goods, Hobby, Book, and Music Stores
Bottom Half of Water Use	Pipeline Transportation	Telecommunications
	Electronics and Appliance Stores	Oil and Gas Extraction
	Insurance Carriers and Related Activities	Credit Intermediation and Related Activities
	Publishing Industries (except Internet)	Clothing and Clothing Accessories Stores
	Transit and Ground Passenger Transportation	Paper Manufacturing
	Furniture and Related Product Manufacturing	Primary Metal Manufacturing
	Performing Arts, Spectator Sports, and Related Industries	Building Material and Garden Equipment and Supplies Dealers
	Mining (except Oil and Gas)	Gasoline Stations
	Rental and Leasing Services	Support Activities for Transportation
	Truck Transportation	Health and Personal Care Stores
	Postal Service	Printing and Related Support Activities
	Other Information Services	Broadcasting (except Internet)
	Internet Service Providers, Web Search Portals, and Data Processing Services	Furniture and Home Furnishings Stores
	Animal Production	
	Administration of Economic Programs	
	Support Activities for Agriculture and Forestry	
	Nonstore Retailers	
	Funds, Trusts, and Other Financial Vehicles	
	Couriers and Messengers	
	Wood Product Manufacturing	
	Administration of Human Resource Programs	
	Rail Transportation	
	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	
	Management of Companies and Enterprises	
	Water Transportation	
	Leather and Allied Product Manufacturing	
	Administration of Housing Programs, Urban Planning, and Community Development	
	Support Activities for Mining	
	Monetary Authorities - Central Bank	
	Fishing, Hunting and Trapping	
	Air Transportation	
	Scenic and Sightseeing Transportation	
	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	
	Wholesale Electronic Markets and Agents and Brokers	
	Space Research and Technology	
	Internet Publishing and Broadcasting	

[45] Table B.6 sorts NAICS codes as a function of high electricity and water use account data.

Table B.7: 2002 NAICS Codes: Southern California Electricity and Natural Gas Accounts Sorted by Use[46]

	Bottom Half of Electricity Use	Top Half of Electricity Use
Top Half of Natural Gas Use	Crop Production	Real Estate
	Beverage and Tobacco Product Manufacturing	Food Services and Drinking Places
	Social Assistance	Utilities
	Electrical Equipment, Appliance, and Component Manufacturing	Food and Beverage Stores
	Furniture and Related Product Manufacturing	Educational Services
	Performing Arts, Spectator Sports, and Related Industries	Hospitals
	Waste Management and Remediation Services	Computer and Electronic Product Manufacturing
	Animal Production	Accommodation
	Textile Mills	Professional, Scientific, and Technical Services
	Support Activities for Agriculture and Forestry	Fabricated Metal Product Manufacturing
		Chemical Manufacturing
		Unassigned
		Amusement, Gambling, and Recreation Industries
		Food Manufacturing
		Transportation Equipment Manufacturing
		Plastics and Rubber Products Manufacturing
		Merchant Wholesalers, Durable Goods
		Ambulatory Health Care Services
		National Security and International Affairs
		Justice, Public Order, and Safety Activities
		Merchant Wholesalers, Nondurable Goods
		Credit Intermediation and Related Activities
		Nonmetallic Mineral Product Manufacturing
		Religious, Grantmaking, Civic, Professional, and Similar Organizations
		Executive, Legislative, and Other General Government Support
		Petroleum and Coal Products Manufacturing
		Administrative and Support Services
		Motor Vehicle and Parts Dealers
		Personal and Laundry Services
		Machinery Manufacturing
		Motion Picture and Sound Recording Industries
		Miscellaneous Manufacturing
		Paper Manufacturing
		Primary Metal Manufacturing
		Nursing and Residential Care Facilities
		Building Material and Garden Equipment and Supplies Dealers
		Gasoline Stations
		Support Activities for Transportation
		Repair and Maintenance
		Printing and Related Support Activities
Bottom Half of Natural Gas Use	Pipeline Transportation	General Merchandise Stores
	Electronics and Appliance Stores	Telecommunications
	Insurance Carriers and Related Activities	Oil and Gas Extraction
	Publishing Industries (except Internet)	Clothing and Clothing Accessories Stores
	Transit and Ground Passenger Transportation	Miscellaneous Store Retailers
	Specialty Trade Contractors	Health and Personal Care Stores
	Heavy and Civil Engineering Construction	Broadcasting (except Internet)
	Mining (except Oil and Gas)	Furniture and Home Furnishings Stores
	Rental and Leasing Services	Warehousing and Storage
	Truck Transportation	Sporting Goods, Hobby, Book, and Music Stores
	Postal Service	
	Apparel Manufacturing	
	Construction of Buildings	
	Other Information Services	
	Museums, Historical Sites, and Similar Institutions	
	Internet Service Providers, Web Search Portals, and Data Processing Services	
	Administration of Economic Programs	
	Nonstore Retailers	
	Funds, Trusts, and Other Financial Vehicles	
	Couriers and Messengers	
	Wood Product Manufacturing	
	Administration of Human Resource Programs	
	Textile Product Mills	
	Rail Transportation	
	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	
	Management of Companies and Enterprises	
	Administration of Environmental Quality Programs	
	Water Transportation	
	Leather and Allied Product Manufacturing	
	Administration of Housing Programs, Urban Planning, and Community Development	
	Support Activities for Mining	
	Monetary Authorities - Central Bank	
	Fishing, Hunting and Trapping	
	Air Transportation	
	Scenic and Sightseeing Transportation	
	Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)	
	Wholesale Electronic Markets and Agents and Brokers	
	Internet Publishing and Broadcasting	
	Space Research and Technology	

[46] Table B.7 sorts NAICS codes as a function of high electricity and natural gas use account data.

Table B.8: 2002 NAICS Codes: Southern California Water Use and Wastewater Flow Accounts Sorted by Use[47]

	Bottom Half of Water Use	Top Half of Water Use
Top Half of Wastewater Flow	Performing Arts, Spectator Sports, and Related Industries Primary Metal Manufacturing Scenic and Sightseeing Transportation Building Material and Garden Equipment and Supplies Dealers Paper Manufacturing Printing and Related Support Activities Management of Companies and Enterprises Oil and Gas Extraction Rail Transportation Space Research and Technology	Petroleum and Coal Products Manufacturing Educational Services Utilities Professional, Scientific, and Technical Services Real Estate Accommodation Food Services and Drinking Places Administrative and Support Services National Security and International Affairs Amusement, Gambling, and Recreation Industries Personal and Laundry Services Textile Mills Merchant Wholesalers, Durable Goods Food Manufacturing Religious, Grantmaking, Civic, Professional, and Similar Organizations Chemical Manufacturing Motion Picture and Sound Recording Industries Hospitals Food and Beverage Stores Ambulatory Health Care Services Miscellaneous Store Retailers Merchant Wholesalers, Nondurable Goods Museums, Historical Sites, and Similar Institutions Repair and Maintenance Beverage and Tobacco Product Manufacturing Justice, Public Order, and Safety Activities Motor Vehicle and Parts Dealers Nursing and Residential Care Facilities Computer and Electronic Product Manufacturing Unassigned Miscellaneous Manufacturing Fabricated Metal Product Manufacturing Transportation Equipment Manufacturing Warehousing and Storage Textile Product Mills Plastics and Rubber Products Manufacturing Waste Management and Remediation Services Nonmetallic Mineral Product Manufacturing Electrical Equipment, Appliance, and Component Manufacturing
Bottom Half of Wastewater Flow	Clothing and Clothing Accessories Stores Support Activities for Transportation Truck Transportation Credit Intermediation and Related Activities Securities, Commodity Contracts, and Other Financial Investments and Related Activities Telecommunications Administration of Economic Programs Funds, Trusts, and Other Financial Vehicles Gasoline Stations Rental and Leasing Services Administration of Housing Programs, Urban Planning, and Community Development Furniture and Home Furnishings Stores Postal Service Furniture and Related Product Manufacturing Nonstore Retailers Insurance Carriers and Related Activities Health and Personal Care Stores Administration of Human Resource Programs Publishing Industries (except Internet) Electronics and Appliance Stores Transit and Ground Passenger Transportation Air Transportation Water Transportation Other Information Services Animal Production Pipeline Transportation Support Activities for Mining Internet Service Providers, Web Search Portals, and Data Processing Services Wood Product Manufacturing Couriers and Messengers Support Activities for Agriculture and Forestry Leather and Allied Product Manufacturing Broadcasting (except Internet) Mining (except Oil and Gas) Lessors of Nonfinancial Intangible Assets (except Copyrighted Works) Monetary Authorities - Central Bank Wholesale Electronic Markets and Agents and Brokers Internet Publishing and Broadcasting Fishing, Hunting and Trapping	General Merchandise Stores Executive, Legislative, and Other General Government Support Heavy and Civil Engineering Construction Administration of Environmental Quality Programs Sporting Goods, Hobby, Book, and Music Stores Crop Production Construction of Buildings Apparel Manufacturing Specialty Trade Contractors Social Assistance Machinery Manufacturing

[47] Table B.8 sorts NAICS codes as a function of high water use and wastewater flow account data.

Appendix C Savings Potential at the Customer Level

C.1 Introduction

This Appendix provides illustrative examples of savings potentials related to the CII customer classes selected by PAC members for WEEP. The information on savings potentials is presented in a series of tables with accompanying references. The sequence of the tables is as follows:

- Commercial and Institutional Customers:
  - Restaurants/Food Service
  - Accommodation (Hotel/Motel)
  - Real Estate Commercial Buildings: Office and Retail
  - Education (Schools and Colleges)
  - Hospitals
  - Professional, Scientific, and Technical Services
  - Amusement, Gambling, and Recreation Industries
  - Real Estate

- Industrial Customers
  - Food Processing
  - Textiles
  - Electronics
  - Fabricated Metals
  - Industrial Laundries
  - Petroleum and Coal Products Manufacturing
  - Chemical Manufacturing
  - Utilities

The percentages included in the summary tables refer to the savings potentials associated with a particular item or operation such as lighting, washing machines, frying machines, or hospitals.

C.2 Guidelines for Reviewing Summary Data

The following guidelines apply to Appendix C data.

C.2.1 Caveats

The summary of savings potentials is not a comprehensive summary of potential energy and water savings. The literature in these areas is wide reaching. The summary was created to provide information that focuses on customers that have large savings potential for electricity, natural gas, water, and wastewater or combinations thereof.

Energy and water savings have some degree of "embedded" water and energy savings respectively. This summary does not directly address energy savings produced by conserved water or the embedded water savings produced by conserved energy.

C.2.2 Approach

The savings potentials estimates reflect the following sectors:

a. *Commercial and institutional customers:* Commercial and institutional customers include office buildings, shopping centers, food services, and commercial laundries. Commercial and institutional customers can sometimes be grouped into common categories of similar end uses.

b. *Industrial customers:* These are customers who may have end uses and processes that are less common, or even unique, but often have large potential for savings. Examples of industrial customers include food processing, textiles, fabricated metals, and electronics.

The customer classes may share end uses such as lighting, cooling, plumbing fixtures, and landscape. Distinguishing the end uses is meant to summarize successful approaches that can be tailored to different customer groups. The examples in this Appendix contain detailed sources by end use for each of the customer classes presented.

C.2.3 Definitions

Savings potential can be technical, economic, or programmatic. Technical savings are "what measures work, to what extent, and if and how they can be measured." Economic savings are "cost effective savings." Programmatic savings refer to "the expected ability of measures to be effectively delivered as a utility program."[48] The tables contain technical savings information since it correlates with our principles for defining CII customer classes as a function of metering data.

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[48] Definitions from "Southern California Edison Company's Application for Approval of Embedded Energy Efficiency Pilot Programs for 2007-2008," Decision 07-12-050 December 20, 2007, Before the Public Utilities Commission of the State of California, Appendix A.

C.3 Commercial and Institutional Customers

Table C.1: Restaurants/Food Service Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Dishwashing[1]	33% to 47%	33% to 47%	33% to 47%
Steaming	Up to 95%	Up to 80%	
Frying/Grilling/Broiling			5% to 31%
Baking		30%	39%
Food Prep. & General Cleaning		55%	
Ice Making	20%	20%	
Refrigeration		14% to 67%	
Ventilation		33%	
Water Heating[1]		15%	15%
Plumbing Fixtures	20% to 50%	10% to 25%	10% to 25%
Lighting		26% to 75%	
Cooling	20% to 30%	20% to 30%	

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Dishwashing

- The CUWCC Web site reports results of a Phase 2 study of pre-rinse spray valves (SBW 2007) for dishwashing in Restaurants/Food Service to yield energy savings for small and medium volume facilities of 335 therms if water is heated with natural gas, and 7,600 kWh per year if heated with electricity.
- The U.S. EPA (2008) reports 47% savings in energy and water for pre-rinse spray nozzles and 34% for ware washers 34%.

Steaming

- Fisher-Nickel (2005, page vi) presents data to show that boiler-based steamers averaged approximately 30 times more water consumption than their boilerless high-efficiency counterparts: 407 gallons/day versus 13.9 gallons/day respectively.
- Fisher-Nickel (2005, page vi) explains that electric boiler-based steamers used five times more energy per day than boilerless steamers.
- CTAC (2008) notes that energy efficient steamers use less energy and water than other gas or electric steam technologies. For instance, ENERGY STAR qualified steamers can save up to 11,160kWh and use 90% less water annually, as compared to standard models.

Frying/Grilling/Broiling

- U.S. EPA (2008) reports savings in energy from efficient cooking appliances to be 31% savings from fryers and 5% savings from griddles.

Baking

- U.S. EPA (2008) reports energy savings from the use of efficient cooking appliances, such as 30% from the use of convection ovens; 39% from the use of combination ovens; and 87% from the use of toasters.

Food Preparation & General Cleaning

- U.S. EPA (2008) reports up to 55% energy savings from the use of an efficient food preparation table.

Ice Making

- U.S. EPA (2008) reports a 20% water and energy savings from the use of an efficient ice maker.

Refrigeration

- U.S. EPA (2008) reports energy savings from the use of efficient refrigeration and freezing appliances, such as 54% savings from the use of solid reach-in refrigerator; 35% savings from the use of solid reach-in freezers; 50% savings from the use of glass reach-in refrigerators; 67% savings from the use of walk-in freezer/coolers; 15% savings from the use of under-counter refrigerators; and 14% savings from the use of under-counter freezers.

Ventilation

- U.S. EPA (2008) reports 33% energy savings from the use of an energy efficient exhaust hood.

Water Heating

- Fisher-Nickel (2007, page viii) notes that a high-efficiency condensing water heater demonstrated natural gas savings of 10% to 20%.
- U.S. EPA (2008) reports 15% energy savings from the use of an efficient hot water heater.

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ultra low flush (ULF) toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.

- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low flow aerator flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- U.S. EPA (2008) reports energy savings from the use of more efficient lighting, such as a 26% savings from the use of efficient florescent lighting and a 75% energy savings from the use of efficient incandescent lighting. EPA used this example savings in the context of restaurants, but the concept is applicable to most CII operations.

Cooling

- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.
- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan’s rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.

Table C.2: Accommodation (Hotel/Motel) Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Swimming Pools	30%	50% to 70%	50% to 70%
Laundry[1]	10% to 90%	45% to 80%	45% to 90%
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Cooling	20% to 30%	20% to 30%	
Landscape	20% to 50%		
Food Service	10% to 30%	10% to 30%	10% to 30%

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Swimming Pools

- Senevirante (2007, page 291 quoting Sydney Water) reports 33% water use reduction by "instituting good management practices," including reducing leakage, installing more efficient bath and shower fixtures, optimizing backwash cycles, and controlling evaporation. Controlling evaporation also conserves energy because 70% of heat loss from swimming pools is through evaporation. For example, pool covers can save 30% to 50% of make-up water, and can result in 50% to 70% energy savings.

Laundry

- Hoffman and Riesenberger (2006) looked at water and energy saving at commercial laundry facilities, estimating 80% to 90% water/sewer savings and 45% to 65% water heating energy savings resulting from installation of a full recycle system; 35% to 55% water/sewer savings and up to 50% water heating savings resulting from installation of a partial recycle system; and 10% to 25% water/sewer savings and 60% to 80% water heating savings resulting from installation of an ozone system.

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.
- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low-flow aerator

flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Cooling

- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.
- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan's rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.

Landscape

- A&N Technical Services (1997) reports a 19% water budget savings based upon rate structures and customer outreach, as well as controlling with a structural model for weather and climate.
- DeSena (1998, as reported in Vickers 2001) describes how the outdoor water use of Irvine Ranch Water District customers was reduced by 50% as a result of its increasing rate block structure.
- CCWD (1994a and 1994b) describes savings from a landscape audit program involving site visits by irrigation management experts who made recommendations for conserving water and changing habits. Water savings were estimated to be 20.6% in the first year, 7.7% in the second year, and 6.5% in the third year.
- Western Policy Research (1996) reports that by effectively controlling climate and landscape size, water consumption could be reduced by 34% overall compared to the period before the retrofit to Emitting Turn Off (ETo) Controllers.
- Other means of water conservation in commercial landscapes include low water zones, xeriscapes, and artificial turf.

Food Service

- See the savings potentials described in the Restaurants/Food Service section of Appendix C, Table C.1.

Table C.3: Real Estate Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Cooling	20% to 30%	20% to 30%	
Landscape	20% to 50%		
Food Service	10% to 30%	10% to 30%	10% to 30%

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.
- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low flow aerator flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Cooling

- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year, respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.
- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan's rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.

Landscape

- A&N Technical Services (1997) reports a 19% water budget savings based upon rate structures and customer outreach, as well as controlling with a structural model for weather and climate.
- DeSena (1998, as reported in Vickers 2001) describes how the outdoor water use of Irvine Ranch Water District customers was reduced by 50% as a result of its increasing rate block structure.
- CCWD (1994a and 1994b) describes savings from a landscape audit program involving site visits by irrigation management experts who made recommendations for conserving water and changing habits. Water savings were estimated to be 20.6% in the first year, 7.7% in the second year, and 6.5% in the third year.
- Western Policy Research (1996) reports that by effectively controlling climate and landscape size, water consumption could be reduced by 34% overall compared to the period before the retrofit to ETo Controllers.
- Other means of water conservation in commercial landscapes include low water zones, xeriscapes, and artificial turf.

Food Service

- See the savings potentials described in the Restaurants/Food Service section of Appendix C, Table C.1.

Table C.4: Education (Schools and Colleges) Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Cooling	20% to 30%	20% to 30%	
Landscape	20% to 50%		
Food Service	10% to 30%	10% to 30%	10% to 30%

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.
- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low flow aerator flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Cooling

- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year, respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.
- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan’s rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.

Landscape

- A&N Technical Services (1997) reports a 19% water budget savings based upon rate structures and customer outreach, as well as controlling with a structural model for weather and climate.
- DeSena (1998, as reported in Vickers 2001) describes how the outdoor water use of Irvine Ranch Water District customers was reduced by 50% as a result of its increasing rate block structure.
- CCWD (1994a and 1994b) describes savings from a landscape audit program involving site visits by irrigation management experts who made recommendations for conserving water and changing habits. Water savings were estimated to be 20.6% in the first year, 7.7% in the second year, and 6.5% in the third year.
- Western Policy Research (1996) reports that by effectively controlling climate and landscape size, water consumption could be reduced by 34% overall compared to the period before the retrofit to ETo Controllers.
- Other means of water conservation in commercial landscapes include low water zones, xeriscapes, and artificial turf.

Food Service

- See the savings potentials described in the Restaurants/Food Service section of Appendix C, Table C.1.

Table C.5: Hospitals Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
X-Ray Processors	98%		
Dialysis Machines	38%		
Sterilizers and Autoclaves	Up to 85%		
Pump and Vacuum Systems	20% to 50%	20%	
Leak Repair	Up to 50%		
Laundry[1]	10% to 90%	45% to 80%	45% to 90%
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Cooling	20% to 30%	20% to 30%	
Landscape	20% to 50%		
Food Service	10% to 30%	10% to 30%	10% to 30%

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

X-Ray Processors

- Metropolitan Water District of Southern California (2001), through their Innovative Conservation Program, estimated water savings of more than 8 million gallons (in annualized terms) across 8 large-volume film processing systems, which translates to a 98.7% savings (or 3.3 acre-feet per year per system). The hospitals included in this study were major facilities with film processing that takes place 24 hours a day. See also CUWCC (2001b and 2001c).

Dialysis Machines

- Senevirante (2007, page 284) describes opportunities for water savings by reusing reject water from the reverse osmosis process during the purification before hemodialysis. The example cited had a 38% water savings.

Steam Sterilizers and Autoclaves

- Senevirante (2007, page 282) itemizes water conservation opportunities for steam sterilizers that includes jacket and chamber condensate cooling modification (up to 85% water savings), ejector water modification, use of chilled water reuse, and unit shut-off when equipment is not in service.

Pump and Vacuum Systems

- Senevirante (2007, pages 284 and 324) notes the opportunities for water savings by recirculating cooling water, replacing a pump with an oil ring, and/or utilizing a dry vacuum pump. For example, dry running pumps can save up to 100,000 liters of water daily at a 740 bed hospital. Another example involved food processing, where a liquid ring vacuum pump was replaced with a dry vacuum pump, resulting in a decrease from 17kW to

13.5kW during peak demand periods, and an expected 50% in water savings.

Leak Repair

- Senevirante (2007, page 278), citing a report conducted by Sydney Water, described the results of a study of 15 hospitals which illustrated that water leaks resulted in close to a 50% increase in water use.

Laundry

- Hoffman and Riesenberger (2006) looked at water and energy saving at commercial laundry facilities, estimating 80% to 90% water/sewer savings and 45% to 65% water heating energy savings resulting from installation of a full recycle system; 35% to 55% water/sewer savings and up to 50% water heating savings resulting from installation of a partial recycle system; and 10% to 25% water/sewer savings and 60% to 80% water heating savings resulting from installation of an ozone system.

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.
- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low-flow aerator flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Cooling

- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.

- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan's rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.
- Senevirante (2007, page 279) notes the added complexity of air conditioning systems in hospitals due to the need for restricting air to prevent the spread of infections, as well as the need for high flow in sterile areas. Nevertheless, water conservation opportunities are "similar to those found elsewhere."

Landscape

- A&N Technical Services (1997) reports a 19% water budget savings based upon rate structures and customer outreach, as well as controlling with a structural model for weather and climate.
- DeSena (1998, as reported in Vickers 2001) describes how the outdoor water use of Irvine Ranch Water District customers was reduced by 50% as a result of its increasing rate block structure.
- CCWD (1994a and 1994b) describes savings from a landscape audit program involving site visits by irrigation management experts who made recommendations for conserving water and changing habits. Water savings were estimated to be 20.6% in the first year, 7.7% in the second year, and 6.5% in the third year.
- Western Policy Research (1996) reports that by effectively controlling climate and landscape size, water consumption could be reduced by 34% overall compared to the period before the retrofit to ETo Controllers.
- Other means of water conservation in commercial landscapes include low water zones, xeriscapes, and artificial turf.

Food Service

- See the savings potentials described in the Restaurants/Food Service section of Appendix C, Table C.1.

Table C.6: Professional, Scientific, and Technical Services Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Clean rooms		70%	
Ice Making	20%	20%	
Food Service	10% to 30%	10% to 30%	10% to 30%
Landscape	20% to 50%		
Water Heating[1]		15%	15%
Plumbing Fixtures	20% to 50%	10% to 25%	10% to 25%
Lighting		26% to 75%	
Cooling	20% to 30%	20% to 30%	

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Clean rooms

- Mills et. al. (1996) explains that energy use in clean rooms can be reduced by 70% using a combination of upgrades such as high-efficiency fans, high and low temperature chillers, low face velocity/high cooling velocity cooling coils, and several heat exchange methods that recover exhaust.

Ice Making

- U.S. EPA (2008) reports a 20% water and energy savings from the use of efficient ice makers.

Water Heating

- Fisher-Nickel (2007, page viii) explains that a high-efficiency water condensing water heater can yield a 10% to 20% in natural gas savings.
- U.S. EPA (2008) reports 15% energy savings by using efficient hot water heaters.

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.
- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low-flow aerator flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- U.S. EPA (2008) reports energy savings from the use of more efficient lighting, such as a 26% savings from the use of efficient florescent lighting and a 75% energy savings from the use of efficient incandescent lighting. EPA used this example savings in the context of restaurants, but the concept is applicable to most CII operations.

Landscape

- A&N Technical Services (1997) reports a 19% water budget savings based upon rate structures and customer outreach, as well as controlling with a structural model for weather and climate.
- DeSena (1998, as reported in Vickers 2001) describes how the outdoor water use of Irvine Ranch Water District customers was reduced by 50% as a result of its increasing rate block structure.
- CCWD (1994a and 1994b) describes savings from a landscape audit program involving site visits by irrigation management experts who made recommendations for conserving water and changing habits. Water savings were estimated to be 20.6% in the first year, 7.7% in the second year, and 6.5% in the third year.
- Western Policy Research (1996) reports that by effectively controlling climate and landscape size, water consumption could be reduced by 34% overall compared to the period before the retrofit to ETo Controllers.
- Other means of water conservation in commercial landscapes include low water zones, xeriscapes, and artificial turf.

Food Service

- See the savings potentials described in the Restaurants/Food Service section of Appendix C, Table C.1.

Table C.7: Amusement, Gambling, and Recreation Industries Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Cooling	20% to 30%	20% to 30%	
Landscape	20% to 75%	50%	
Swimming Pools	30%	50% to 70%	50% to 70%
Laundry[1]	10% to 90%	45% to 80%	45% to 90%
Food Service	10% to 30%	10% to 30%	10% to 30%

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.
- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low-flow aerator flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Cooling

- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.

- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan's rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.

Landscape

- A&N Technical Services (1997) reports a 19% water budget savings based upon rate structures and customer outreach, as well as controlling with a structural model for weather and climate.
- DeSena (1998, as reported in Vickers 2001) describes how the outdoor water use of Irvine Ranch Water District customers was reduced by 50% as a result of its increasing rate block structure.
- CCWD (1994a and 1994b) describes savings from a landscape audit program involving site visits by irrigation management experts who made recommendations for conserving water and changing habits. Water savings were estimated to be 20.6% in the first year, 7.7% in the second year, and 6.5% in the third year.
- Western Policy Research (1996) reports that by effectively controlling climate and landscape size, water consumption could be reduced by 34% overall compared to the period before the retrofit to ETo Controllers.
- DRBC (2002) explains that switching from a manual to an automatic irrigation system at golf courses can result in water savings of 40% to 75%.
- Snow (2001) explains that different grasses can reduce water use at golf courses by 30% to 50%. Additionally, improved irrigation systems can reduce water use by 35% and electricity use by 50% as demonstrated by the SCGA Members Club in Murrieta, CA.
- Other means of water conservation in commercial landscapes include low water zones, xeriscapes, and artificial turf.

Swimming Pools

- Senevirante (2007, page 291 quoting Sydney Water) reports 33% water use reductions by "instituting good management practices," including reducing leakage, installing more efficient bath and shower fixtures, optimizing backwash cycles, and controlling evaporation. Controlling evaporation also conserves energy because 70% of heat loss from swimming pools is through evaporation. For example, pool covers can save 30% to 50% of make-up water, and can result in 50% to 70% energy savings.

Laundry

- Hoffman and Riesenberger (2006) looked at water and energy saving at commercial laundry facilities, estimating 80% to 90% water/sewer savings and 45% to 65 % water heating energy savings resulting from installation of a full recycle system; 35% to 55% water/sewer savings and up to 50% water heating savings resulting from installation of a partial recycle system; and 10% to 25% water/sewer savings and 60% to 80% water heating savings resulting from installation of an ozone system.

Food Service

- See the savings potentials described in the Restaurants/Food Service section of Appendix C, Table C.1.

C.4 Industrial Customers

Table C.8: Food Manufacturing Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Washing	19% to 27%		
Heating and Drying	30% to 34%		9,000 - 17,000 therms/yr/site
Process Cooling	9% to 26%	44,000 to 1,200,000 kWh/yr/site	
Pumping, Conveyance, Motors	20% to 50%	20%	
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Space Cooling	20% to 30%	20% to 30%	

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Washing

- Pacific Institute (2003, Appendix F) estimates water savings potential for dairy processing to include a 4% saving in carton washing and a 28% savings in the sanitation of equipment. This is the technical potential given current market penetration of devices. For fruit and vegetable processing, a 22% water savings was realized through combined improvements in washing. Finally, for beverage processing, 24% water savings was realized from the use of self-closing nozzles and 17% water savings from the reuse of rinse waters, resulting in an overall process water savings of 19% to 27%.
- Senevirante (2007, pages 311 and 314) describes benchmarking figures for typical and best practice water consumption in the food processing industry. For example, in chicken processing, typical water usage is 13 to 37.8 liters/bird, and 8 to 15 liters/bird is best practice, which calculates to a 38% to 60% differential. Additionally, opportunities for water conservation are discussed, such as replacing water consuming cleaning processes with a dry pre-clean phase, and using efficient nozzles in a bottling plant to achieve a 46% water savings.

Heating and Drying

- Pacific Institute (2003, Appendix F) describes a potential 34% water savings for fruit and vegetable processing by recycling steam condensate. This is the technical potential given current market penetration of devices.
- Senevirante (2007, p. 312) discusses a potential 30% savings of plant water by changing from water thawing to air thawing.

- BASE Energy, Inc. (2005) discusses energy savings in boiler systems, such as an effective condensate return system (saving 9,000 - 17,000 therms/year); use of a heat recovery economizer (saving 5,000 - 48,000 therms/year); tuning and adjusting the air-to-fuel ratio (saving 5,000 - 15,000 therms/year); and installing automatic blowdown controls (saving 3,000 - 13,000 therms/year).

Process Cooling

- Pacific Institute (2003, Appendix F) discusses water savings potential from the enhancement of cooling systems. For example, in dairy processing a 30% water savings was realized through the use of cold storage, and 9% to 26% savings was realized in fruit and vegetable processing and beverage processing through improvements in cooling processes (technical potential given current market penetration of devices).
- BASE Energy, Inc. (2005, page 8) describes how load shifting of frozen vegetables resulted in the reduction of refrigeration energy costs by 56%. Additionally, more general examples for reducing electricity use in refrigeration are discussed, including the use of demand-based defrost control (resulting in 46,000 - 765,000 kWh/yr savings); implementation of floating head pressure control (resulting in 100,000 - 1,200,000 kWh/yr savings); use of ammonia sub-cooling (resulting in 230,000 - 585,000 kWh/yr savings); reconfiguration of condensers (resulting in 265,000 kWh/yr savings); installation of an intermediate pressure suction line (resulting in 44,000 kWh/yr savings); increasing suction pressure (resulting in 78,000 kWh/yr savings); improving the pre-cooling of blanched vegetables (resulting in 156,000 kWh/yr savings); and use of two-stage compression instead of one stage (resulting in 410,000 kWh/yr savings).

Pumping, Conveyance, Motors

- Senevirante (2007, pages 311 and 324) discusses changing from water conveyance of food products to mechanical conveyance, as well as the application of a dry vacuum pump to replace a liquid ring vacuum pump, which can reduce energy demand from 17kW to 13.5kW during peak demand periods, and is expected to reduce water demand by 50%.
- North Carolina DENR (1998) describes a case study where conveyance water was recycled resulting in a savings of 20%.
- BASE Energy, Inc. (2005) discusses energy savings related to motors that are used for pumping, conveying, and ventilating. Examples of energy savings include controlling the motors with variable flow drives (resulting in savings of 42,000 -168,000 kWh/yr); installing premium motors as existing motors burn out (resulting in savings of 20,000 - 127,000 kWh/yr); installing cogged-type V-belts (resulting in savings of 29,000 - 102,000 kWh/yr); and utilizing On/Off motor control (resulting in savings of 15,000 - 46,000 kWh/yr).

Plumbing Fixtures

- Pacific Institute (2003) describes a 49% water savings potential for restrooms in a beverage processing.
- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.
- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low-flow aerator flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- BASE Energy, Inc. (2005) describes how electricity savings from lighting end uses in food processing facilities can be achieved by controlling existing lighting (resulting in savings of 8,000 - 50,000 kWh/yr) or by installing high efficiency lighting (resulting in savings of 4,000 - 255,000 kWh/yr).
- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Space Cooling

- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.
- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan’s rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.

Landscape

- Pacific Institute (2003) discusses 38% to 50% water savings in landscape at food processing operations.

Table C.9: Textiles Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Preparation Scouring	33%		
Dyeing	56%		
Printing	10%		
Washing	18%		
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Cooling	9% to 41%	20% to 30%	

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Preparation Scouring

- Pacific Institute (2003, Appendix F) describes a 33% water savings potential (technical potential given current market penetration of devices) in preparation operations that includes reuse of scouring, bleach, and mercerizing water.

Dyeing

- Pacific Institute (2003, Appendix F) describes a 56% water savings potential (technical potential given current market penetration of devices) in dying operations that includes reuse of rinse water from dyeing for dye bath make-up, use of reclaimed water in carpet dyeing, and avoidance of bath overflow.

Printing

- Pacific Institute (2003, Appendix F) describes 10% water savings potential (technical potential given current market penetration of devices) in printing operations.

Washing

- Pacific Institute (2003, Appendix F) describes an 18% water savings potential (technical potential given current market penetration of devices) in washing operations that includes counter-current washing and spray rinsing.

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.

- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low-flow aerator flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Cooling

- Pacific Institute (2003, Appendix F) describes water savings potential between 9% and 41% (with best estimate of 26%) in cooling operations (technical potential given current market penetration of devices).
- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.
- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan's rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.

Table C.10: Fabricated Metals Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Process	25% to 42%		
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Cooling	9% to 41%	20% to 30%	

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Process Water

- Pacific Institute (2003, Appendix F) describes potential process water savings between 25% and 42% (with best estimate of 33%) through the use of such measures counter current rinsing, flow restrictors, turn-off when not in use, agitated tanks, spray rinses, reactive or cascade rinses, conductivity controllers, flow-meters, timer rinse controls and acid recovery systems (technical potential given current market penetration of devices).

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.
- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low-flow aerator flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Cooling

- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year, respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.
- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan's rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.
- Pacific Institute (2003, Appendix F) describes water savings potential between 9% and 41% (with best estimate of 26%) in cooling operations (technical potential given current market penetration of devices).

Table C.11: Electronics Product Manufacturing Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Rinsing	29% to 43%		
Ultra Purified Water (UPW)	6%		
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Cooling	20% to 30%	20% to 30%	

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Rinsing

- Pacific Institute (2003, Appendix F) discusses water savings potential for rinsing operations in high tech industries (technical potential given current market penetration of devices), which includes modifying rinse tools (potential of 1% saving); cascade rinsing/spray rinses (potential of 29% savings); rinsing optimization (potential of 25% savings); recycling UPW by selecting cleanest rinse streams (potential of 33% savings); and reusing rinse effluent in wet scrubbers (potential of 1% savings).

Ultra Purified Water

- Pacific Institute (2003, Appendix F) describes a 6% water savings by improving efficiency of the UPW production unit (technical potential given current market penetration of devices).

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.
- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low-flow aerator flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Cooling

- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year, respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.
- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan's rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.

Table C.12: Industrial Laundries Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Tunnel Washers	60% to 70%	60% to 70%	60% to 70%
Water Reuse and Filtration	50% to 80%		
Heat Exchange		Up to 60%	Up to 60%
Plumbing Fixtures[1]	20% to 50%	10% to 25%	10% to 25%
Lighting		30%	
Cooling	20% to 30%	20% to 30%	

[1] Energy savings would be either electricity or natural gas depending on water heating equipment.
* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Tunnel Washers

- Senevirante (2007, page 347) explains how continuous batch washers or tunnel washers and the use of counter current washing reduces water and steam usage by 60% to 70% compared to using washer-extractor machines.

Water Reuse and Filtration

- Senevirante (2007, pages 347 and 353) explains how to achieve approximately 30% water savings from reusing final rinse water in washer-extractor type machines. Additionally, filtration systems can save 50% to 65% of water and energy, and more extensive filtration systems can save up to 80% of water and effluent. The case study presented in this source calculates how a system savings in water, wastewater, energy, and detergent can exceed the cost of the additional power consumption and maintenance, resulting in a payback period of 11 months.

Heat Exchange

- Senevirante (2007, page 349) describes how recovering waste heat from hot water using a heat exchanger can reclaim as much as 60% of the heat.

Plumbing Fixtures

- Koeller (2003) reports that high-efficiency toilets are designed to be 20% more efficient that ULF toilets, which represents a reduction of 40% to 60% compared to toilets produced before the ULF standards (Veritec Consulting 2002 and Engineering Technologies Canada 2001).
- CUWCC (2001a) estimates that restaurants can save up to 46 gallons/day of water from the installation and use of ULF toilets.
- CUWCC (2007a) reports that the threshold definition of a high-efficiency urinal is 0.5 gallons per flush or less, which represents a 50% savings over existing national standards.
- Senevirante (2007, page 273) describes the importance of pressure regulation in faucet flow restrictors. For instance, an ultra low-flow aerator

flows 1.7 liters/minute compared to a conventional-flow, which can be as high as 15 to 18 liters/minute. Furthermore, a 40% water savings based on flow rates is asserted for showerheads.

Lighting

- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Cooling

- Gentili (2003) reports water savings of 20% to 30% from two large cooling towers by increasing the cycles of concentration with controllers of 1,850,000 and 1,250,000 gallons per year, respectively.
- Lelic and Blair (2004) describe a 21% decrease in cooling tower make up water by using variable speed drives for cooling fans. Energy savings also occur by using variable speed drives for cooling fans.
- BASE Energy, Inc. (2008) estimates that a 440 ton cooling tower retrofitted with a fan controller to control the fan’s rotational speed has the potential to produce electrical energy savings of approximately 89,000 kWh per year with a 10 kW reduction during peak demand periods.

Table C.13: Petroleum and Coal Products Manufacturing Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas****
Energy Recovery:			
Flare Gas Recovery			Up to 49%
Power Recovery			7.3 million kWh/yr
Steam Generation and Distribution	10% to 15%		1% to 26%
Heat Exchanges	10% to 15%		0.7%
Process Heaters			3% to 18%
Process Integration	10% to 40%		10% to 30%
Distillation			10% to 35%
Power Generation – Combined Heat and Power (CHP) Generation			38% to75%
Motors, Pumps, and Fans		1.2% to 49%+	
Compressors		2% to 20%	
Lighting		30%	

* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.
** And other petroleum-type fuels, including but not limited to refinery fuel gas, and fluid catalytic cracker (FCC) coke.

Energy Recovery

- Worrell and Galitsky (2005, page 34) note opportunities for flare gas energy recovery at refineries through improved process control equipment and new technologies including gas-recovery systems and ignition systems without pilots. The study cites an example of a U.S. refinery that plans to install new recovery compressors and storage tanks to reduce flaring, projecting $52 million in annual savings. An additional benefit to flare gas recovery is reduced air emissions.
- Worrell and Galitsky (2005, page 35) also discuss opportunities for power recovery through the installation of recovery turbines at the FCC and hydrocrackers. An upgrade of a recovery turbine at a U.S. refinery led to 22 MW of power savings, and 4 MW of additional exported power to the grid. At a second refinery, a 910 kW power recovery turbine was installed at a refinery, which led to the production of 7.3 million kWh/year of additional power.

Steam Generation and Distribution

- Worrell and Galitsky (2005, pages 36-41) report that “30% of onsite energy use in U.S. refineries is used in the form of steam” and that efficiency opportunities exist in the generation, distribution, and end-use of steam. Energy efficiency measures performed on boilers (e.g., improved process control, reduction in flue gas quantity and excess air, improved insulation, boiler maintenance, and heat recovery) can lead to an estimated 1% to 26% fuel savings, in addition to reduction in emissions and damage to structures. Furthermore, installing control systems and modifying standby boilers can "result in energy savings of up to 85% of the standby boiler."

- Worrell and Galitsky (2005, page 42) note that additional efficiency opportunities exist in the distribution system. Improved insulation, steam traps, and leak recovery, as well as maintenance and automatic monitoring of the steam trap systems can lead to 3% to 15% fuel savings. Recovering flash steam in the distribution system and boiler can lead to an additional fuel savings, though the "savings are strongly site dependent." Worrell and Galitsky cite one study where flash steam recovery led to an 83% fuel savings.
- Loretitsch, Karajeh, and Mottin (2005, pages 8-11) state that refineries in southern California have been successfully using recycled water (specifically Title-22 water) as boiler feed water and in their cooling towers. This report explains that both potable and Title 22 water require similar purification processes and chemical treatment to be acceptable as boiler makeup. Demineralization by reverse osmosis (RO) or ion exchange or both are typically used to improve Title 22 water to boiler makeup standards. In some instances, RO permeate can be used without additional purification. Single pass RO permeate is suitable for low-pressure boilers; and double pass RO permeate is pure enough to be used in high-pressure power boilers. As an example in one case study, a refinery chose to blend 85% RO permeate with 15% nitrified Title 22 water to obtain a Title 22 water product that was of excellent quality.

Heat Exchangers

- Worrell and Galitsky (2005, page 43) explain that cleaning heat exchanger tubes of the crude distillation unit (CDU) and other furnaces can generate 0.7% energy savings. One example refinery cited $14 million worth of savings from regular maintenance to heat exchangers and insulation.
- Loretitsch, Karajeh, and Mottin (2005, pages 10-11) state that recycled water can be successfully utilized in refinery cooling water systems. This report explains that both potable and Title 22 water require similar purification processes and chemical treatment to be acceptable as boiler makeup. Demineralization by RO or ion exchange or both are typically used to improve Title 22 water to boiler makeup standards. In some instances, RO permeate can be used without additional purification. Single pass RO permeate is suitable for low-pressure boilers; and double pass RO permeate is pure enough to be used in high-pressure power boilers. As an example in a case study, high quality makeup water permitted cooling water cycles to be raised from 4 to 5 with freshwater to 10 to 14 with recycled water. This in turn provided greater water savings by reducing blowdown requirements by over 80%. Water treatment costs were reduced by over 85% compared to that for freshwater, which was due to higher water quality and the subsequent need for lower chemical treatment use to control corrosion, deposits, and microbiological growth. Cooling water

equipment protection also improved, resulting in more efficient operation as well as an estimated increase in life expectancy by 100%, which was a major cost savings for the refinery. Additionally, water treatment monitoring has improved to assure consistently good water chemistry.

Process Heaters

- Worrell and Galitsky (2005, pages 49-50) cite that the theoretical maximum thermal efficiency for furnaces is approximately 92%, but that the average efficiency for a furnace is only 75% to 90%. They conclude that "this suggests that on average a 10% improvement in energy efficiency can be achieved in furnace and burner design." Refineries can achieve fuel savings by limiting excess air oxygen levels (3% to 6% savings) and by preheating the combustion air (8% to 18% savings).

Process Integration

- Worrell and Galitsky (2005, page 45) note that "Total Site Pinch Analysis has been applied by over 40 refineries around the world to find optimum site-wide utility levels by integrating heating and cooling demands of various processes, and by allowing the integration of CHP." Energy savings at refineries using Total Site Pinch Analysis range from 10% to 30%.
- Natural Resources Canada (2004, page 20) reports that 10% to 40% water savings potential for oil/petroleum refining through process integration, including a combination of heat integration; water network optimization and wastewater; minimization utility management; integration of cogeneration systems; and energy efficiency through water network optimization.
- Worrell and Galitsky (2005, page 45, as reported in Polley and Polley, 2000) indicate that other industries, such as the food industry, have reported up to a 50% reduction in water intake as a result of water pinch.

Distillation

- Worrell and Galitsky (2005, page 46) describes how process integration at the CDU can save between 10% and 19% of fuel use.
- Worrell and Galitsky (2005, pages 51-53) explain that distillation is "one of the most energy intensive operations in the petroleum refinery," and that changes in operation procedures and the optimization of the distillation column can increase energy efficiency. Specifically, they note that Technip/Elf's newly designed crude preheater and distillation column reduces fuel usage by up to 35%.

Power Generation – CHP Generation

- Worrell and Galitsky (2005, page 74) report that 6,000 megawatt electric[49] (MWe) of cogeneration capacity exists in the petroleum refining industry, but only 10% of steam is generated in cogeneration units. It is estimated that "the potential for CHP installations is…an additional 6,700 MWe."
- Worrell and Galitsky (2005, page 74) note that cogeneration plants are "significantly more efficient than standard power plants because they take advantage of what are losses in conventional power plants by utilizing waste heat."
- Worrell and Galitsky (2005, page 77) explains that gasification provides the opportunity for cogeneration using the heavy bottom fraction and refinery residues. While the synthesis gas can be used as feedstock for chemical processes, the most attractive application seems to be generation of power in an integrated gasification combined cycle. In this installation the synthesis gas is combusted in a gas turbine, with an adapted combustion chamber to handle the low to medium-BTU gas, generating electricity. The hot flue gases are used to generate steam. The steam can be used onsite or used in a steam turbine to produce additional electricity (i.e., the combined cycle). Cogeneration efficiencies can be up to 75% lower heating value (LHV) and for power production alone the efficiency is estimated at 38% to 39%.

Motors, Pumps, and Fans

- Worrell and Galitsky (2005, page 56) identify that energy savings can be maximized by using a systems approach that addresses the entire motor system, including pumps, compressors, motors, and fans.
- Worrell and Galitsky (2005, pages 56-57) note that installing properly sized motors can reduce energy consumption by 1.2%, and replacing heavily used motors with high efficiency motors, correcting low power factors and voltage unbalance, and utilizing adjustable or variable speed drives can add additional savings.
- Worrell and Galitsky (2005, pages 59-60) explain that proper operations and maintenance on pump systems can result in a 2% to 7% reduction in electricity use. Reducing the need for additional pump capacity and installing properly sized and energy efficient pumps can increase energy savings by 5% to 10% and by 17% to 30% respectively. They add that on average "installing parallel systems for highly variable loads saves 10% to 50% of the electricity for pumping."
- Worrell and Galitsky (2005, page 70) note that adjustable speed drives installed on fans can result in 14% to 49% energy savings. Properly sized fans and high efficiency belts can also improve energy savings.

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[49] One million watts of electric capacity. See http://www.teachmefinance.com/Scientific_Terms/Megawatt_electric_MWe.html.

Compressors

- Worrell and Galitsky (2005, pages 65-69, as reported in Radgen and Blaustein, 2001) state that proper maintenance to compressor systems can improve efficiency and save energy. For example, leak repair and maintenance can lead to a 20% reduction in annual energy consumption, while filter maintenance can lead to a 2% reduction. Additional efforts, such as maximizing the allowable pressure dew point at the air intake, sizing pipe diameter correctly, and recovering heat can reduce energy consumption in the compressor systems.

Lighting

- Worrell and Galitsky (2005, pages 71-72) explain that installing lighting controls, replacing low efficiency lamps with high efficiency lamps and ballasts, and utilizing LED lights can increase efficiency in refineries.
- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Table C.14: Chemical Manufacturing Savings Potentials

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Natural Gas**
Steam Systems	10%		2% to 26%
Furnaces and Process Heaters			5% to 25%
Heating and Cooling	70%	1.5 to 2.5 million kWH/yr	7 TBtu**
Process Integration	Up to 50%		10% to 30%
Motors, Pumps, Fans and Blowers		2% to 50%	
Compressors and Compressed Air		2% to 20%	
Building HVAC		Up to 30%	
Lighting		Up to 30%	
Process Specific			Up to 20%

* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.
**Trillion British Thermal Units (TBtu)

Steam Systems

- Neelis, Worrell and Masanet (2008, page 47, as reported in U.S. DOE-OIT 2002a) note a study by the U.S. Department of Energy which estimates potential fuel savings from efficiency measures (e.g., reduced steam generation pressure, improved process integration and management of steam flows) at 12.4%.
- Neelis, Worrell and Masanet (2008, page 48) explain that a chemical facility in the Netherlands previously used sea-water treated by reverse osmosis, and now utilizes effluent water from a nearby sewage treatment plant. This reduced the facility’s energy costs for water treatment by 60%.
- Neelis, Worrell and Masanet (2008, pages 49-50) also note that a reduction in flue gas quantities and excess air, an improvement in insulation and heater circuit controls, and regular maintenance of the boiler can improve energy savings by 2% to 26%. Furthermore, installing control systems and modifying standby boilers can “result in energy savings of up to 85% of the standby boiler.”
- Neelis, Worrell and Masanet (2008, pages 54-55) suggest that additional efficiency opportunities exist in the steam distribution system. Improved insulation, steam traps, and leak recovery, as well as maintenance and automatic monitoring of the steam trap systems can lead to 3% to 15% fuel savings. Recovering flash steam in the distribution system and boiler can lead to an additional fuel savings, though the “savings are strongly site dependent.” A chemical facility in Louisiana implemented a flash steam recovery project that recovers 100% of the flash steam in one process, resulting in a net energy savings of 2.8%.
- Neelis, Worrell and Masanet (2008, page 56, as reported in OIT, 1998) indicate that a condensate recovery system in the boiler produces a

maximum of 10% energy savings, and reduces the need for treated boiler water.

Furnaces and Process Heaters

- Neelis, Worrell and Masanet (2008, page 57-58) state that the theoretical maximum thermal efficiency for furnaces is approximately 92%, but that the average efficiency for a furnace is only 75% to 90%. They conclude that “this suggests that typical savings of 10% can be achieved in furnace and burner design, and operations.” The chemical industry can also save between 5% and 25% by limiting oxygen in excess air and between 2% and 5% by improving heat containment (e.g., reducing wall heat losses, controlling furnace pressure, maintaining door and tube seals, and reducing cooling of internal parts and radiation heat loss).

Heating and Cooling

- Neelis, Worrell and Masanet (2008, page 60) report that “the management and optimization of heat transfer amount processes is…key to increasing overall energy efficiency.” Fouling impedes heat transfer, and requires the use of additional fuel.
- Neelis, Worrell and Masanet (2008, page 61) note that the optimization of cooling efforts reduces energy use. In one example, the installation of a new, efficient chiller and optimization of the cooling of the air compressors could reduce the electricity demand by 1.5 million and 1 million kWh per year respectively. At another site, cooling water system optimization and maintenance resulted in a 70% decline in water use.
- Neelis, Worrell and Masanet (2008, page 61-62) cite that waste heat can be “recovered for space heating and feed (water) preheating.” At one site, heat was recovered in a production unit that amounted to natural gas savings of 7 TBtu. At a second site, waste water (via a heat exchanger) pre-heats fresh water. This process reduced steam demand by 90%.

Process Integration

- Neelis, Worrell and Masanet (2008, page 63) note that total site pinch analysis integrates CHP into the analysis. Energy savings range from 10% to 30%.
- Neelis, Worrell and Masanet (2008, page 63, as reported in Polley and Polley, 2000) indicate that industries have reported up to a 50% reduction in water intake as a result of water pinch.

Electric Motors, Pumps, Fans and Blowers

- Neelis, Worrell and Masanet (2008, pages 65-69) explain that developing a motor management plan, strategically selecting efficient and properly sized motors, and performing the proper maintenance can improve the efficiency of motors. “The savings associated with ongoing motor maintenance programs are significant, and could range from 2% to 30% of total motor system energy use." Correcting the power factor and minimizing voltage unbalances will also improve efficiency.

- Neelis, Worrell and Masanet (2008, pages 70-76, as reported in Xenergy, 1998) explain that 21% of the energy consumed by pumps could be saved through "equipment or control system changes" including "speed reduction or control measures and other system efficiency measures." Energy savings from operations and maintenance are estimated at 2% to 7% of pumping electricity use. Energy savings also stems from proper monitoring, reducing the need for new capacity, installing more efficient and properly sized pumps (2% to 25% less energy consumption), and using multiple pumps for varying loads (10% to 50% less electricity consumption).
- Neelis, Worrell and Masanet (2008, page 77, as reported in Xenergy, 1998) note that more efficient fan systems could reduce energy consumption by 5.9%.

Compressors and Compressed Air

- Neelis, Worrell and Masanet (2008, pages 79-84, as reported in Xenergy, 1998) set the savings potential for compressed air systems at 18%. Energy savings can be accomplished through maintenance, monitoring, repairing of leaks (estimated at a 20% reduction in energy consumption), and by installing high efficiency motors (estimated at a 2% reduction in energy consumption).

Building HVAC

- Neelis, Worrell and Masanet (2008, pages 88-91) discuss facility uses of electricity, which accounts for 10% of total electricity use. Energy efficiency improvements can be made by using an energy efficient design and by modifying fans, insulation, recovering heating and cooling water, installing energy monitoring and control systems. Repairing duct leakage in "industrial and commercial spaces could reduce HVAC energy consumption by up to 30%."

Lighting

- Worrell and Galitsky (2005, pages 71-72) explain that installing lighting controls, replacing low efficiency lamps with high efficiency lamps and ballasts, and utilizing LED lights can increase efficiency in refineries.
- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

Process Specific

There are numerous specific chemical processes, each of which will present a different opportunity for energy and water efficiency. One example is presented below.

- Neelis, Worrell and Masanet (2008, page 95 as reported in Bowen, 2006) notes a study by the leading ethylene technology supplier. The study estimates the “average specific energy consumption of a U.S. gas cracker unit to be ~20% higher compared to units in the European Union and Japan.”

Table C.15: Utilities Savings Potentials[50]

Water and Energy Savings Potential*			
Item	**Water**	**Electricity**	**Fossil Fuels**
Generation Types:			
Circulating Fluidized Bed Combustion (CFBC)			41.6% to 43.4%
Combustion Turbine Combined Cycle (CTCC)			30% to 40%
Steam Generation and Distribution	10% to 15%		1% to 26%
Motors, Pumps, and Fans		1.2% to 49%+	
Compressors		2% to 20%	
Lighting		30%	

* All figures are general illustrations of technical savings potential. Actual savings will depend on many variables including existing equipment, new construction or retrofit, economic costs and benefits, and programmatic factors.

Fluidized Bed Performance

- Electric Power Research Institute (EPRI) (2008, pages 4-2 to 4-3) indicates that efficient atmospheric CFBC units have improved performance in comparison to pulverized coal fired units. The first supercritical CFBC unit is being built in Poland and is expected to have net plant efficiency of 43.4% LHV or 41.6% higher heating value. In addition to efficiency benefits, CFBC units have reduced sulfur dioxide (SO_2), nitrogen dioxide (NO_x), and mercury emissions, and lower variable operating costs (e.g., for fuel and limestone).

Combustion Turbine Combined Cycle

- EPRI (2008, pages 5-2 to 5-3) states that CTCC units have a 30% to 40% higher efficiency than pulverized coal units. CTCC units pass hot exhaust gas from the combustion turbine through a heat recovery steam generator, exchanges the gas with water, producing steam and cooling the gas.

Steam Generation and Distribution

- Worrell and Galitsky (2005, pages 36-41) report that efficiency opportunities exist in the generation, distribution, and end-use of steam. Energy efficiency measures performed on boilers (e.g., improved process control, reduction in flue gas quantity and excess air, improved insulation, boiler maintenance, and heat recovery) can lead to an estimated 1% to 26% fuel savings, in addition to reduction in emissions and damage to structures. Furthermore, installing control systems and modifying standby boilers can "result in energy savings of up to 85% of the standby boiler."
- Worrell and Galitsky (2005, page 42) note that additional efficiency opportunities exist in the distribution system. Improved insulation, steam traps, and leak recovery, as well as maintenance and automatic monitoring

[50] This customer class is quite broad. The examples provided cover only portions of electricity generation.

of the steam trap systems can lead to 3% to 15% fuel savings. Recovering flash steam in the distribution system and boiler can lead to an additional fuel savings, though the “savings are strongly site dependent.” Worrell and Galitsky cite one study where flash steam recovery led to an 83% fuel savings.

- Loretitsch, Karajeh, and Mottin (2005, pages 8-11) state that refineries in southern California have been successfully using recycled water (specifically Title-22 water) as boiler feed water and in their cooling towers. This report explains that both potable and Title 22 water require similar purification processes and chemical treatment to be acceptable as boiler makeup. Demineralization by RO or ion exchange or both are typically used to improve Title 22 water to boiler makeup standards. In some instances, RO permeate can be used without additional purification. Single pass RO permeate is suitable for low-pressure boilers; and double pass RO permeate is pure enough to be used in high-pressure power boilers. As an example in one case study, a refinery chose to blend 85% RO permeate with 15% nitrified Title 22 water to obtain a Title 22 water product that was of excellent quality.

Motors, Pumps, and Fans

- Worrell and Galitsky (2005, page 56) identify that energy savings can be maximized by using a systems approach that addresses the entire motor system, including pumps, compressors, motors, and fans.
- Worrell and Galitsky (2005, pages 56-57) note that installing properly sized motors can reduce energy consumption by 1.2%, and replacing heavily used motors with high efficiency motors, correcting low power factors and voltage unbalance, and utilizing adjustable or variable speed drives can add additional savings.
- Worrell and Galitsky (2005, pages 59-60) explain that proper operations and maintenance on pump systems can result in a 2% to 7% reduction in electricity use. Reducing the need for additional pump capacity and installing, properly sized and energy efficient pumps can increase energy savings by 5% to 10% and by 17% to 30% respectively. They add that on average “installing parallel systems for highly variable loads saves 10% to 50% of the electricity for pumping.”
- Worrell and Galitsky (2005, page 70) note that adjustable speed drives installed on fans can result in 14% to 49% energy savings. Properly sized fans and high efficiency belts can also improve energy savings.

Compressors

- Worrell and Galitsky (2005, pages 65-69 as reported in Radgen and Blaustein, 2001) state that proper maintenance to compressor systems can improve efficiency and save energy. For example, leak repair and maintenance can lead to a 20% reduction in annual energy consumption, while filter maintenance can lead to a 2% reduction. Additional efforts, such as maximizing the allowable pressure dew point at the air intake, sizing pipe diameter correctly, and recovering heat can reduce energy consumption in the compressor systems.

Lighting

- Worrell and Galitsky (2005, pages 71-72) explain that installing lighting controls, replacing low efficiency lamps with high efficiency lamps and ballasts, and utilizing LED lights can increase efficiency in refineries.
- Senevirante (2007, page 120) describes 30% energy efficiency improvements in lighting in office buildings through the implementation of a combination of improved switches, energy efficient fixtures, and greater use of natural light.

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Appendix D Acronyms

ACt	Annual Cost in Years
Afy	Acre Feet per Year
Appl. Stds.	Appliance Standards
B/C	Benefits-Cost Ratio
Bldg. Stds.	Building Standards
Bt	Benefits in Years
CCF	Hundred Cubic Feet
CDU	Crude Distillation Unit
CEC	California Energy Commission
CE	Cost Effectiveness
CES	Current Employment Statistics
CFBC	Circulating Fluid Bed Combustion
CHP	Combined Heat and Power
CII	Commercial, Industrial, and Institutional
CIP	Clean-in-Place
Cons Prog	Conservation Programs
CPUC	California Public Utilities Commission
Ct	Cost in Years
CTCC	Combustion Turbine Combined Cycle
CUWCC	California Urban Water Conservation Council
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency

EPRI	Electric Power Research Institute
ETo	Emitter Turn Off
FCC	Fluid Catalytic Cracker
FV	Future Value
GWh	Gigawatt Hours
HEU	High Efficiency Urinals
HVAC	Heating, Ventilation, and Air Conditioning
IC	Initial Capital Costs
kWh	Kilowatt Hour
LACSD	Sanitation Districts of Los Angeles County
LADWP	Los Angeles Department of Water and Power
LED	Light Emitting Diode
LHV	Lower Heating Value
MWD	Metropolitan Water District of Southern California
MWh	Megawatt Hour
MWe	Megawatt Electric
n	Period of Years
NAICS	North American Industry Classification System
NBER	National Bureau of Economic Research
NPV	Net Present Value
OMB	Office of Management and Budget
PAC	Project Advisory Committee
PG&E	Pacific Gas and Electric Company

PV	Present Value
QFER	Quarterly Fuel and Energy Report
r	Discount Rate
RO	Reverse Osmosis
SCE	Southern California Edison
SDCWA	San Diego County Water Authority
SDG&E	San Diego Gas & Electric Company
SIC	Standard Industrial Classification
SoCalGas	Southern California Gas Company
SP	Simple Payback
TBtu	Trillion British Thermal Units
therms	A unit of heat equal to 100,000 British thermal units (1.054 × 108 joules)
ULF	Ultra low flush
UPW	Ultra Purified Water
UWMPS	Urban Water Management Plans
WACC	Weighted Average Cost of Capital
WEEP	Water and Energy Efficiency Program

Appendix E Glossary of Terms

Term	Definition
Avoided Costs	The amount of money that an electric utility would need to spend for the next increment of electric generation to produce or purchase elsewhere the power that it instead buys from cogenerate or small-power producer. Federal law establishes broad guidelines for determining how much a qualifying facility (QF) gets paid for power sold to the utility.[51]
Benefit-Cost Ratio	The Benefit-Cost Ratio is the sum of discounted benefits to the sum of discounted costs of a program over time. If the ratio is above one then the total benefits of the project are greater than the costs. The benefit-cost ratio allows for a quick comparison of the benefits relative to the costs and provides a general rate of return for the project. The disadvantage of using a benefit-cost ratio is that it does not indicate the magnitude of the total value of the project.
CII Customers	Commercial, Industrial, and Institutional Customers.
Concordance	Demonstrates relationship between SIC and NAICS codes.[52]
Conservation Savings	Savings resulting from water or energy conservation, which is the practice of decreasing the quantity of water or energy used. It may be achieved through efficient water or energy use, or by reduced consumption of water or energy services. Energy or water conservation may result in increase of financial capital, environmental value, national security, personal security, and human comfort. Individuals and organizations that are direct consumers of water or energy may want to conserve energy in order to reduce water or energy costs and promote economic security. Industrial and commercial users may want to increase efficiency and thus maximize profit.[53]
Cost-Benefit Analysis	An analysis designed to determine the feasibility of a project by quantifying the costs and benefits over the life of the project. The project is typically considered to be worth pursuing if the benefits outweigh the costs.[54]
Cost-Effectiveness Ratio	The cost-effectiveness ratio is the sum of discounted costs over the sum of the discounted water, electricity, natural gas, or wastewater saved through a specific program over time. In this scenario, the cost-effectiveness ratio provides a measure of the costs associated with saving a specified amount of water or energy.

[51] Definition from Websters-Online-Dictionary.org.
[52] See http://www.statcan.gc.ca/subjects-sujets/standard-norme/concordances/background-contexte-eng.htm.
[53] See Section 6.0 and http://74.125.47.132/search?q=cache:OUnf_80Z2fMJ:www.nwppc.org/energy/rtf/meetings/Archivemtgs/2000/2000_0808/appendixa.doc+definition+of+conservation+savings&cd=1&hl=en&ct=clnk&gl=us.
[54] Definition from InvestorWords.com.

Term	Definition
County Land Use Code	Code developed for land use, planning, and tax purposes, which can be informative for utility planning.
Customer Sector	Customer sectors are defined as top-level, broad customer classifications, and are used by energy utilities and water districts for rate making, rate categories, or other financial planning purposes. Examples of these top-level customer categories include commercial, industrial, institutional, and for water districts, landscape sectors.
Discount Rate (*r*)	The rate at which society as a whole is willing to trade off present benefits for future benefits. When weighing the decision to undertake a project with long-term benefits verses a project with short-term benefits and long-term costs, the discount rate plays an important role in determining the outcome of the analysis. The process of discounting reflects how individuals value economic resources.[55]
End Uses	The ultimate use for electricity or water.
Environmental Benefits	Benefits to the environment that may not be quantified or may have an unknown monetary value.
Externalities	Positive or negative impacts on any party not directly involved in an economic decision. An externality occurs when an economic activity causes external costs or external benefits to a third party who did not directly affect the economic transaction.[56]
Future Value	The amount of money an investment will grow to at some date in the future by earning interest.[57]
Internal Rate of Return	The internal rate of return calculates the discount rate that would make the net present value of the project equal to zero. It is calculated through an iterative process where different discount rates are applied to the NPV equation until the NPV is zero. If market interest rates are less than the internal rate of return, then the project is beneficial.
Market Rate of Return	The Market Rate of Return is the ratio of money gained or lost on an investment relative to the amount of money invested. The positive value for the rate of return corresponds to capital growth, a negative value to capital decay, and a value of 0 to no change.
Monetary Costs	The property of having material worth, often indicated by the amount of money something would bring if sold.[58]

55 Definition from http://www.csc.noaa.gov/coastal/economics/discounting.htm.
56 See Rosen and Gayer, 2008.
57 See Bodie and Merton, 2000.
58 See http://www.thefreedictionary.com/monetary+value.

Term	Definition
NAICS	The *North American Industry Classification System (NAICS)* is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data. The codes consist of a six-digit, business-type indicator, though some codes may consist of four or less digits.[59]
Net Present Value (NPV)	The Net Present Value (NPV) enables streams of costs and benefits over time to be expressed in their equivalent present day value and compared to one another. NPV sums the discounted value of net benefits, which are accrued over a specified period of time. An NPV above zero indicates that the benefits outweigh the costs of the project. A project is considered admissible if its net present value is greater than zero. Among admissible projects, the preferred project is the one with the highest net present value.
Pinch Analysis	Method to improve the efficient use of energy and water in industrial processes by investigating energy flows within a process and identifying ways to maximize heat recovery and minimize the demand for external utilities (e.g., steam and cooling water). Pinch analysis is utilized in the chemical, petrochemical, oil refining, pulp and paper, food and drink, and steel and metallurgy industry sectors.[60]
Positive Externality	A Positive Externality or external benefit results when an economic activity causes external benefits to a third party who did not directly affect the economic transaction. Positive externalities are associated with water and energy conservation.[61]
Present Value (*PV)*	The value today of a stream of benefits or costs occurring over time, as discounted through the use of an interest rate.[62]
Price Effects	The impact of a price on the market or economy.[63]
Programmatic Savings Potential	The expected ability of measures to be effectively delivered as a utility program.
Risk Premium	A Risk Premium is the minimum difference a person requires to be willing to take an uncertain bet, between the expected value of the bet and the certain value that he is indifferent to. From society's perspective, the risk premium is a transfer payment and nets to zero.[64]
SIC	*Standard Industrial Classification (SIC)* system classifies establishments by their primary type of activity. The SIC was replaced by the *NAICS* in 1997.[65]
Simple Payback Period	The simple payback period is the amount of time it will take to "repay" the initial investment in a project, and is calculated by dividing initial cost of the project by the annual cost savings.

[59] Definition from census.gov/naics.
[60] Definition from Natural Resources Canada's Pinch Analysis: For the Efficient Use of Energy, Water, and Hydrogen.
[61] See Rosen and Gayer, 2008.
[62] See Bodie and Merton, 2000 and Brealey and Myers, 2000.
[63] Definition from BNET, http://dictionary.bnet.com/definition/price+effect.html.
[64] See Brealey and Myers, 2000.
[65] Definition from census.gov/epcd/www/sic.

Term	Definition
Social Discount Rate	The appropriate value of the annual discount rate to use in computing present discount value for social investments. The measure is used to help guide choices about the value of diverting funds to social projects. Determining this rate is not always easy and can be the subject of discrepancies in the true net benefit to certain projects.
Technical Savings Potential	What measures work, to what extent, and if and how they can be measured.
Urban Water Management Planning Act	The Urban Water Management Planning Act was enacted by the California Legislature in 1983. The Act states that every urban water supplier that provides water to 3,000 or more customers, or that provides over 3,000 acre-feet of water annually, should make every effort to ensure the appropriate level of reliability in its water service sufficient to meet the needs of its various categories of customers during normal, dry, and multiple dry years. The Act describes the contents of the Urban Water Management Plans as well as how urban water suppliers should adopt and implement the plans.[66]

[66] Definition from http://www.owue.water.ca.gov/urbanplan/index.cfm.

Appendix F Bibliography

Reference	Bibliographic Citation
A&N Technical Services 1997	A&N Technical Services. Landscape Water Conservation Programs: Evaluation of Water Budget Based on Rate Structures. Prepared for Metropolitan Water District of Southern California. September 1997.
BASE Energy Inc, 2005	BASE Energy, Inc. Energy Efficiency Opportunities in Fresh Fruit and Vegetable Processing/Cold Storage Facilities. Presented at 2005 ACEEE Summery Study on Energy Efficiency in Industry, July 19-22, West Point, NY. 2005.
BASE Energy, Inc. 2008	BASE Energy, Inc. Energy Savings for a Commercial Building. April 2008. Available at: http://baseco.com/publications.html.
Bowen 2006	Bowen, C, S. Stone, and Webster. Olefin technology efficiency today/tomorrow. Presentation by Bowen, Stone and Webster at IEA workshop 'Feedstock substitutes, energy efficient technology & CO2 reduction for petrochemical products.' December 12-13, 2006.
Brealey and Myers 2000	Brealey, R. A, & Myers, C. *Principles of Corporate Finance* (6th ed.). Boston: McGraw-Hill/Irwin. 2000.
Bodie and Merton 2000	Bodie, Z. & Merton, C. *Finance*. Upper Saddle River: Prentice Hall. 2000.
California Water Plan	Department of Water Resources. Bulletin 160, California. Water Use Plan. 2005.
CALFED 2006	CALFED Bay-Delta Program Water Use Efficiency Element. Water Use Efficiency Comprehensive Evaluation. August 2006. Available at: http://calwater.ca.gov/content/Documents/library/WUE/2006_WUE_Public_Final.pdf.
CCWD 1994	Contra Costa Water District (CCWD). Landscape Water Audit Evaluation. August 1994.
CCWD 1994	CCWD. Weather Normalized Evaluation. August 1994.
CEC 2003	CEC. August 2003. California Energy Demand 2003-2013 Forecast. Available at: http://www.energy.ca.gov/reports/2003-08-08_100-03-002.PDF.
CEC 2007	CEC. California Energy Demand 2008-2018 Staff Revised Forecast. November 2007. Available at: http://www.energy.ca.gov/2008_energypolicy/documents/index.html.
CEC Integrated Energy Report	CEC. Integrated Energy Policy Report. December 2007. Available at: http://www.energy.ca.gov/2007_energypolicy.
CPUC and CEC 2001	California Public Utilities Commission and California Energy Council (CPUC and CEC). California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects. October 2001. Available at: http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF.

Reference	Bibliographic Citation
CTAC 2008	Customer Technology Application Center (CTAC). Connectionless/Boilerless Steamers. Southern California Edison Customer Technology Application Center, Food Service Technology Center. 2008. Available at: http://www.sce.com/RebatesandSavings/EnergyCenters/CTAC/TourofEdisonCTAC/foodservicecenter.htm.
Current Employment Statistics	Available at: http://www.nber.org/nberces.
CUWCC 1996	California Urban Water Conservation Council (CUWCC). Guidelines to Conduct Cost Effectiveness Analysis of Best Practices for Urban Water Conservation. Prepared by D.M. Pekelney, T. Chesnutt, and M. Hannemann. 1996.
CUWCC 1999	CUWCC. Best Management Practice 9. Conservation Programs for Implementing Commercial, Industrial, and Institutional. 1999. Document can be purchased at: http://www.cuwcc.org/docDetail.aspx?id=1808.
CUWCC 2001a	CUWCC. The CII ULFT Savings Study: Second Edition. Prepared by Hagler Bailly Services. February 2001.
CUWCC 2001b	CUWCC. Water-saving X-Ray Film Processors. California Urban Water Council summary of LADWP study in the WaterLogue, Vol. 1, No. 7. December 2001.
CUWCC 2001c	CUWCC. Water-saving X-Ray Film Processors. California Urban Water Conservation Council Summary of LADWP study in the WaterLogue Vol. 1. No. 7. December 2001.
CUWCC 2007a	CUWCC. High Efficiency Urinals (HEUs) – U.S. and Canada, Revised. June 2008.
CUWCC 2007b	CWUCC. Direct Utility Avoided Cost Model. 2007. Available at: http://www.cuwcc.org/direct-utility-avoided-costs-environmental-benefits-models.aspx.
CUWCC 2007c	CWUCC. 2007. Environmental Benefits Model. April 2007. Available at: http://www.cuwcc.org/direct-utility-avoided-costs-environmental-benefits-models.aspx.
CUWCC-FSTC 2002	California Urban Water Conservation Council – Food Service Technology Center (CUWCC-FSTC). CUWCC-FSTC Pre-Rinse Spray Valve Specifications VS 1.0. 2002.
DeSena 1998	Desena, M. Irvine Ranch Water District Users Rate Structures to Spur Conservation. U.S. Water News, Vol. 15, No. 21. September 1998.
DRBC 2002	Delaware River Basin Commission (DRBC). Water Conservation Guidelines for Golf Courses, Updated. October 2002. Available at: http://www.state.nj.us/drbc/golfcourses.pdf.
Engineering Technologies Canada 2001	Engineering Technologies Canada. Evaluation of Ultra-Low Flow (6 Litre) Gravity Toilets in Two Schools. Prepared for Prince Island Department of Fisheries, Aquaculture and Environment. November 2001.

Reference	Bibliographic Citation
EPRI 2008	Electric Power Research Institute (EPRI). Program on Technology Innovation: Integrated Generation Technology Options. November 2008.
Fisher-Nickel 2005	Fisher-Nickel Inc. Evaluating the Water Savings Potential of Commercial "Connectionless" Food Steamers. Food Service Technology Center. Prepared for the Metropolitan Water District of Southern California and East Bay Municipal Utility District. June 2005.
Fisher-Nickel 2007	Fisher-Nickel Inc. Energy Efficiency Potential of Gas-Fired Commercial Hot Water Heating Systems in Restaurants – An Emerging Technology Field Monitoring Study. Food Service Technology Center. April 2007.
FSTC	Food Service Technology Center (FSTC). April 2003. Steamers. Available at: http://www.pge.com/003_save_energy/pdf/steamers.pdf.
Gentili 2003	Gentili, M. Water Conservation Topics. Presentation to Los Angeles Department of Water and Power. May 2003.
Hoffman and Riesenberger 2006	Hoffman, B. and J. Riesenberger. Commercial Laundry Conservation Technologies. Presented at the AWWA Water Sources Conference in Albuquerque, New Mexico. February 2006.
IPIECA 2005	International Petroleum Industry Environmental Conservation Association (IPIECA). Water Resources Management in the Petroleum Industry. 2005.
Koeller 2003	Koeller, J. Dual-Flush Toilet Fixtures—Field Studies and Water Savings, Revised. December 2003.
Koeller 2007	Koeller, JA Primer on HETs. February 2007. Available at: www.cuwcc.org/toilet_fixtures.lasso.
Lelic and Blair 2004	Lelic, F. S. and G. Blair. Saving Water While Conserving Energy: Initiatives for ICI Customers. AWWA Water Resources Conference Proceedings. 2004.
Loretitsch, Karajeh, and Mottin 2005	Loretitsch, G.A., Karajeh, F., and J. Mottin. The Hot and Cold of Recycling in Refineries. April 2005.
Metropolitan Water District of Southern California 2001	Metropolitan Water District of Southern California. Metropolitan Water District of Southern California Innovative Conservation Program – Water Saver/Plus Recycling System Final Report. Prepared by C&A X-Ray. September 2001.
MWD's Regional Urban Water Management Plan	Metropolitan Water District of Southern California. Regional Urban Water Management Plan. November 2005
Mills et al. 1996	Mills, E., et al. Energy Efficiency in California Laboratory-Type Facilities. California Institute for Energy Efficiency. July 1996.
NAICS codes	NAICS Codes 1997, 2002, 2007. Available at: http://www.census.gov/eos/www/naics/.
Natural Resources Canada 2004	Natural Resources Canada. Process Integration: A systems approach to optimal water management. February 2004.
Neelis, Worrell and Masanet 2008	Neelis, Maarten, Worrell, Ernst, and Masanet. Energy Efficiency Improvement and Cost Saving Opportunities for the Petrochemical Industry. Prepared for Ernst Orlando Lawrence Berkeley National Laboratory. 2008.

Reference	Bibliographic Citation
North Carolina DENR 1998	North Carolina Department of Environment and Natural Resources (DENR). 1998. Water Efficiency Manual for Commercial, Industrial, and Institutional Facilities. August 1998.
Occupational Safety and Health Administration	Available at: http://osha.gov/pls/imis/sic_manual.html.
OIT 1998	Office of Industrial Technologies. 1998. Steam Challenge. Available at: http://www.oit.doe.gov/steam.
OMB Circular No. A-94	Benefit-Cost Analysis of Federal Programs: Guidelines and Discounts. December 2008. Available at: http://www.whitehouse.gov.omb/agencyinformation_ciruculars_pdf/m09-07.pdf.
Pacific Institute 2003	Pacific Institute. Waste Not Want Not: The Potential for Urban Water Conservation in California. November 2003.
Polley and Polley 2000	Polley, G.T. and H.L. Polley. 2000. Design Better Water Networks. Chemical Engineering Progress 296 pp.47-52. February 2000.
Price Effects	Available at: http://dictionary.bnet.com/definition/price+effect.html.
Radgen and Blaustein 2001	Radgen, P. and E. Blaustein (eds.). Compressed Air Systems in the European Union, Energy, Emissions, Savings Potential and Policy Actions. Fraunhofer Institute, Karlsruhe, Germany. 2001.
Rosen and Gayer 2008	Rosen, H. S., & Gayer, T. *Public Finance* (8th ed.). Boston: McGraw-Hill/Irwin. 2008.
SBW 2007	SBW Consulting, Inc. and Koeller & Co. Pre-Rinse Spray Valve Programs: How are they really doing? December 2005.
Senevirante 2007	Senevirante, M. 2007. A Practical Approach to Water Conservation for Commercial and Industrial Facilities, Elsevier Butterworth-Heinemann, Oxford, UK.
Snow 2001	Snow, J. T. 2001. Water Conservation on Golf Courses. Water Right – Conserving Our Water, Preserving Our Environment Case Study 7, page 48. International Turf Producers Foundation.
Urban Water Management Plan	Urban Water Management Plan. Culver City, Golden State Water Company. December 2005.
U.S. Census Bureau	Available at: http://www.census.gov/epcd/ec97/brdg.
U.S. DOE-OIT 2002a	U.S. DOE-OIT (2002a). Steam System Opportunity Assessment for the Pulp & Paper, Chemical Manufacturing and Petroleum Refining Industries. Office of Industrial Technologies, U.S. Department of Energy, Washington, DC, USA. Downloaded from http://www1.eere.energy.gov/industry/
U.S. EPA 2008	U.S. EPA. Commercial Food Service Equipment Web Site, Best Practices Tool. 2008. Available at: http://www.energystar.gov/index.cfm?c=commercial_food_service.commercial_food_service.
Veritec Consulting 2002	Veritec Consulting. Dual-Flush Toilet Project, completed on behalf of Canada Mortgage and Housing Corporation. April 2002.

Reference	Bibliographic Citation
Water Efficiency Guide for Business Managers	DWR. Water Efficiency Guide for Business Managers and Facility Engineers. October 1994.
Western Policy Research 1996	Western Policy Research. Do Centrally Controlled Irrigation Systems Use Less Water? The Aliso Viejo Experience, prepared for the Metropolitan Water District of Southern California. 1996.
Worrell and Galitisky 2005	Worrell, E. and C. Galitisky. Energy Efficiency Improvement and Cost Saving Opportunities For Petroleum Refineries. Prepared for Ernst Orlando Lawrence Berkeley National Laboratory. 2005.
Xenergy 1998	Xenergy, Inc. Final Report: Commercial Lighting Market Effects Study. Oakland CA: San Diego Gas & Electric Company and Pacific Gas and Electric Company. 1998.