Greenhouse Gas Emissions, Energy Use and Emissions Reduction Potential

Report prepared for the

Sonoma County Water Agency

by the

Climate Protection Campaign
www.climateprotectioncampaign.org

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The Sonoma County Water Agency has undertaken many projects in recent years to make its operations more energy efficient and to switch its energy sources from fossil fuels to renewables. Results of these efforts may not be reflected in this report.

ACKNOWLEDGMENTS

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Executive Summary

The Sonoma County Water Agency is committed to reduce greenhouse gas (GHG) emissions from its operations. The Water Agency contracted with the Climate Protection Campaign to measure the amount of GHG emissions produced by its operations, and to make recommendations for emission reduction targets and strategies to achieve those targets. This report summarizes the results of this work. A companion report, "Greenhouse Gas Emissions from Water Supply Operations: Current Inventory and Potential Reductions," by Rosenblum Environmental Engineering, is also part of this work.

Greenhouse Gas Emissions Inventory Results

Total greenhouse gas emissions produced by Sonoma County Water Agency (SCWA or "Agency") operations in 2000 were 12,365 tons; in 2005 they were 22,217 tons representing an 80 per cent increase. Emissions spiked in 2005 due to the transition to Power and Water Resources Pooling Authority (PWRPA) as the primary power source and the unavailability of Western Area Power Administration (WAPA) hydropower in the first three months of 2005. As the graph that follows illustrates, GHG emissions can increase at the same time that energy use decreases due to changes in the source of power.

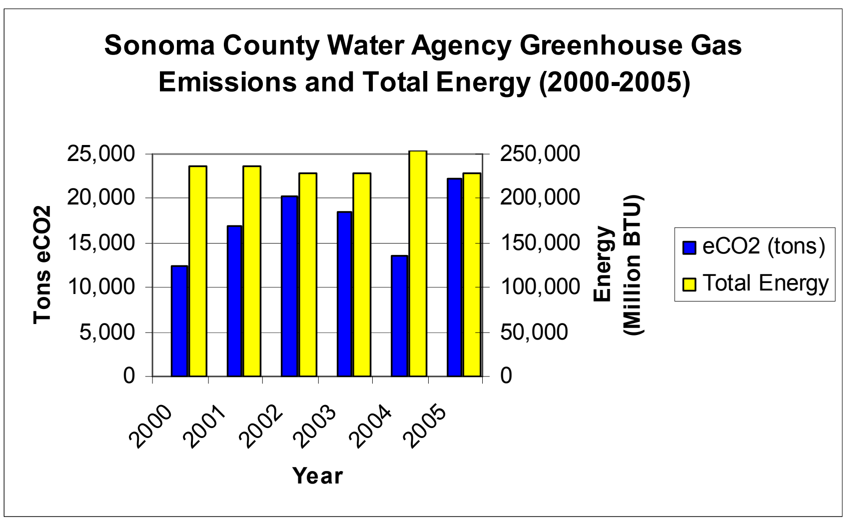

Figure 1

Energy and Emissions Study Results

This study[1] focuses on greenhouse gas emissions (GHG) from electricity used to pump water across SCWA's service area. Figure 2 shows that water-supply pumping represented 71 percent of SCWA's total GHG emissions in 2005.

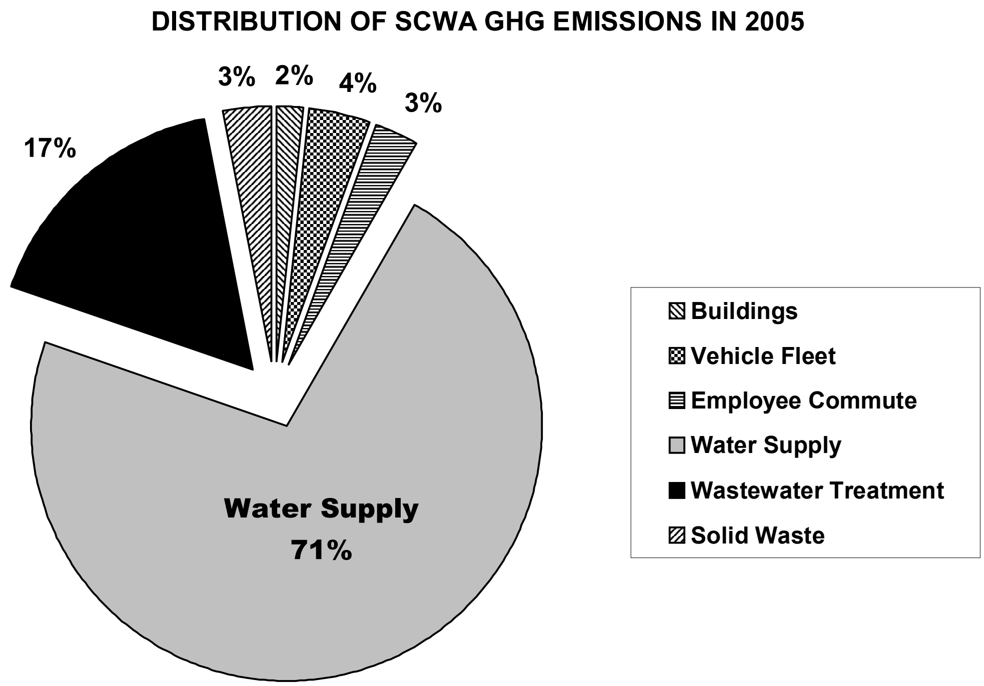

Figure 2

Baselines were derived for the annual water supply, electricity use, electricity cost, and GHG emissions (based on the fuel mix used to generate the electricity supplied to SCWA in 2005). Data from years 2004 and 2005 were used to derive these baselines, which are shown in Table 2, along with the unit values.

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[1] Sonoma County Water Agency Greenhouse Gas Emissions from Water Supply Operations: Current Inventory and Potential Reductions, Rosenblum Environmental Engineering, May 2007.

2005 Baseline Values for SCWA Operations

TOTAL WATER MG/yr	TOTAL ENERGY MWhr/yr	TOTAL COST $/yr	TOTAL GHG Ton-CO2/yr	ELECTRICTY RATE $/MWhr	UNIT ENERGY MWhr/MG	UNIT COST $/MG	UNIT GHG Ton-CO2/MG
21,200	56,800	$4,390,000	10,600	$77	2.7	$207	0.5

Table 1

Three pathways to significant GHG reduction

SCWA has made a commitment to reduce GHG emissions from its operations. The question that this study seeks to answer is: What actions will be required for SCWA to meet both the countywide GHG target of 25 percent reduction below 1990 levels by 2015, as well as the statewide target of 80 percent reduction below 1990 levels by 2050? Both of these targets are in line with the Fourth Assessment of the Intergovernmental Panel on Climate Change[2] of emissions reduction required to "avoid dangerous anthropogenic interference in the climate (stabilization of atmospheric carbon dioxide at less than 500 ppm)."

The study evaluates and quantifies the potential for reducing GHG emissions by estimating reductions in energy use from three approaches or pathways:

- Improving equipment and aqueducts
- Optimizing pump/storage operations for peak power reductions
- Improving water efficiency throughout the service area to reduce the need for pumping

End-use water efficiency significantly affects SCWA emissions

The study compares the effect on SCWA GHG emissions of three end-use water efficiency scenarios for 2020 with the 2005 baseline. The three scenarios are:

- **Standard Efficiency** is based on SCWA's current conservation target of 9,200 acre-feet per year (AF/yr). This scenario includes implementation of all the California Urban Water Conservation Council's Best Management Practices (BMPs).

[2] *Climate Change 2007: Mitigation of Climate Change Summary for Policy Makers*, Page 23. http://www.ipcc.ch/SPM040507.pdf

- **Available Efficiency** is based on the Pacific Institute recommendations[3] and includes off-the-shelf equipment and controls, proven designs, and readily available services considered economically feasible at a $600/acre-feet (AF) average life-cycle cost for new water supply. The average reduction from efficiency measures across SCWA's service area and all user sectors would be 38 percent of the 2020 supply that would have been required without efficiency measures.
- **GHG Target Efficiency** or ***GHG Reduction Optimized Efficiency***[4]reduces SCWA GHG emissions by 70 percent. The average water use reduction required from end-use efficiency measures across SCWA's service area and all user sectors would be 51 percent of the 2020 supply that would have been required without efficiency measures. Since the reduction is so large, feasibility must be confirmed with demand-side analyses. Another study is being conducted by Climate Protection Campaign that is intended to be a companion report for the City of Santa Rosa.

Note: Electrical power reductions of 12 percent from pump/drive efficiency improvements, optimization of operations to reduce peaks, and transmission system improvements implemented in the Water Supply, Transmission, and Reliability Project (Water Project) are included in all the scenarios.

Figure 3 summarizes changes in water demand, electricity use, electricity costs, and GHG emissions for the three scenarios described above. All of these parameters increase for the Standard Efficiency scenario, while all parameters are reduced for the two other scenarios. It must be noted that *without* the water and energy efficiency measures that are included in Standard Efficiency scenario, the increases in these four areas would have been much larger: 45 percent for water; 77 percent for energy; 100 percent for cost; and 150 percent for GHG emissions.

The main points summarized in Figure 3 are:

- Current water supply plans will lead to a 62 percent <u>increase</u> in GHG emissions by 2020, while additional water efficiency could <u>decrease</u> GHG emissions 43 to70 percent.

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[3] *Waste Not, Want Not: The Potential for Urban Water Conservation* , Pacific Institute, 2003.

[4] Required to achieve the 70 percent or more reduction in GHGs estimated to be required by the Intergovernmental Panel on Climate Change to stabilize atmospheric carbon dioxide.

- Current water supply plans will be accompanied by a nearly three-fold increase in energy costs by 2020, while additional demand-side water efficiency could even stabilize energy costs at 2005 levels (the 48 percent increase for the Available Efficiency scenario would still save $6 million per year compared to the current plan, and cost stabilization under the GHG Target Efficiency scenario would save $8.2 million per year).

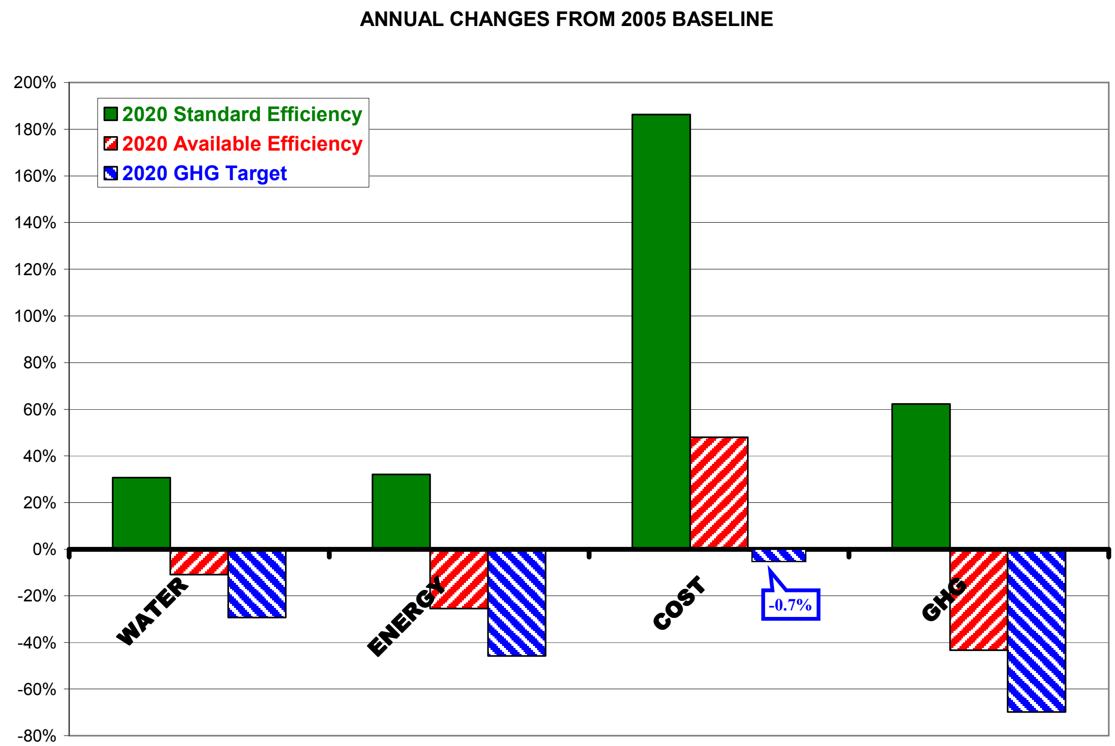


Figure 3

It is important to note that the additional water efficiency scenarios examined in this report are not the only means to reducing GHG emissions and costs.

Other methods for SCWA to reduce GHG emissions include:

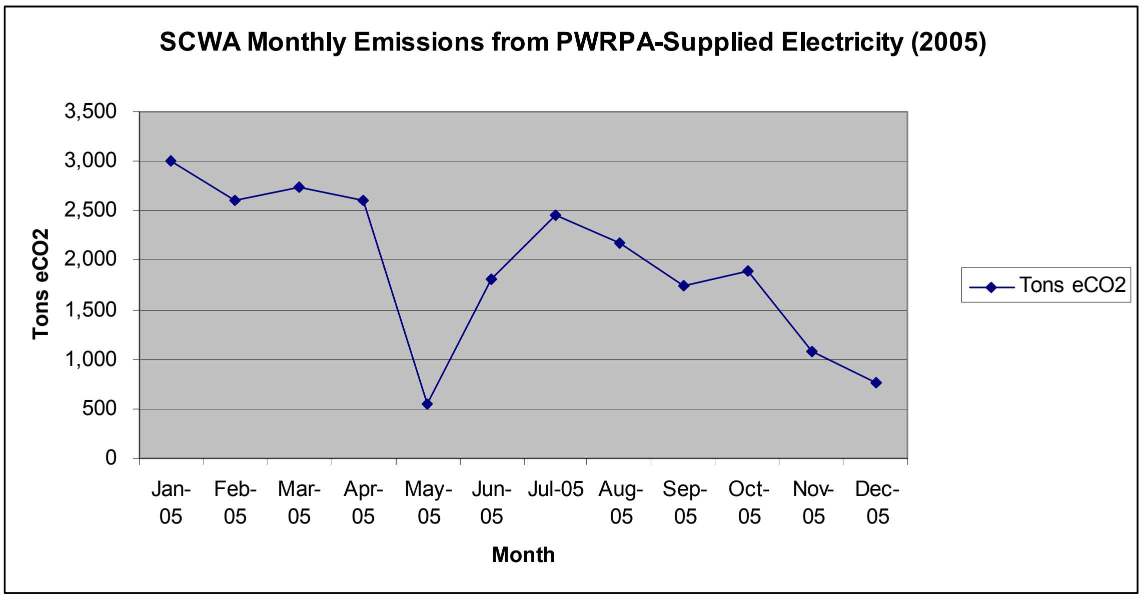
- Additional energy efficiency beyond 12 percent
- Displacement of potable water with recycled water

- Procurement of additional electricity from renewable resources[5]

The bottom line is that finding cost-effective combinations of methods to reduce GHG emissions should be part of all current and future project designs.

Hydropower: Advantages and drawbacks

SCWA's GHG emissions are very sensitive to the availability of hydropower from the Western Area Power Agency (WAPA). Maximum hydropower is available in May with zero GHG emissions; then hydropower falls off during subsequent summer months, and GHG emissions increase — just as SCWA's energy demands for water pumping increase (see Figure 4). The very large reduction in water demand called for in the GHG Target Efficiency scenario is the only way for SCWA to potentially get by with only hydropower from May through August, with zero GHG emissions and no need to purchase fossil-fueled market power. Otherwise, additional non-emitting resources are required.



[5] These methods were not evaluated or included in cost comparisons. No assumptions were made about the availability or cost of obtaining additional renewable resources. However, strategies such as Community Choice Aggregation might allow SCWA to obtain electricity from new renewable resources at a competitive cost.

Figure 4

In 2005, very little WAPA hydropower was available in January, February, and March, causing relatively high GHG emissions. It is possible that, in other years, more hydropower will be available in these months. If so, the increased hydropower would reduce annual GHG emissions.

The combination of water and energy efficiency measures with other renewable energy sources besides WAPA hydropower could result in very much lower GHG emissions, and lower costs, by 2020. It is also important to note that large-scale hydropower such as WAPA's is not eligible for renewable resource funding from the State of California. Eligible renewables could be cost-effectively developed locally by SCWA in conjunction with a load aggregation program such as Community Choice Aggregation.

Figure 5 shows the breakdown between hydropower and market power for each of the efficiency scenarios, based on the assumption that WAPA hydropower energy supplied to SCWA in each month will remain the same as in 2005. This might not be the case, especially in drought years, so creating a portfolio of additional renewable resources will not only replace market power, but will also provide a safeguard against climate impacts on hydropower.

ANNUAL ENERGY FROM WAPA HYDROPOWER AND MARKET PURCHASES

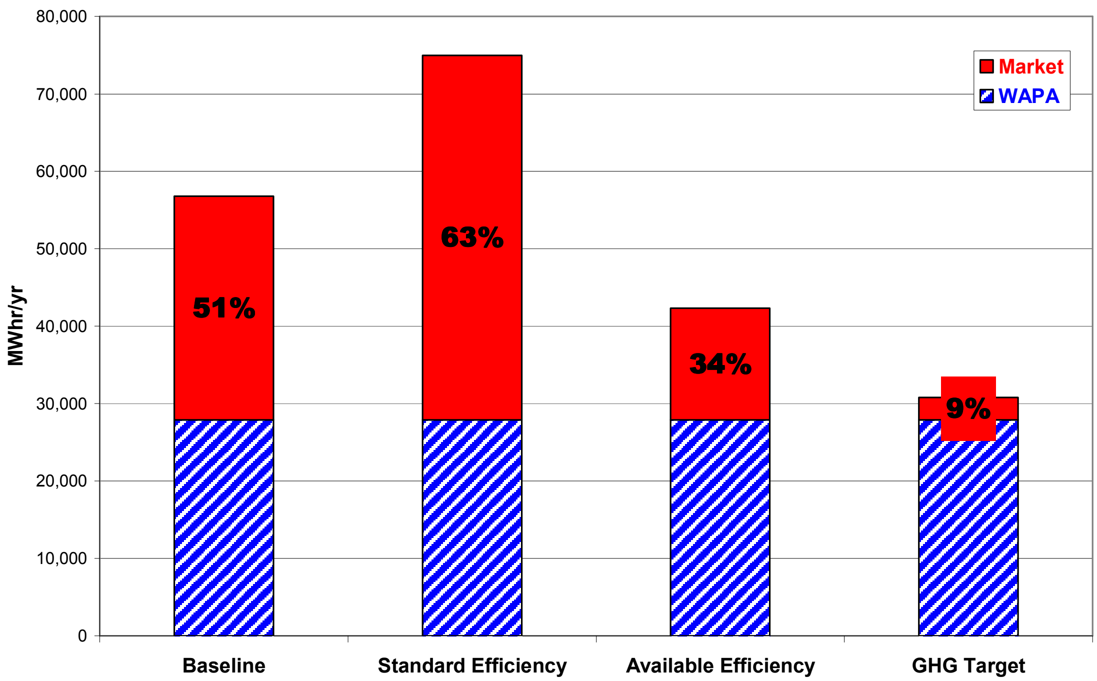


Figure 5

Far lower life-cycle costs, and even net savings, are expected if regional end-use energy savings and wastewater processing energy savings are included in the calculations. This will be demonstrated in a companion study for the City of Santa Rosa, which will estimate implementation costs and performance for the efficiency measures, with their end-use and wastewater savings, and displacement of potable water with recycled water.

Introduction

The Sonoma County Water Agency (SCWA or "Agency") is committed to a process to reduce greenhouse gas (GHG) emissions from its operations. This process has five steps:

1. Conduct a baseline inventory
2. Set an emissions reduction target
3. Create a plan for reducing emissions
4. Implement the emissions reduction plan
5. Monitor emissions

The Water Agency contracted with the Climate Protection Campaign to measure the amount of GHG emissions produced by its operations, and to make recommendations for emission reduction targets and strategies to achieve those targets.

Greenhouse Gas Emissions Inventory

The GHG inventory conducted for the Agency by Climate Protection Campaign covered the following sectors of operations:

- Buildings
- Vehicle Fleet
- Employee Commute
- Water/Wastewater
- Solid Waste

Electricity use, natural gas use, fuel use, and solid waste disposal numbers were used to compute GHG emissions. Data from the years 2000–2005 was used for the inventory, although only data from the baseline year (2000) and emissions study year (2005) are presented here.

Inventory Results

For the year 2000, baseline inventory results are shown in Table 2 and Figure 6.

Sector	Equiv CO2 (tons)	Equiv CO2 (%)	Energy (million Btu)	Remarks
Buildings	379	3.1	4,325	Electricity and natural gas
Vehicle Fleet	946	7.7	11,016	Diesel and gasoline*
Employee Commute	762	6.2	8,896	71,168 gallons gasoline
Water/Wastewater	9,583	77.5	212,000	62,115,913 kWh (PG&E, WAPA)
Waste	694	5.6		Biosolids and green waste
Total	12,365	100.0	236,236	

Table 2

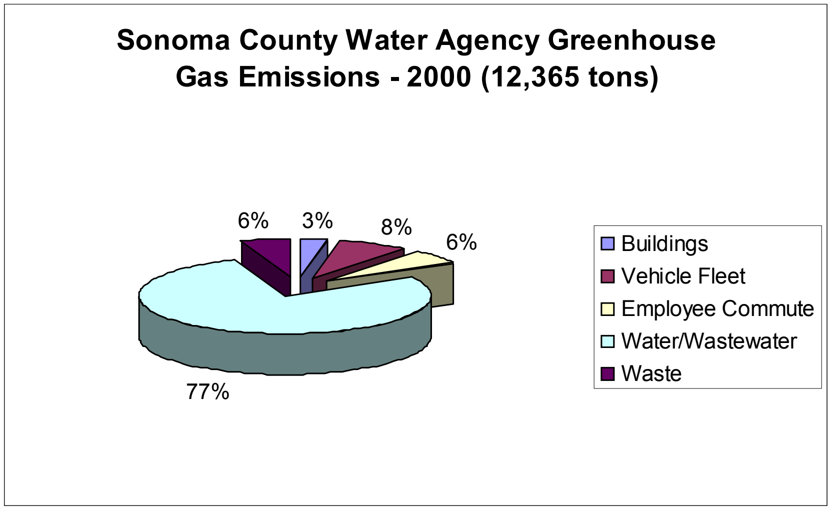


Figure 6

For 2005 (the example emissions study year), inventory results are shown in Table 3 and Figure 7 below.

Sector	Equiv CO2 (tons)	Equiv CO2 (%)	Energy (million Btu)	Remarks
Buildings	553	3	6,501	Electricity and natural gas
Vehicle Fleet	946	4	11,016	Diesel and gasoline
Employee Commute	668	3	7,800	63,934 gallons gasoline
Water/Wastewater	19,307	87	203,650	59,669,487 kWh (PWRPA & PG&E)
Waste	743	3		
Total	*22,217*	*100*	*228,967*	

Table 3

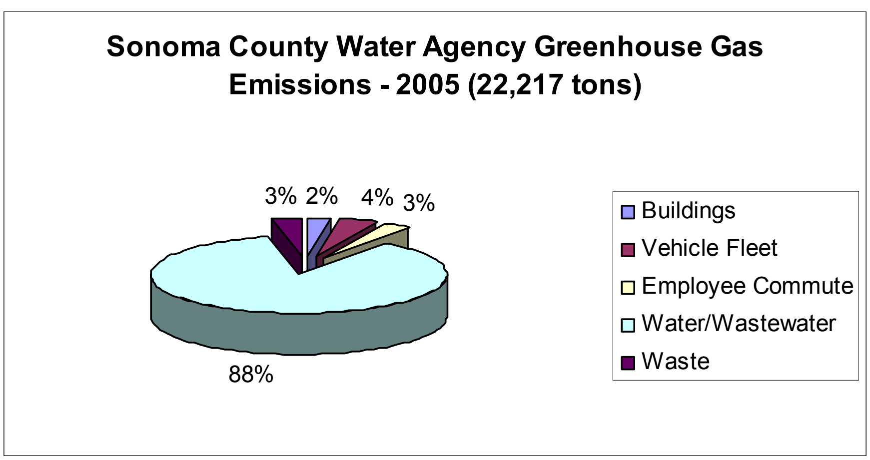


Figure 7

Comparative Analysis of Baseline and Current Years

The overall energy use by SCWA in all sectors decreased by about 3 percent comparing 2000 and 2005, but the GHG emissions increased by almost 80 percent. The two sectors that increased the most in GHG emissions are the Building Sector (379 tons in 2000; 553 tons in 2005) and the Water/Wastewater Sector (9,583 tons in 2000; 19,307 tons in 2005). The change in the Building Sector was caused by the construction of the new administration building on Airport Boulevard. However, the change in the Water/Wastewater Sector, which accounts for the majority of the increase overall, was caused by the change in the power provider from WAPA and PG&E to Power and Water Resources Pooling Authority (PWRPA).

The Change in the Water/Wastewater Sector

The GHG emissions caused by operations in the Water/Wastewater Sector increased by almost 10,000 tons, or more than double, in 2005 compared to 2000. The indirect emissions from electricity use resulted from the consumption of 62,115,913 kWh for water supply and wastewater operations in 2000. In 2005, emissions resulted from the consumption of 59,669,487 kWh. The energy use is fairly directly related to water deliveries. Specifically, the operation of the Wohler pumps (44,777 MWh in 2000; 38,965 MWh in 2005) accounts for most of the energy use by the Agency.

Although the Wohler pumps used less electricity in 2005 vs. 2000, GHG emissions from this electricity use more than doubled. There are two factors in this increase: (1) the reduced availability of WAPA hydropower and (2) the acquisition of GHG-producing market power[6] by PWRPA.

Water/Wastewater GHG Emissions Profile

From 2000 through 2004, the Agency purchased energy from Western Area Power Administration (WAPA) for the Wohler Road pumping installation, the largest energy user for the Agency. WAPA supplies hydroelectric power primarily from federal dams in the Central Valley. Except for 2000,[7] all the remaining energy needs of the Agency were filled by PG&E. In addition, any shortfall in the energy requirement of the Agency was "backstopped" by PG&E. If the available hydropower fell below the required energy level, the necessary excess would be supplied by PG&E.

This made the emissions profile of the Agency dependent on the availability of hydroelectric power. Less hydroelectric power (which is zero emissions) in 2001, 2002, and 2003, meant more PG&E power. This accounts for the increase in emissions in those years, even though the energy use was the same or less than 2000. Figure 8 shows the increase in emissions, even as energy use decreased.

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[6] Market power is electricity that is purchased on the "day ahead" or "spot" electricity market. This market is where additional electricity can be purchased. PWRPA uses these market purchases to make up for shortfalls in hydroelectric power.

[7] Energy was purchased from Constellation New Energy in 2000.

In 2005, the Agency joined the Power and Water Resources Pooling Authority (PWRPA). All of the largest energy users in the Agency were transferred to PWRPA, while the smaller accounts remained on PG&E. All of the WAPA power formerly applied only to Wohler was now distributed among all the large energy users. Additional energy, beyond what was available from WAPA, was purchased by PWRPA through various power marketers, including Coral Energy and Calpine. The overall effect on emissions was a large GHG increase in 2005 because the market power purchased by PWRPA is much "dirtier" (higher GHG emissions) than PG&E. Where PG&E power has an emissions coefficient of 0.73 lbs eCO_2/kWh, market power has an emissions coefficient of 1.39 lbs eCO_2/kWh[8].

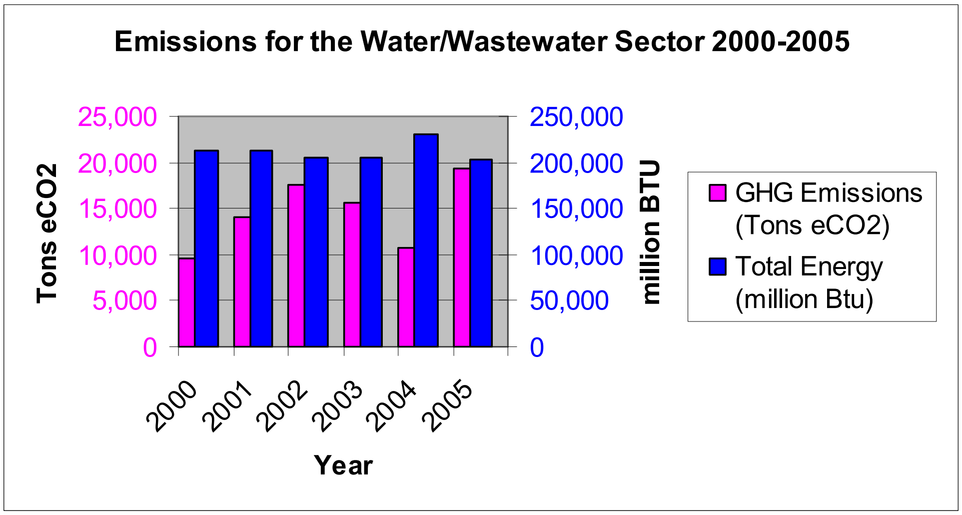


Figure 8

Inventory Summary

Since 2000, greenhouse gas emissions from Agency operations have been largely dependent on the availability of hydroelectric power from WAPA. When power purchasing was switched over to PWRPA, the "dirtier" power purchased on the market displaced "cleaner" power from PG&E. This nearly doubled emissions in 2005 from the baseline year, 2000.

[8] Based on Coral Energy Power Content Label for 2005: 5 percent Eligible Renewables, 38 percent Coal, 24 percent Large Hydroelectric, 33 percent Natural Gas.

Setting a GHG Emissions Reduction Target

An emission reduction target can be expressed either as an intensity goal[9] or as an absolute reduction goal. In order to be consistent with reduction targets set by local governments in Sonoma County, only an absolute reduction target is considered. This target is expressed in the following way: "X percent reduction below baseline year Y emissions by target year Z." In this report, we use year 2000 as a baseline year. This is consistent with the baseline year used by the local governments in Sonoma County.[10]

Target Setting Process

The process of setting a target can be expressed as follows:

1. Determine strategies for GHG reduction
2. Quantify electrical energy and GHG reductions from various strategies
3. Quantify financial effect of various strategies
4. Determine GHG target
5. Identify steps required to achieve target
6. Identify risks to achieving target

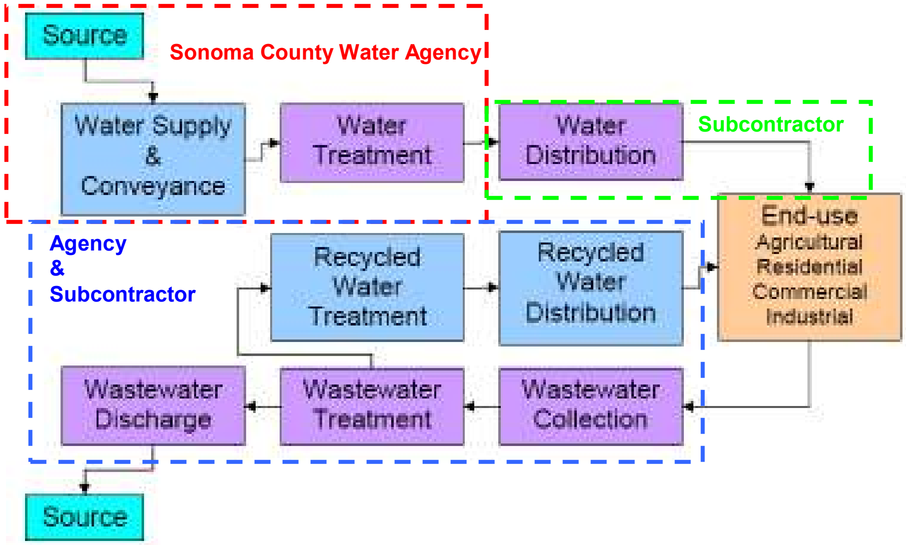
In the following sections, we present the results of each step of this process. We begin with an overview of the relationship between energy, water use, and greenhouse gas emissions.

Overview

Energy, water, and greenhouse gas emissions are integrally related. At each stage in the California Water Use Cycle, shown in Figure 9 below, energy is used, and greenhouse gas emissions occur as a result of the energy use.[11]

[9] An intensity goal uses a metric called the "greenhouse gas intensity", which is the amount of greenhouse gas produced per unit of production or revenue.
[10] AB 32, California's new greenhouse gas emissions control law, sets a target of reducing emissions statewide to 1990 levels by 2020. It is likely, but not certain, that "upstream" emitters will be capped. This means that electricity producers will probably be subject to the cap, but not consumers. This will raise the cost of electricity and fossil fuels generally, which increases the strategic value for large energy consumers of setting aggressive reduction targets.
[11] *California's Water-Energy Relationship, California Energy Commission Final Staff Report, 2005*: http://energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF

Figure 9



Energy is used, and corresponding greenhouse gas emissions occur, at different levels throughout this cycle. Table 4 below shows the amount of energy used in each portion of the cycle, along with the percentage of the total energy used in California.

Table 4

	Electricity (GWh)	Natural Gas (Million Therms)	Diesel (Million Gallons)
Water Supply and Treatment			
Urban	7,554	19	?
Agricultural	3,188		
End Uses			
Agricultural	7,372	18	88
Residential	27,887	4,220	?
Commercial			
Industrial			
Wastewater Treatment	2,012	27	?
Total Water Related Energy Use	48,012	4,284	88
Total California Energy Use	250,494	13,571	?
Percent	19%	32%	?

As Table 4 shows, the portions of the Water Use cycle that the Sonoma County Water Agency (SCWA) and its subcontractors are concerned with represents 26.5 percent of the electricity and 1 percent of the natural gas use. This is about 11 percent[12] of the total

[12]Total greenhouse gas emissions from water-related energy use are calculated using standard statewide coefficient for electricity use, and standard coefficients for natural gas and diesel combustion. Using these coefficients, total greenhouse gas emissions are 44,790,580 tons. SCWA and its subcontractors are

greenhouse gas emissions associated with electricity, natural gas, and diesel use in the Water Use Cycle. This is important to keep in mind when evaluating GHG reduction measures. End-use water reduction will reduce energy use and emissions in the End Uses portion of the Water Use Cycle. There is also a ripple-through effect that will reduce emissions in the other sectors of the Cycle.

The operations of the SCWA represent the Water Supply and Conveyance portion of the cycle in Sonoma County, as well as providing the Wastewater Treatment/Recycled water portions of the cycle for some areas. The focus of this report is on the water supply-side activities of the Agency, which constitute the majority of its energy use and greenhouse gas emissions.

To provide a demand-side perspective to this supply-side report, a companion report[13] is also being prepared for GHG reductions for Santa Rosa's water and wastewater operations (Santa Rosa uses 36 percent of SCWA's annual supply). The overall intent of both reports is to consider the feasibility and effectiveness of GHG-reductions throughout the entire water cycle, from river extraction through customer use to wastewater treatment, discharge, and reclamation. This approach allows consideration across jurisdictional boundaries, and the combination of private and public costs and benefits. For example, customer (demand-side) energy savings resulting from water efficiency improvements will be two to three times higher than savings from decreased water supply pumping, greatly multiplying regional GHG reductions from SCWA's water efficiency efforts.

Summary of Energy and Emissions Study Findings

The full report[14] prepared for the Agency discussing energy use, greenhouse gas emissions, and the feasibility and cost of various emission reduction targets is available under separate cover as "Sonoma County Water Agency Greenhouse Gas Emissions from Water Supply Operations: Current Inventory and Potential Reductions" November 1, 2006, by Rosenblum Environmental Engineering.

Introduction to Study

SCWA delivers water to urban water agencies in Sonoma and Marin counties from the Russian River.

SCWA's maximum demand from its customers is 68,200 acre-feet per year (AF/yr)[15] while current average demand is 65,200 AF/yr.[16] Because a 2 percent annual population

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concerned with the Water Supply and Treatment and Wastewater Treatment portions of the cycle. The emissions from these portions of the Water Use cycle are 4,938,110 tons. This represents 11 percent of the total.

[13] Funded by City of Santa Rosa

[14] Prepared by John Rosenblum, PhD, Rosenblum Environmental Engineering

[15] This is the total <u>current</u> Reasonable Annual Need defined in *Description of Model that Calculates the Allocation of Water Available to Sonoma County Water Agency for Its Customers During a Water Supply Deficiency Taking Demand Hardening into Account*, April 4, 2006, by John Olaf Nelson Water Resources Management for the 11th Restructured Water Supply Agreement (JONWRM Model).

[16] Average annual deliveries for 2004 and 2005, from SCWA records.

growth is predicted in the service area, SCWA has initiated the Water Supply, Transmission, and Reliability Project (Water Project) to satisfy a maximum demand of 94,100 AF/yr by 2020.[17] This represents a 44 percent increase over SCWA's 2005 water deliveries.

If no measures are taken that reduce greenhouse gas emissions, the increased energy use to deliver additional water will result in dramatically increased (109 percent above 2005 baseline) greenhouse gas emissions by 2020.

One of the key objectives of the energy and emissions study was to identify the most cost-effective, "biggest bang for the buck" measures to reduce greenhouse gas emissions by Agency operations. Greenhouse gas emissions reduction must occur while population is increasing in the service territory. Given these factors, our study began by looking at the following areas:

- Pumping, conveyance, and storage infrastructure
- Operations methodologies
- Electric power purchasing practices
- Water system energy intensity (unit-energy per unit-of-water-delivered)

Key Findings of Energy and Emissions Study

- 17 percent emissions reduction[18] feasible in water system operations through efficiency improvements
- Change in power purchasing practices increased emissions from 2004 to 2005
- Future water demand increases will increase emissions, given current power supply fuel mix,[19] even if system efficiency is improved
- Decreasing end-user water demand is the most cost-effective way to significantly decrease Agency GHG emissions

Other findings of the target setting study:

- Future power supply fuel mix to the Agency may become more "GHG-intense" (more GHG emissions per kWh) if hydropower availability decreases
- Comparison of current per capita water use in Agency service territory with American Water Works Association (AWWA) (1999) average[20] indicates significant potential for reductions

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[17] This is the total future Reasonable Annual Need defined in the JONWRM Model.
[18] 17 percent emissions reduction corresponds to a 12 percent reduction in energy use. The non-linear relationship is due to the use of a greater percentage of hydropower as the overall energy requirement decreases. Please refer to companion technical report for details.
[19] Power supply fuel mix is the mix of fuels used to generate electric power (e.g., hydro, natural gas, coal, etc.)
[20] Mayer, DeOreo, Opitz, Kiefer, Davis, Dziegliewski, and Nelson, *Residential End Uses of Water*, AWWA Research Foundation, 1999

- Actual programs in areas with similar per capita water use have achieved significant reductions in water use (Seattle, 37 percent reduction)
- Aggressive water efficiency programs leverage GHG emissions reductions due to reductions in transmission energy as a result of decreased water heating energy use by end user

Strategies for Reducing GHG Emissions

Based on the findings listed above, the study identifies the following strategies for significantly reducing GHG emissions from SCWA water supply operations.

Improve System Efficiency through Pump, Aqueduct and System Management Improvements

- All pumps and motors should be evaluated for efficiency and should be upgraded to more efficient models if necessary
- Reduce friction in aqueducts[21]
- Manage the combination of pumps used at any time to minimize energy use for different zone and aqueduct demands
- Manage pump and storage scheduling so pumps are run less with high flows[22]
- Improve coordination with contractors (e.g., by sharing real-time system operation data [Supervisory Control and Data Acquisition])

Reduce Pumping Energy Use by Reducing Water Demand

Investments in aggressive demand-side solutions to reduce potable water use compare favorably with infrastructure expansion in terms of dollars-per-unit volume of water delivered. This concept is similar to the familiar “negawatts” of energy efficiency (i.e., cutting energy use by efficiency improvements is more cost effective per unit of energy than increasing generation capacity). This study shows that the cost per unit GHG reduction is lowest for demand-side reduction measures, when the additional GHG reduction from end-use energy reduction is considered.

Increase Renewable Power Purchases

There are interesting options available for increasing renewable power purchases. One example might be to leverage the market power of aggregated demand to negotiate long-term contracts with renewable power developers. This could result in an incentive to develop local power resources.

[21] Aqueduct improvements are included as part of the Water Project.
[22] Pumping and storage management to reduce high flows “spreads” the pumping energy use

Summary Discussion of Strategies

There are three principal pathways to GHG emissions reduction for the Agency:

1. Energy efficiency improvements and peak-power reduction opportunities for the Russian River supply pumps, storage tanks, and the booster pumps
2. Obtaining electricity from sources with lower unit GHG emissions
3. Conveyance energy reductions resulting from water efficiency improvements throughout the service area that lower the overall demand for water

Emissions Reductions through Energy Efficiency Improvement

This study found that the current water system "wire-to-water"[23] efficiency was high, averaging 62 percent over all flow rates. Wire-to-water efficiency could be improved, according to a 2003 study[24], by:

- Improving the efficiency of individual pumps
- Relieving piping constraints
- Changing booster pumping schedules

Improving system efficiency to 70 percent, for example, could reduce energy use by 12 percent. SCWA is already involved in making some efficiency upgrades. Piping constraint relief depends on the Water Project for implementation

Emissions Reductions through Load Management

There are potential emission reductions available through load management to reduce maximum flow rates. Increasing water demand results in much larger increases in power demand, and load management will reduce both maximum flow rates and power demand.

Use of Hydroelectric and Other Non-Emitting Electricity Sources

The primary non-emitting electric energy source for the Agency has been Western Area Power Administration (WAPA) hydroelectric power. To the extent that the Agency can work with its power buying partners to buy more electricity generated by non-fossil-fuel-powered generators, the GHG emissions caused by electricity use will be reduced.

In 2005, 54 percent of the energy supplied to the Agency from PWRPA was from hydroelectric resources. PWRPA projects that the percentage of hydropower it will supply in 2006 will be higher, possibly as high as 70 percent.. However, hydroelectric availability varies considerably from year to year. For example, in 2002, WAPA hydroelectric power only accounted for less than 16 percent of the total energy used in the Water and Wastewater operations of the Agency.[25]

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[23] Total electric energy used for pumping vs. total volume of water delivered

[24] *Energy Efficiency Study of the Sonoma County Water Agency's Russian River Pumping System, Provimetrics, Corp.,* April 2003

[25] 9,442,911 kWh supplied by WAPA, out of a total of 60,017,286 kWh used in Water Supply and Wastewater operations.

Emission Reduction Potential in Water Demand Reduction

The emission reduction potentials from three end-use water efficiency scenarios for 2020 were compared with a 2005 baseline. These three efficiency scenarios are based on increasingly aggressive end-use water conservation policy with increasing demand reduction effects:

- **Standard Efficiency** is based on SCWA's current conservation target of 9,200 AF/yr (10 percent of 2020 supply) for water conservation, including all the California Urban Water Conservation Council's Best Management Practices (BMPs). Energy efficiency benefits from transmission system improvements are also included in this option.
- **Available Efficiency** is based on the Pacific Institute's November 2003 report *Waste Not, Want Not: The Potential for Urban Water Conservation*. This includes off-the-shelf equipment and controls, proven designs, and readily available services considered economically feasible at a $600/acre-feet (AF) average life-cycle cost for new water supply. The average reduction from efficiency measures across SCWA's service area and all user sectors would be 38 percent of 2020 supply.
- **GHG Target Efficiency** or ***GHG Reduction Optimized Efficiency*** is based on achieving a target of 70 percent GHG reductions by 2020.[26]. The average water use reduction required from efficiency measures across SCWA's service area and all user sectors would be 51 percent of 2020 supply. Since the water use reduction required is so large, feasibility must be confirmed with demand-side analyses, which is the intent of the companion report for Santa Rosa.[27]

These three water efficiency scenarios are compared in the following sections on the basis of relative energy cost savings, energy demand reduction, and water delivery reductions.

Comparison of End Use Water Efficiency Scenarios

SCWA has included end-use water efficiency improvements in its plan for 2020. This study refers to the Agency's currently planned level of water efficiency as "Standard Efficiency." Figure 10 summarizes the improvements in water, energy, cost, and reduction in GHG emissions resulting from the Agency's planned "Standard Efficiency" scenario over a "No Efficiency" scenario.

[26] According to the Intergovernmental Panel on Climate Change (IPCC) (http//:www.ipcc.ch), this reduction target is required to stabilize atmospheric carbon dioxide concentration at a level that avoids dangerous anthropogenic interference in the climate. The Sonoma County communitywide target, adopted by the Sonoma County Board of Supervisors, is 25 percent reduction below 1990 levels by 2015. The State of California has adopted a target of reduction to 1990 levels by 2020. The governor of California has issued an executive order directing the state to reduce emissions to 80 percent below 1990 levels by 2050.

[27] This report is due to be released Fall 2007.

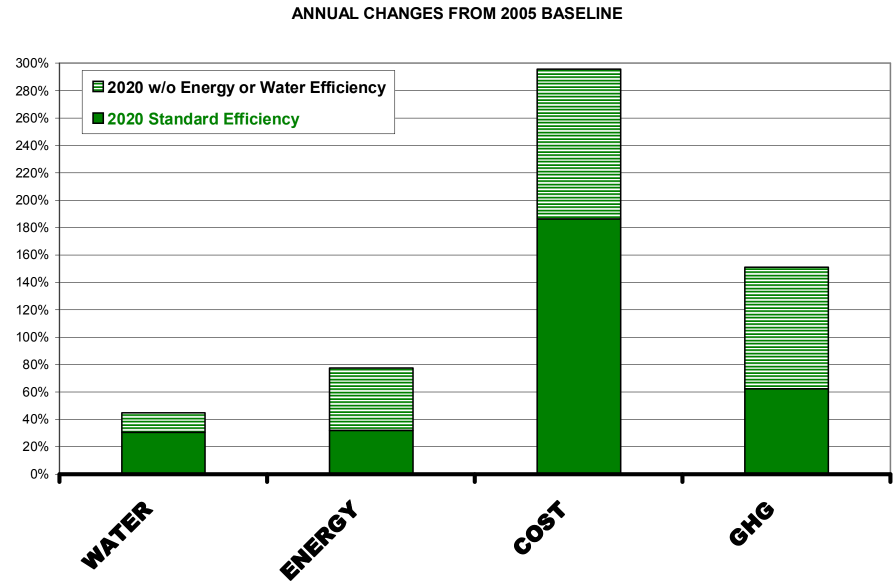

Figure 10

Figure 11 shows the comparison between the three end-use efficiency scenarios in terms of water deliveries, energy use, cost, and GHG emissions. In this comparison the three scenarios are normalized to the 2005 baseline.

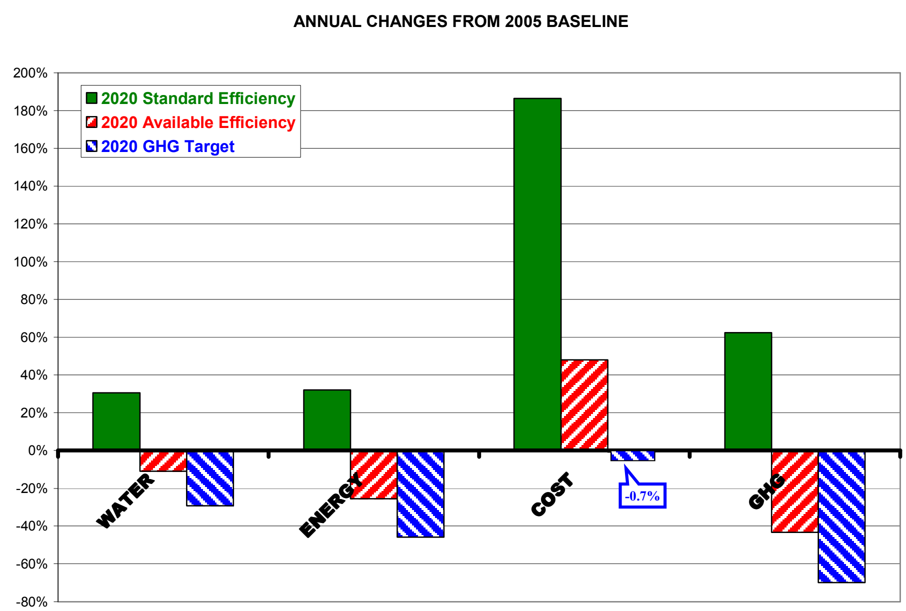

Figure 11

Monthly Energy Cost Reduction Comparison

Figure 12 compares *monthly energy costs* in 2020 to the 2005 baseline.

Finding: The Standard Efficiency scenario will be accompanied by a nearly three-fold increase in energy costs by 2020, but costs would have quadrupled without the energy and water efficiency measures already included in Agency planning. The 48 percent increase for the Available Efficiency scenario will still save $6 million per year compared to the Standard Efficiency scenario. Cost stabilization (i.e., the 0.7 percent reduction) under the GHG Target Efficiency scenario will save $8.2 million per year compared to the Standard Efficiency scenario.[28]

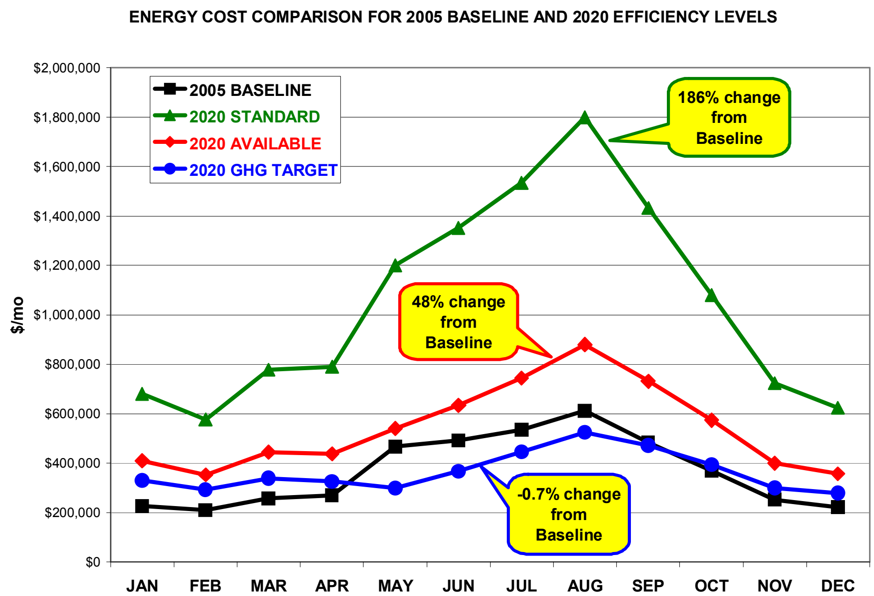

Figure 12

Monthly Energy Demand Reduction Comparison

Figure 13 compares *monthly energy demand* in 2020 to the 2005 baseline.

Finding: Both the Available and GHG Target efficiency scenarios reduce annual energy demand below the baseline.[29]. The 32 percent increase in annual energy use for the Standard Efficiency option is larger than the increase in water deliveries, but Figure 10 shows that energy use would have been 77 percent higher than the baseline without water efficiency.

[28] The end-use efficiency improvements required to achieve this level of water demand reduction are cost-effective for the customer. Although beyond the scope of this report, the companion report being prepared for the City of Santa Rosa quantifies the cash flow for the customer using an on-bill financing system.

[29] The energy reductions in winter months are very small, reflecting the "flattening" of the energy-flow correlation in Figure 13.

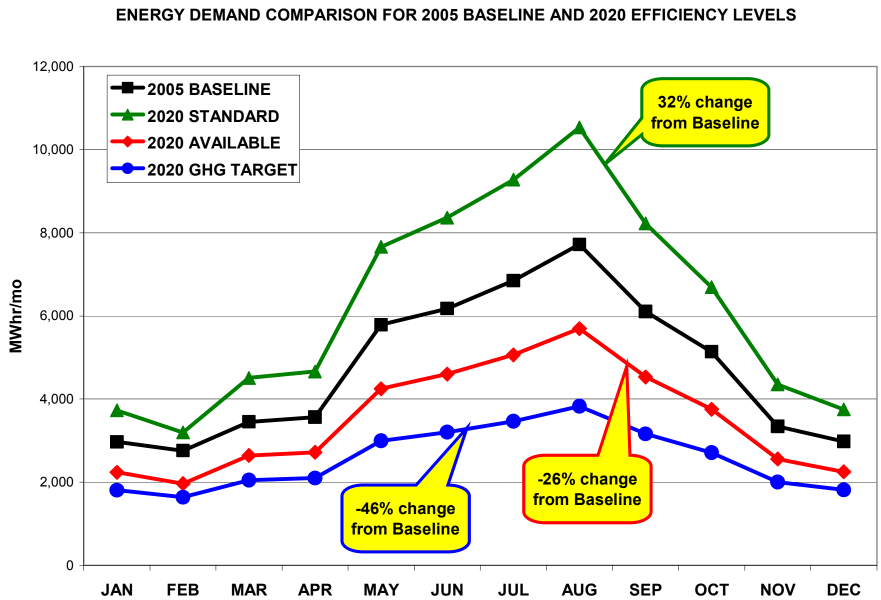

Figure 13

Monthly Water Delivery Reduction Comparison

Figure 14 compares *monthly water deliveries* in 2020 to the 2005 baseline.

Finding: Both the Available and GHG Reduction Optimized efficiency scenarios reduce water deliveries below the baseline, and even though water deliveries are 30 percent larger for the Standard Efficiency option, they would have been 44 percent higher without efficiency.

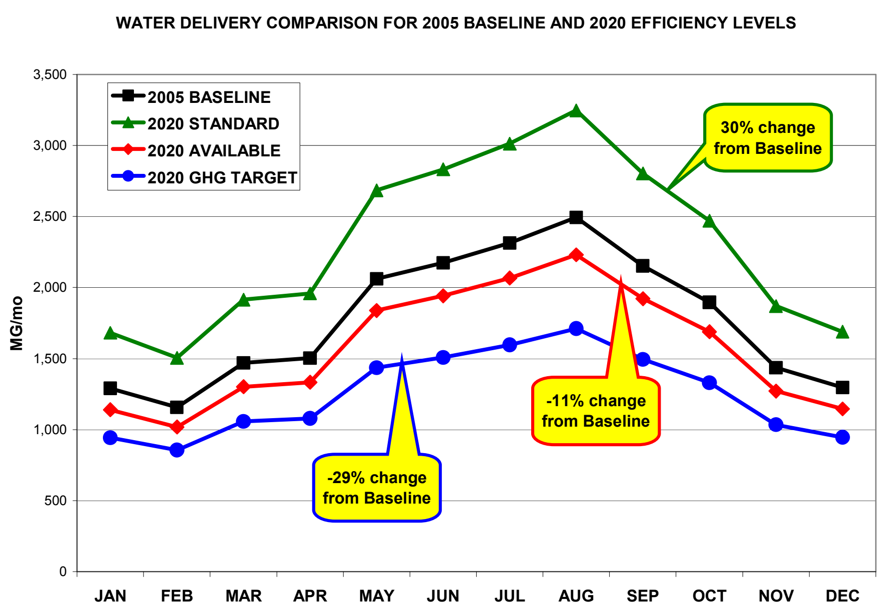

Figure 14

GHG Emissions Reduction Comparison

Figure 15 compares *monthly GHG emissions* in 2020 to the 2005 baseline.

Finding: Both the Available and GHG Target efficiency scenarios reduce GHG emissions significantly below the baseline. The 62 percent increase of GHG emissions for the Standard Efficiency is still significantly below the 151 percent increase shown in Figure 10 that would have occurred without water efficiency.

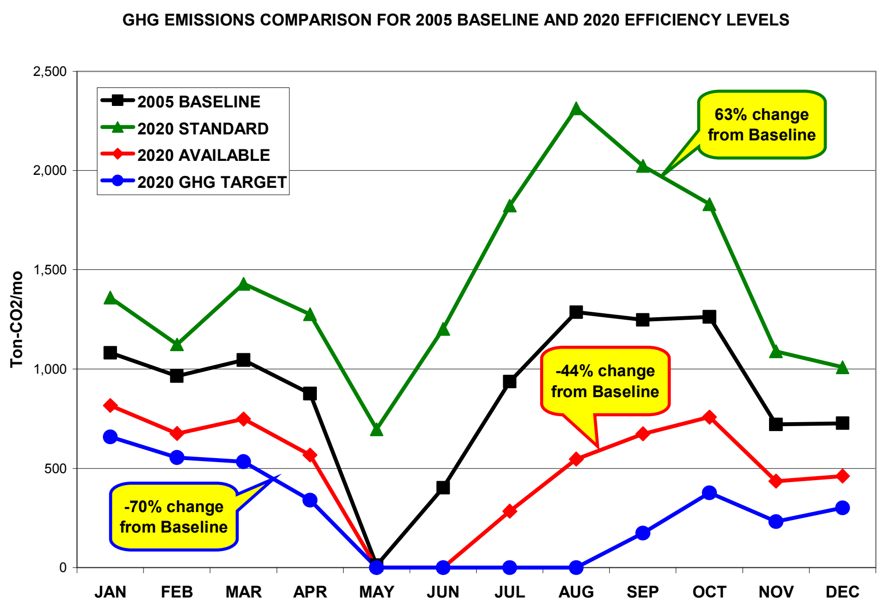

Figure 15

The impact of the "run-of-the-river" availability of WAPA hydropower is clearly reflected in the shape of the curve in Figure 15. Maximum hydropower is available in May with zero GHG emissions; then hydropower falls off during subsequent summer months, and GHG emissions increase —just as SCWA's energy demands increase. In 2005, very little WAPA hydropower was available in January, February, and March, causing relatively high GHG emissions. It is possible that in 2020, more hydropower will be available in these months to significantly reduce annual GHG emissions.

Given the sensitivity of SCWA's GHG emissions to the availability of WAPA hydropower, the details of the PWRPA contract are almost as important as water efficiency. The combination of water and energy efficiency measures with other renewable energy sources besides WAPA hydropower could result in very much lower GHG emissions, and lower costs, by 2020 It is important to note that large-scale hydropower such as WAPA's is not eligible for renewable resource funding from the

State of California[30]. Eligible renewables could be developed locally by SCWA, including wind, methane/cogen from dairy manure, landfill biogas, and photovoltaics.[31]

Hydropower and Market Power Use Comparison

Figure 16 shows the breakdown between hydropower and market power for each of the efficiency scenarios, based on the assumption that WAPA hydropower energy supplied to SCWA in each month will remain the same as in 2005. This might not be the case, especially in drought years, so creating a portfolio of additional renewable resources will not only replace market power, but will also provide a safeguard against climate impacts on hydropower.

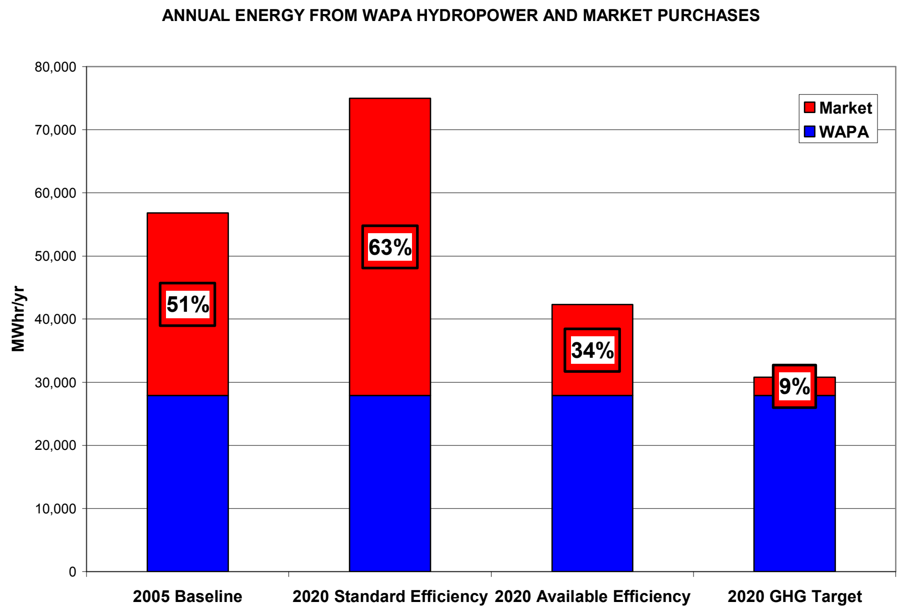

Figure 16

Other Implications of Water Demand Reduction

Although it is beyond the scope of this report, far lower life-cycle costs[32] are expected, and even net savings, when regional end-use energy savings and wastewater energy savings are included in the calculations. This will be demonstrated in the companion study for Santa Rosa, which will estimate implementation costs and performance for the efficiency measures with their end-use and wastewater savings, and displacement of potable water with recycled water.

[30] Hydropower produced from dams is not considered an eligible renewable because of the environmental impact of the dam.
[31] Although beyond the scope of this report, cost-effective local renewable resource rollout can be achieved through a Community Choice Aggregator. This entity may construct renewable power projects using municipal bonds. Preliminary analysis shows a life-cycle cost for renewables of under $0.05/kWh to just over $0.08/kWh, depending on the resource.
[32] Life-cycle costs are the total costs associated with all phases of the Water Use Cycle (see Figure 9).

Further Investigation

Life-cycle cost effectiveness will require the following updated information:

- Total cost for the Water Project, including Caisson 6 and transmission system improvements already underway
- Identification of construction projects that will be required to increase reliability even if peak supply capacity is reduced
- A projection of future electricity procurement contracts including rates, hydropower availability, and credits for lower demands
- SCWA's operating budget for water efficiency
- Bond terms and possible state financial incentives

Recommendations

Continuing the Three Pathways to Emission Reductions

The Sonoma County Water Agency (SCWA) is facing a potentially significant increase in its annual water deliveries over the next 20 years. At the same time, the need to significantly reduce global greenhouse gas (GHG) emissions is becoming urgent. How is it possible to reconcile these two conflicting demands?

Many areas of municipal service and private business are facing the same dilemma: increasing need and demand for services in the face of increasingly severe penalties for ignoring the GHG consequences of business as usual. However, the way forward is clear. There are three principal pathways for reducing greenhouse gas emissions impacts:

- Continuing system operation efficiency improvement in overall system operations including load shifting and redistribution
- Implementing renewable power purchase strategy to increase renewable portfolio, including local power sources
- Continuing efforts to significantly reduce per capita, end-use demand

Continuing System Operation Efficiency Improvement

The Energy and Emissions study[33] conducted by Climate Protection Campaign for the Agency found that a 12 percent improvement in system wire-to-water efficiency was very likely. However, further improvements could possibly be identified through continued study and analysis of available data. Some recommendations to improve further study of system operation are:

1. Use all 2004–2006 Supervisory Control and Data Acquisition (SCADA) data for more detailed energy/water analysis
2. Develop work-arounds for missing parameters/data
3. Add pressure and power tests/measurements where data unavailable
4. Extract peak power effects by cross-referencing Power and Water Resources Pooling Authority (PWRPA) billing information with SCWA SCADA data
5. Develop fire safety limits for tank levels with local fire marshals
6. Quantify and define contractor pumping needs and schedules

Closer cooperation with contractors could improve the Agency's ability to use energy more effectively. Specifically:

1. Coordinate pumping and tank filling schedules with contractors
2. Integrate instrumentation and controls on both the Agency side and the contractor side

[33] Sonoma County Water Agency Greenhouse Gas Emissions from Water Supply Operations: Current Inventory and Potential Reductions. Rosenblum Environmental Engineering, June 22, 2007

Implementing Renewable Power Purchase Strategy

The Agency is the largest electricity user in the county. As such, there is significant leverage in purchasing electric power. The Agency is using this fact to its advantage in its relationship with PWRPA. However, there are other approaches to power purchasing that may have benefits that extend beyond simply offering lower rates. The Agency has explored load aggregation with PWRPA. Load aggregation as a strategy can benefit the broader community in the county through Community Choice Aggregation.

Community Choice Aggregation (CCA) can offer: (1) the benefits of power purchasing leverage for favorable rates; (2) the capability to negotiate long-term power contracts to lock in favorable rates; and (3) the ability to build an aggressive portfolio of renewable resources. CCA will encourage development of locally based renewable power resources, as well as be able to take advantage of pre-existing local power resources, such as Warm Springs Dam.

Continuing to Reduce Per Capital, End-Use Demand

Working closely with contractors, the Agency can pilot more effective ways to overcome market barriers to significant reductions in end-use demand. In this way, the Agency and the contractors can help the community capture the large GHG reduction benefits of technology that is already cost-effective for customers (because of water, wastewater, and energy savings).

Monitoring Progress

The annual inventory of GHG emissions is an essential element of an emission reduction program. Inventorying and reporting GHG emissions provides critical information on the impact of the Agency's internal operations. In addition, an annual GHG emissions inventory will show the effectiveness of the measures the Agency is pursuing to reduce its emissions.

Ideally, the Agency will internally track its electricity and natural gas use on a monthly basis. Although the overall impact of efficiency and other measures may be more visible on longer time scales, the "real time feedback" enabled by regular monitoring can allow a fast response to "hot spots" or energy problem areas.

Action steps to take to implement a GHG monitoring program:

1. Select software and populate a database with all historical electricity and natural gas billing data.
2. Improve transportation fuel tracking system and integrate fuel consumption data with electricity and natural gas consumption data.
3. Track individual "hot spot" energy use so that system energy consumption patterns can be identified. This can include monitoring individual pumps.

Conclusion

The Sonoma County Water Agency (SCWA) has taken a critical first step to making significant reductions in GHG emissions caused by its operations. An inventory of emissions has been completed that establishes an emissions baseline. It is not surprising that the majority of GHG emissions in the Agency's inventory are due to energy use in water supply pumping. The emissions inventory shows that total Agency emissions have nearly doubled since the baseline year, although emissions are highly dependent on the availability of WAPA hydropower.

An emissions and energy study was conducted for the purposes of determining and quantifying strategies for cost-effective emissions reduction. The three principal pathways for achieving emissions reductions are:

1. **Improve system efficiency — up to 17 percent emissions reduction by 2020**. More reductions might be possible with further study of system operation data (SCADA).
2. **Improve end-use water efficiency — up to 70 percent emissions reduction by 2020** with a 29 percent reduction in water deliveries; a 44 percent reduction in emissions is possible with an 11 percent reduction in water deliveries.[34]
3. **Increase portfolio of renewables** in electric power purchasing — reducing amount of power purchased on the spot market and substituting renewables will decrease overall emissions.

Significant efficiency increases and emissions reductions can be achieved from optimizing system operation schedules, and could be quantified from a detailed evaluation of operations data. Additional energy savings and emissions reductions could probably be achieved through closer cooperation with the water contractors. There are especially interesting opportunities for real-time sharing of system operation data that might make coordination much easier.

Further study and the addition of more monitoring points in the system might also pave the way for more aggressive automation of pumping operation rules. If real-time data was available from the contractors, more decision-making support could be provided so that peak electrical demands could be shifted or minimized.

Finally, improving end-use water efficiency can potentially have the greatest effect on emission reduction, both from the Agency's standpoint, and from the standpoint of the community. Water-related energy use comprises 19 percent of California's electricity use, and 32 percent of natural gas use.[35]. Almost all of its greenhouse gas emissions are generated by end-users, which means that water efficiency programs will have a tremendous regional multiplier effect.

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[34] These emission reductions include the 17 percent reduction through system efficiency improvement.
[35] Source: *California's Water-Energy Relationship, California Energy Commission Final Staff Report,* November 2005

Going forward, climate protection and greenhouse gas emissions reduction will become a higher priority for both State and local governments as a result of the passage of AB 32. This fact should become the basis for future budget planning by SCWA on both the capital improvement side and on the operational side.