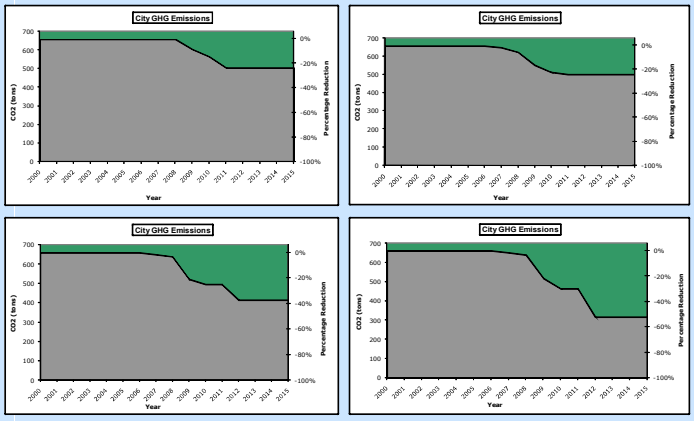
City of Sonoma
Greenhouse Gas Emissions
Reduction Action Plan Analysis

Final Report

February 22, 2008

Climate Protection Campaign



Prepared by MSI Integrated Solutions, Inc.
Under the direction of the Climate Protection Campaign

with funding from the

Sonoma County Energy Watch
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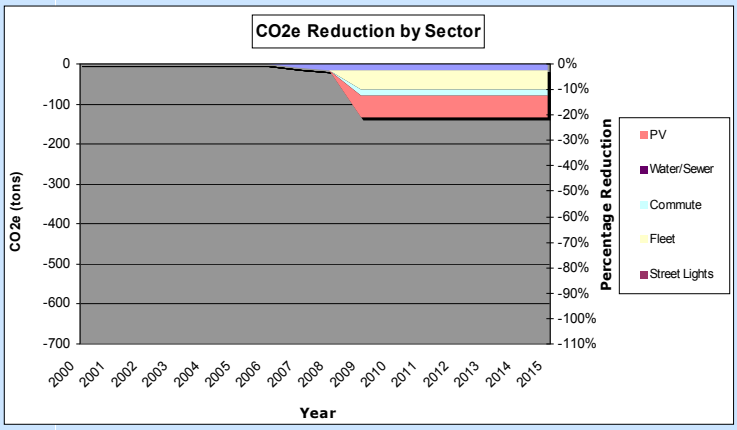
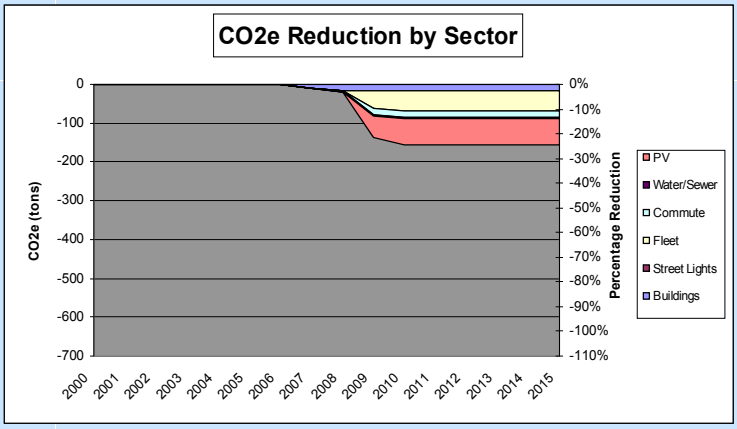

CO2e Reduction by Sector
CO2e (tons)
Percentage Reduction
Year
PV
Water/Sewer
Commute
Fleet
Street Lights


CO2e Reduction by Sector
CO2e (tons)
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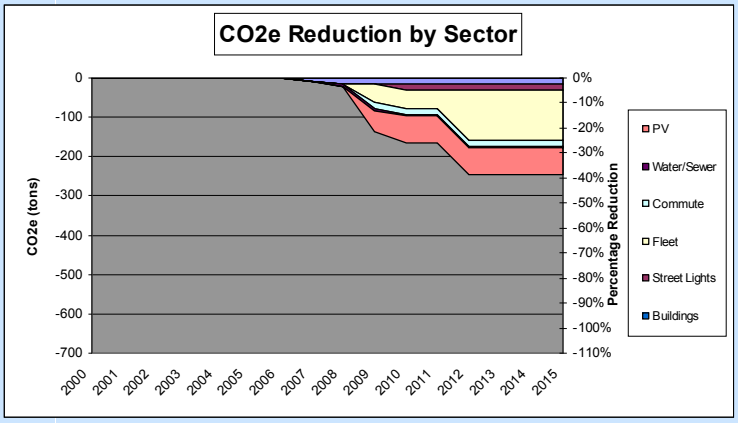
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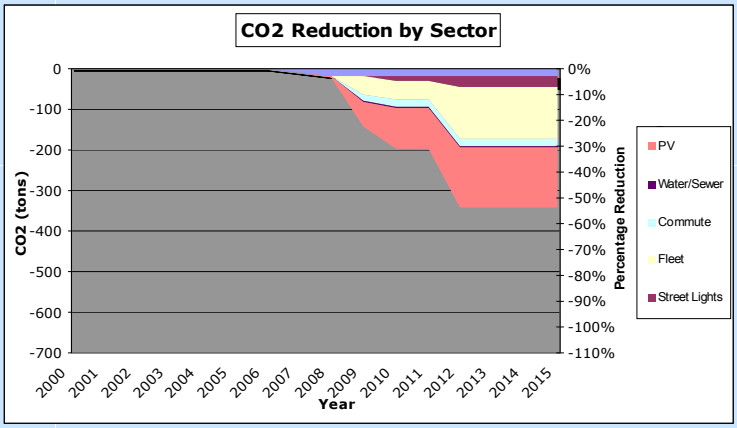
CO2 Reduction by Sector
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Acknowledgements

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[1] This program is funded by the California utility ratepayers under the auspices of the California Public Utilities Commission (CPUC). Legal Notice: This report was prepared as a result of work sponsored by the California Public Utilities Commission (Commission). It does not necessarily represent the views of the commission, its employees, or the state of California. The commission, the state of California, its employees, implementers, and subimplementers make no warranty, expressed or implied, and assume no legal liability for the information in the report: nor does any party represent that the use of this information not infringe upon privately owned rights. This report has not been approved or disapproved by the commission nor has the commission passed up on the accuracy or adequacy of the information in this report.

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1.0 Executive Summary

The City of Sonoma is implementing the ICLEI program to reduce the greenhouse gas (GHG) emissions from city controlled sources. This program has five steps, referred to as "Milestones." Milestone 1, creating the GHG inventory, and Milestone 2, setting a reduction target have been completed. The City Council has adopted a reduction target for internal operations of 20% below 2000 levels by 2010. Milestone 3 requires the creation of a plan to meet this target. This report and associated analysis provides the roadmap to satisfy Milestone 3 providing five measure-specific plans to reduce emissions by more than 20%. Furthermore, the framework associated with this material will support the City in meeting the requirements of Milestone 4 (implementation) and Milestone 5 (monitoring and adjustment). The framework facilitates the integration of new and revised information, taking advantage of new opportunities and allowing adjustments to under performing initiatives.

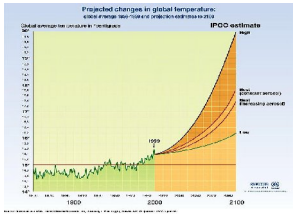
The analysis, and resulting GHG emissions reduction plans, incorporates many opportunities in the various contributing sectors (Building Efficiency, Fleet, Commute, Water/Sewer, Streetlights, and Photovoltaic), as identified by the City Staff utilizing the best available information at the time of research. The results provide an emissions impact estimate for five plans with the corresponding financial analysis.

The results for each plan include the GHG emissions reduction expressed in tons CO2e (equivalent CO_2 emissions) [2] and as a percentage of the total City GHG emissions. These results are presented along with a number of other important metrics, including the internal rate of return (IRR) and net present value (NPV) of each plan. These are critical in the financial evaluation of the "investment". Other information includes the budget resources not sent to the utility company and the fuel companies, and the value of the resources redirected to local investments. Plan C, for example, results in over $1.4 million in local investment over the 25 year life of the plan.

The intent of this work is to allow the independent plans to be considered on their merits in numerous areas, providing the capability to compare the comprehensive costs and benefits of competing paths, and thereby allow Policy Makers the ability to select the most appropriate path to reducing global warming pollution emissions in the City of Sonoma. Five Action Plans are presented resulting in reductions from 20% to over 50%. Each plan has advantages and challenges, which are described in the following sections of this report.

[2] CO2e: Equivalent CO_2 in lbs or tons. The additional greenhouse gases such as methane are converted into the equivalent amount of CO_2 for analysis and clearer presentation.

1.1 Background



Sonoma County public jurisdictions (cities and counties) have adopted global warming pollution reduction targets and have committed to developing action plans. The first step, creating the inventory of emissions produced by the internal operations has been completed for all cities and the county. The City of Sonoma emissions by sector are presented as a percentage of the total emissions in Figure 1 below.

The total emissions for 2000 are 659 tons of CO2e. Solid waste provides a GHG credit as the waste facility utilized by the waste contractor is equipped to gather and utilize the methane produced[3]. There were no significant new sources of GHG emissions identified since the baseline year of 2000[4]. This assumption can be modified when energy usage data become available for the newly renovated police station and community meeting facility building.

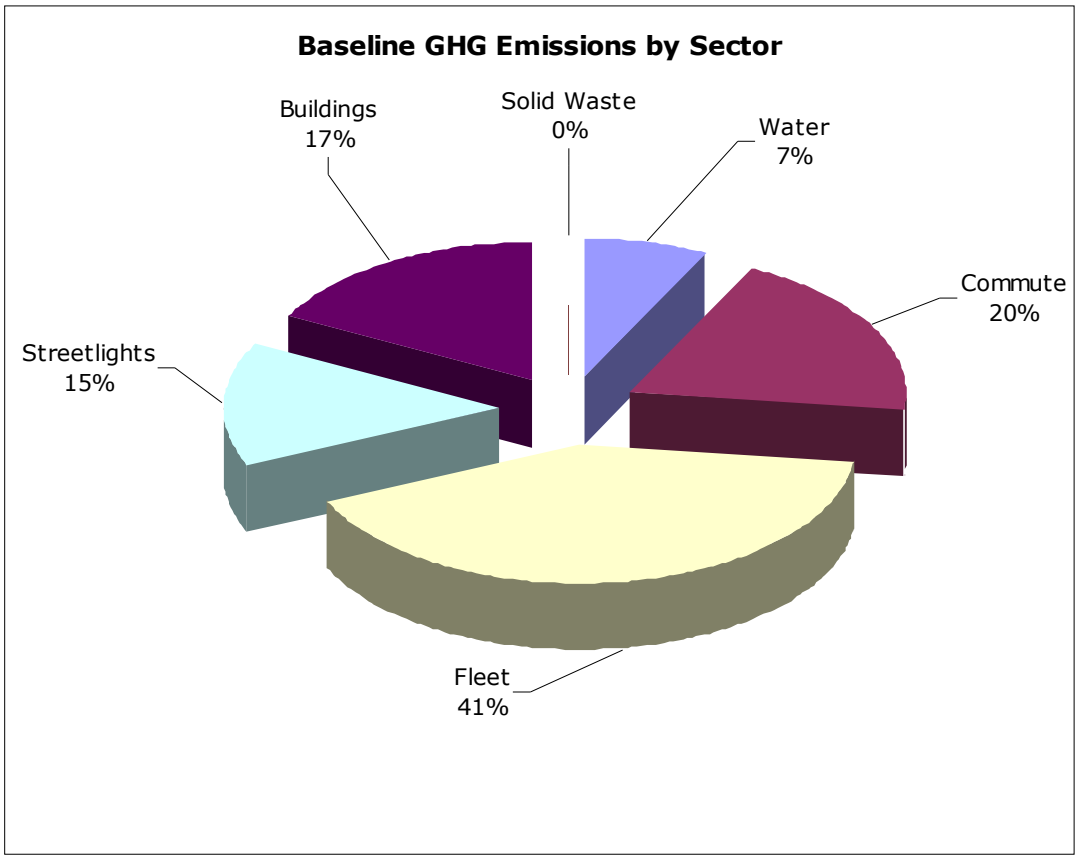


Figure 1: City of Sonoma GHG inventory as a percentage of the 2000 total

[3] This approach is consistent with the ICLEI methodology for solid waste.
[4] The baseline has been modified to reflect the transfer of Police services to the County.

Many of the measures available to reduce GHG emissions also will reduce the City electricity and natural gas costs. These costs are a significant element of the municipal budget, and the potential volatility of their costs represents a threat beyond the control of City Staff. Figure 2 below provides the trends for the annual cost of utility supplied electricity and natural gas based on four rate escalation scenarios. The electricity and natural gas related measures contained in this analysis will reduce the vulnerability to utility price increases.

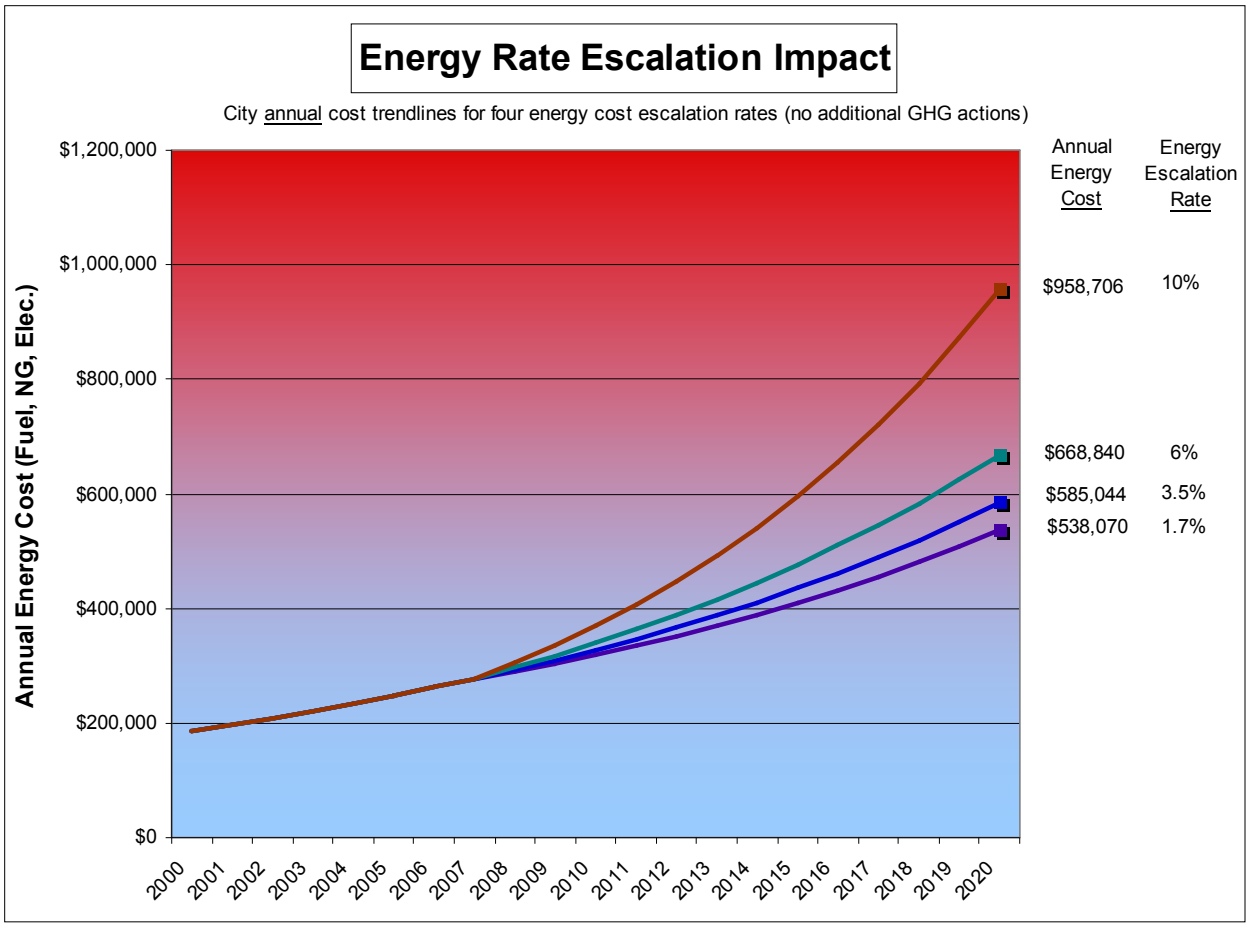


Figure 2: Energy Rate Escalation Scenarios

1.2 Methodology

Plan D: 245	Tons CO2 Avoided	37.2%	% Reduction
Community Benefit (over 25 year life of plan)		Financial Metrics	
$$$ Avoided Utility Company Payments	$992,228	SPB	13.7
$$$ Avoided Fuel Purchases	$2,025,116	IRR	13.6%
$$$ Invested Locally in GHG Projects	$1,643,870	NPV	$572,494

The Sonoma GHG emissions inventory for 2000 was established in 2003[5] and provides the baseline for this work. The specific actions and events affecting this baseline, either positive or negative, are factored into the inventory and the resulting trend. Contracting for Police services with the County, for example, required a modification to both the baseline and trend.

The options for future action by the city, comprised of measures applicable to building and equipment energy efficiency, fuel efficiency, alternative fuel options, and distributed energy generation projects, have been identified and quantified. These have been evaluated and presented as individual measures, and as groups of measures (plans). Each is assigned a status (completed, pending or future) and an implementation date to enable the trending and future results graphs.

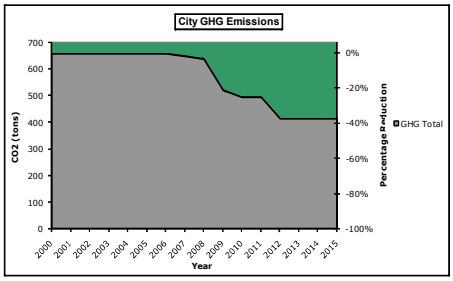
The measures are grouped to create comprehensive GHG emissions reduction plans. Each of the plans is analyzed to provide profiles enabling the evaluation of the plans individually and in comparison to the other plan options. Measures of specific data such as capital cost, year of implementation, financing, energy and cost savings were processed to provide the following information for the five action plans:

- Emissions reduction in tons CO2e avoided and as percentage of target
- CO2e reduction by sector
- Annual Cash Flow including debt service, replacement cost and incremental O&M costs
- Outstanding principal and debt service by year
- Simple Payback (SPB) for each plan
- Internal Rate of Return (IRR) for each plan
- Net Present Value (NPV) for each plan
- Avoided utility company payments (NPV over life of plan)
- Avoided fuel purchases (NPV over life of plan)
- Value invested locally in emission reduction projects

A measure evaluation matrix was employed to quantify subjective considerations to allow their inclusion in the planning process. The evaluation scoring contributes to the understanding of the opportunities *but is not intended to provide a final ranking of the measures*. The decision to include measures in each plan is dependent on its role in achieving the objective of that plan, and is therefore independent of any fixed criteria or ranking. The results of the evaluation are provided in the Appendices.

[5] GHG Inventory Report City of Sonoma , Gary Albright, City of Sonoma , September 2003.

1.3 Results



Five plans have been created for consideration by the City of Sonoma. These plans consist of numerous measures to reduce GHG emissions, reduce energy costs, address equipment problems, and reduce the uncertainty of the city's future annual energy costs. Summary financial information is provided in Table 1 below. The results contained in this table should be considered with the Action Plan Evaluations provided in the Appendices to understand the relative strengths of each combination of measures populating the Action Plans. Detailed information for each measure is provided within the Measure Details section of this report.

Plan Results and Comparison Tables

Table 1 provides important financial information for each plan including the net annual cash flow. The "% Reduction" is the amount of CO2e reduced as a percentage of the total city emissions. Plan A provides a reduction of 23.5% below the year 2000 (baseline) emissions. Plan E provides a strategy to reduce the city's emissions to 52.1% below 2000 emissions.

The financial analysis is provided with each plan. The critical metrics of Internal Rate of Return (IRR) and Net Present Value (NPV) provide important information to evaluate the worthiness of the investment from a cash flow perspective. It is important to note the large negative net cash flows in the later years of each plan represent reinvestment in photovoltaic (PV) systems (replacement of the associated inverters after 12 years) and the replacement of the energy efficient fleet options after 10 years of service.[6] Both costs may be considered overstated, and therefore conservative.

[6] The assumption is that the cost of inverters will increase at the generally assumed inflation rate of 3%. However likely advances in technology, and improved economies of scale for the industry suggest this is overly conservative. The aggressive fleet measure assumes all vehicles are repurchased in one year (after a 10 year life). In practice, the purchases are phased which would spread the investment over several years.

GHG Action Plan Summary					
Analysis	**Plan A**	**Plan B**	**Plan C**	**Plan D**	**Plan E**
% Reduction	23.5%	20.3%	23.6%	37.2%	52.1%
SPB	25.0	7.1	17.0	13.7	20.9
IRR	NA	28.3%	8.8%	13.6%	2.0%
NPV	($1,068,361)	$231,318	$113,184	$572,494	($548,747)
Annual Cash Flow	**Plan A**	**Plan B**	**Plan C**	**Plan D**	**Plan E**
2007	$0	($1,264)	($1,264)	($1,264)	($1,264)
2008	$0	$4,525	$4,525	$4,525	$4,525
2009	$0	($2,736)	($11,381)	($16,106)	($11,370)
2010	$13,140	($1,403)	($9,987)	($14,694)	($33,418)
2011	($77,172)	($453)	($27,642)	($40,566)	($131,353)
2012	($195,798)	$534	($26,062)	($38,816)	($128,884)
2013	($192,197)	$2,921	($23,053)	($60,588)	($257,898)
2014	($188,470)	$4,898	($20,422)	($56,149)	($250,912)
2015	($184,610)	$6,003	($18,628)	($52,423)	($244,551)
2016	($180,615)	$7,152	($4,581)	($32,892)	($237,885)
2017	($216,027)	$8,344	($2,627)	($28,727)	($204,847)
2018	($211,744)	$9,583	($587)	$21,215	($178,885)
2019	($207,311)	$10,870	$1,543	$25,880	($159,315)
2020	($179,853)	$35,073	$26,636	$53,686	($151,446)
2021	($136,644)	($13,734)	($21,234)	$28,039	($62,147)
2022	($101,564)	$37,901	($35,085)	$17,304	($220,118)
2023	($214,494)	$39,397	$33,927	$89,656	$193,131
2024	$125,860	$40,951	$36,581	$95,892	($81,939)
2025	$131,320	$42,564	$39,356	$102,509	$213,270

Table 1: GHG Action Plan Financial Results

Energy Rate Escalation and Associated Budget Vulnerability

There is considerable discussion about the availability of fossil fuels in the near and middle term future (5 to 20 years). The "Peak Oil" movement suggests that we are at or near the point where our increased global demand for oil cannot be supplied from new petroleum discoveries, while production from existing oil fields is waning. Similar arguments are made for natural gas supply vs. demand. If demand outstrips supply, simple economics indicates that the cost to consumers will escalate rapidly, until the global demand is sufficiently dampened and realigns with available supply. The concern is significant enough to have prompted a US government sponsored study to determine the impacts of demand exceeding supply in the near future.[7] This issue has important implications for local Sonoma County jurisdictions. Forty percent of PG&E power is generated by natural gas. A spike in the cost of this energy source will result in

[7] Hirsch, Robert. et al. (February 2005) "Peaking of World Oil Production: Impacts, Mitigation, & Risk Management." SAIC.

significant increases in the cost of electrical power, as well as increased volatility in the cost of natural gas used directly by the City.

Energy efficiency projects and photovoltaic energy systems can play a significant role in moderating this vulnerability. Figure 3 below provides potential impact of energy efficiency strategies on the associated vulnerability. For example, under the 3.5% escalation rate scenario, the city would reduce its fleet fuel and utility payments by nearly $270,375 per year ($585,044 - $314,669) in 2020 by implementing the aggressive Action Plan E.

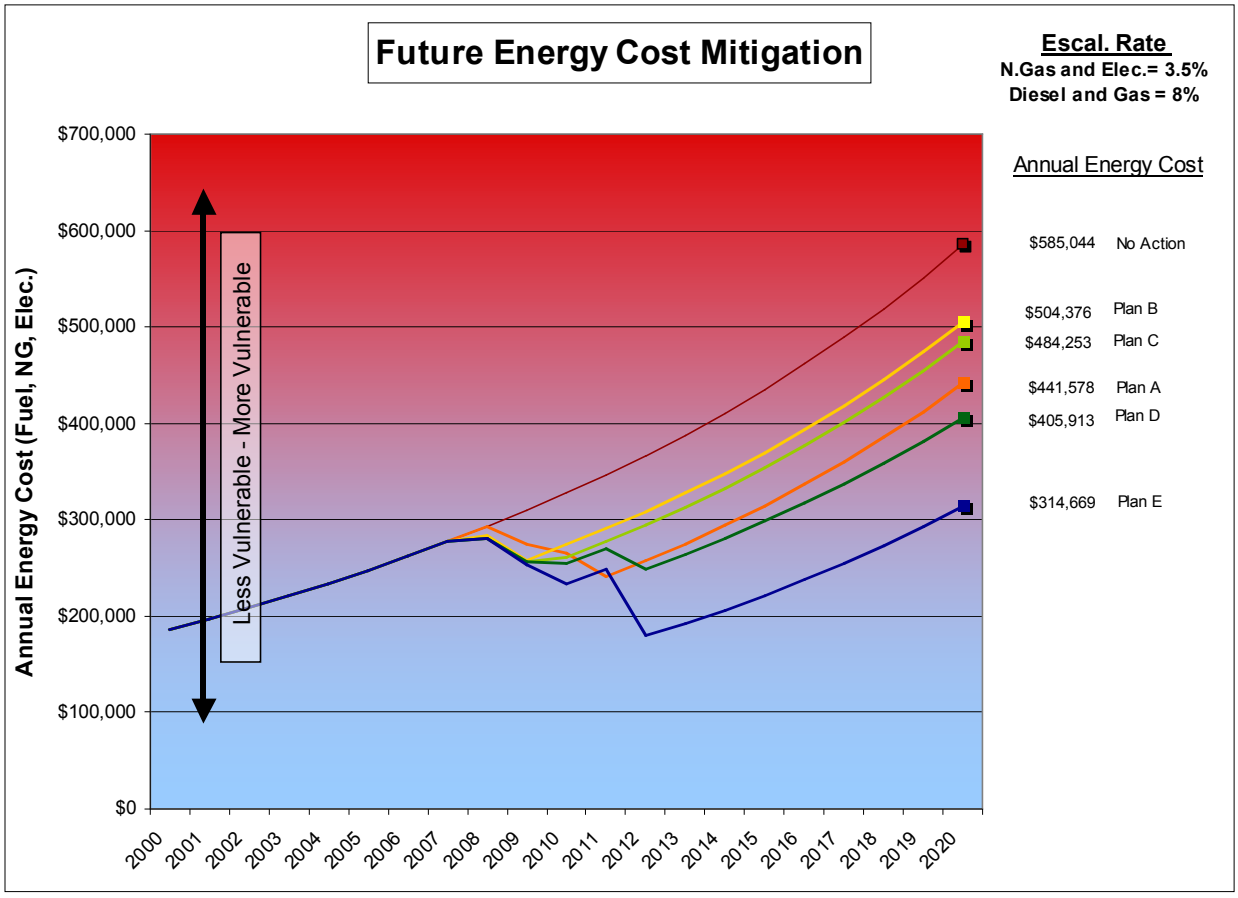


Figure 3: Annual Cost of Energy

Action Plan Details

The measures used in this analysis are provided in Table 2 below. The first five columns indicate which measure is included in each Action Plan. More information on the measures is available in the Measure Details section of the report. The material that follows provides the results for each Action Plan. It is important to note that some measures are mutually exclusive. Measures 7, 8 and 9, for example, apply to the same set of equipment, the city pumps. Measure 7 is more aggressive, setting a lower threshold of annual savings as the criteria for inclusion. Therefore, a plan would select only one of these measures. The fleet measures incorporate similar considerations.

Action Plan					Measure Summary	Description	Implementation Date
A	B	C	D	E			
n	y	y	y	y	**Measure 1**	City Hall HP Replacement	2007
n	y	y	y	y	**Measure 2**	City Hall Programmable Thermostats	2007
n	y	y	y	y	**Measure 3**	Carnegie and Visitor Cntr Prog. Thermostats	2007
n	y	y	y	y	**Measure 4**	Lighting Retrofit	2008
n	n	n	y	y	**Measure 5**	Streetlighting HPS to LED A	2010
n	n	n	n	y	**Measure 6**	Streetlighting HPS to LED B	2012
n	n	n	n	y	**Measure 7**	Pump Measures 1 (5 units)	2009
n	n	n	y	n	**Measure 8**	Pump Measures 2 (3 units)	2008
n	n	y	n	n	**Measure 9**	Pump Measures 3 (2 units)	2008
y	y	y	y	y	**Measure 10**	PV6 150 kW -CREBS	2009
y	y	y	y	y	**Measure 11**	PV1-30kWac	2009
y	n	n	n	y	**Measure 12**	PV3-60kWac	2010
y	n	n	n	n	**Measure 13**	PV4- 200kWac	2011
y	n	y	y	y	**Measure 14**	PV2 Suppying 100% Wtr &Wste energy cost	2010
n	n	n	n	y	**Measure 15**	PV2 Suppying 100% Streetlighting Energy Cost	2012
n	n	n	n	y	**Measure 16**	PV2 Suppying 100% Fleet Electric Energy Cost	2008
n	n	y	n	n	**Measure 17**	Vehicle Replacement Strategy 1	2010
n	n	n	y	y	**Measure 18**	Vehicle Replacement Strategy 2 (aggressive)	2012
n	y	y	y	y	**Measure 19**	Biodiesel B50	2009
n	y	y	y	y	**Measure 20**	Commute	2009
5	8	11	12	16			

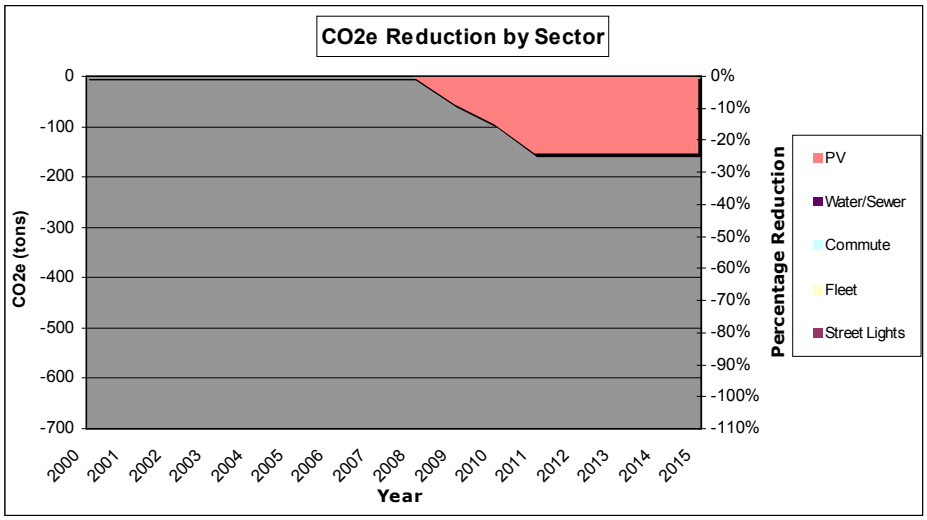
Table 2: Measure List

Plan A:	155	Tons CO2 Avoided	23.5%	% Reduction

Community Benefit (over 25 year life of plan)		Financial Metrics	
$$$ Avoided Utility Company Payments	$1,387,098	SPB	25.0
$$$ Avoided Fuel Purchases	$0	IRR	NA
$$$ Invested Locally in GHG Projects	$2,883,337	NPV	($1,068,361)

Action Plan A: This plan meets the GHG reduction goal utilizing only photovoltaic systems, replacing electricity purchased from the utility with solar generated electricity. A number of project funding methodologies are included and the total installed PV capacity would replace 64% of the total electricity (kWh) currently purchased from PG&E. These measures (See Plan Details) include systems utilizing IRS zero interest bonds, systems matched to water and sewage pump meters, and systems to offset building electricity consumption. The cash flow reflects the challenging economics of meeting the GHG goal utilizing only one strategy. The Plan Details section provides the specific measures included in each plan. The resulting annual cash flow is the net income to the city (energy cost savings minus project debt service, replacement costs and associated O&M).

Annual Cash Flow	Plan A
2007	$0
2008	$0
2009	$0
2010	$13,140
2011	($77,172)
2012	($195,798)
2013	($192,197)
2014	($188,470)
2015	($184,610)
2016	($180,615)
2017	($216,027)
2018	($211,744)
2019	($207,311)
2020	($179,853)
2021	($136,644)
2022	($101,564)
2023	($214,494)
2024	$125,860
2025	$131,320

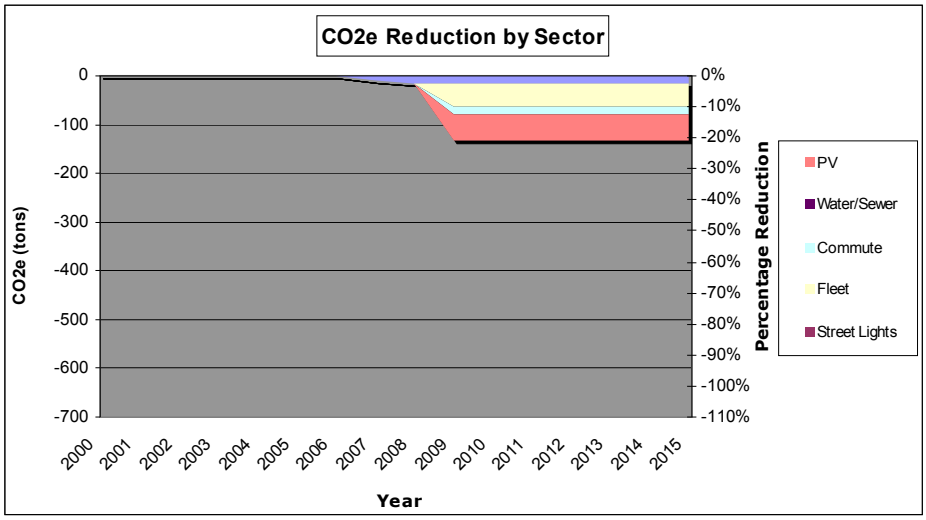


Plan B:	134	Tons CO2 Avoided	20.3%	% Reduction

Community Benefit (over 25 year life of plan)		Financial Metrics	
$$$ Avoided Utility Company Payments	$708,412	SPB	7.1
$$$ Avoided Fuel Purchases	$868,415	IRR	28.3%
$$$ Invested Locally in GHG Projects	$1,073,197	NPV	$231,318

Action Plan B: This plan includes a combination of 8 measures consisting of building efficiency (HVAC and lighting), photovoltaic and fleet fuel initiatives. The building measures in all plans are based on the energy analysis provided by the Association of Bay Area Governments Energy Watch program (ABAG EW). The implementation dates for all measure in this plan span from 2007 to 2011. The plan allows the City to exceed the target of 20% GHG emissions reduction by 2010. The projected reduction of 20.3% does not provide a margin of flexibility for changing conditions and unforeseen difficulties in implementing the plan. The resulting annual cash flow is the net income to the city, energy cost savings minus project debt service, replacement costs and associated O&M.

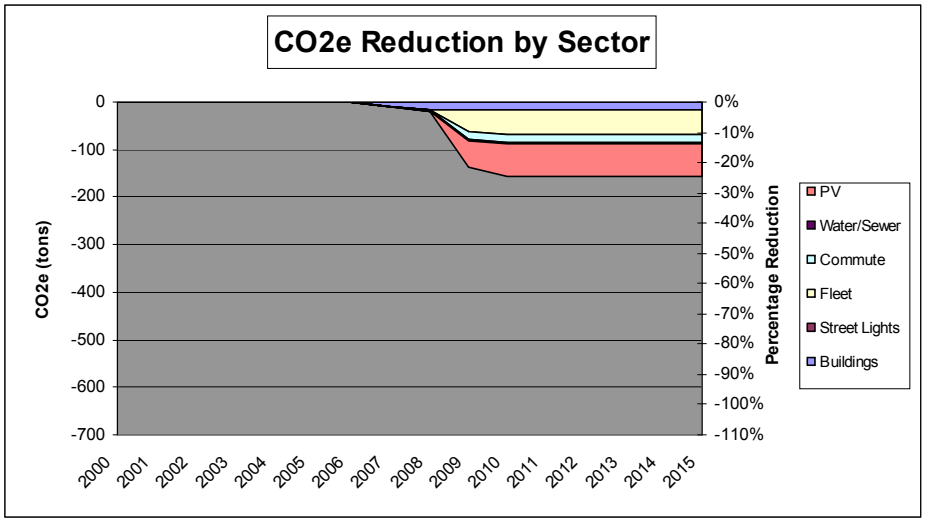
Annual Cash Flow	Plan B
2007	($1,264)
2008	$1,347
2009	($5,914)
2010	($4,581)
2011	($3,631)
2012	($2,644)
2013	$2,921
2014	$4,898
2015	$6,003
2016	$7,152
2017	$8,344
2018	$9,583
2019	$10,870
2020	$35,073
2021	($13,734)
2022	$37,901
2023	$39,397
2024	$40,951
2025	$42,564



Plan C:	156	Tons CO2 Avoided	23.6%	% Reduction
Community Benefit (over 25 year life of plan)			**Financial Metrics**	
$$$ Diverted from Utility Company	$866,615		SPB	17.0
$$$ Diverted from Fuel Purchases	$995,066		IRR	8.8%
$$$ Invested Locally in GHG Projects	$1,455,320		NPV	$113,184

Action Plan C: This plan includes 11 measures. In addition to all of the measures of Plan B, Plan C includes a more aggressive biodiesel fuel approach (50% biodiesel), a fleet replacement strategy, and pump efficiency measures. Plan C significantly exceeds the City target of 20% GHG emissions reduction by 2010, yet maintains attractive financial metrics. The Internal Rate of Return approaches 9% and the Net Present Value exceeds $100,000 over the term of the analysis (25 years). The annual net cash flow (energy cost savings minus project debt service, replacement costs and associated O&M) is negative for several years. However, the magnitude appears quite reasonable given the IRR and NPV results.

Annual Cash Flow	Plan C
2007	($1,264)
2008	$1,347
2009	($14,559)
2010	($13,165)
2011	($30,820)
2012	($29,240)
2013	($23,053)
2014	($20,422)
2015	($18,628)
2016	($4,581)
2017	($2,627)
2018	($587)
2019	$1,543
2020	$26,636
2021	($21,234)
2022	($35,085)
2023	$33,927
2024	$36,581
2025	$39,356

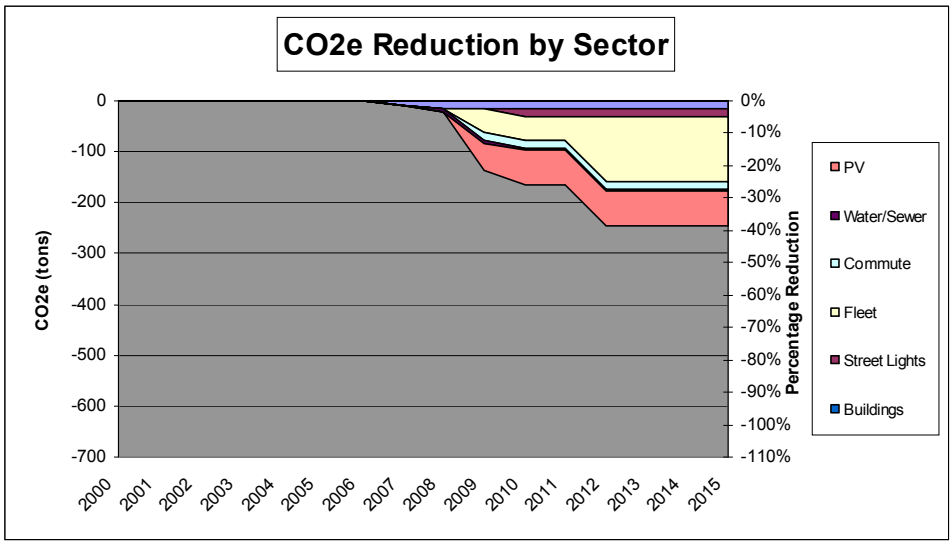


Plan D:	245	Tons CO2 Avoided	37.2%	% Reduction

Community Benefit (over 25 year life of plan)		Financial Metrics	
$$$ Avoided Utility Company Payments	$992,228	SPB	13.7
$$$ Avoided Fuel Purchases	$2,025,116	IRR	13.6%
$$$ Invested Locally in GHG Projects	$1,643,870	NPV	$572,494

Action Plan D: This plan includes all building efficiency projects and many of the measures of Plan B and C for a total of 12 measures. This plan results in almost a doubling of GHG emissions reduction as compared to the City target of 20%. The pump and fleet measures of Plan C are replaced with a much more aggressive fleet replacement strategy and pump replacement measure, and a future streetlighting measure (2010). The combination of measures yields very impressive financial metrics, IRR exceeding 13% and a NPV of over $550,000 over the life of the plan. Furthermore the annual net cash flow is significantly more attractive than the previous plans. The Plan Details section provides the specific measures included in each plan. The resulting annual cash flow is the net income to the city (energy cost savings minus project debt service, replacement costs and associated O&M).

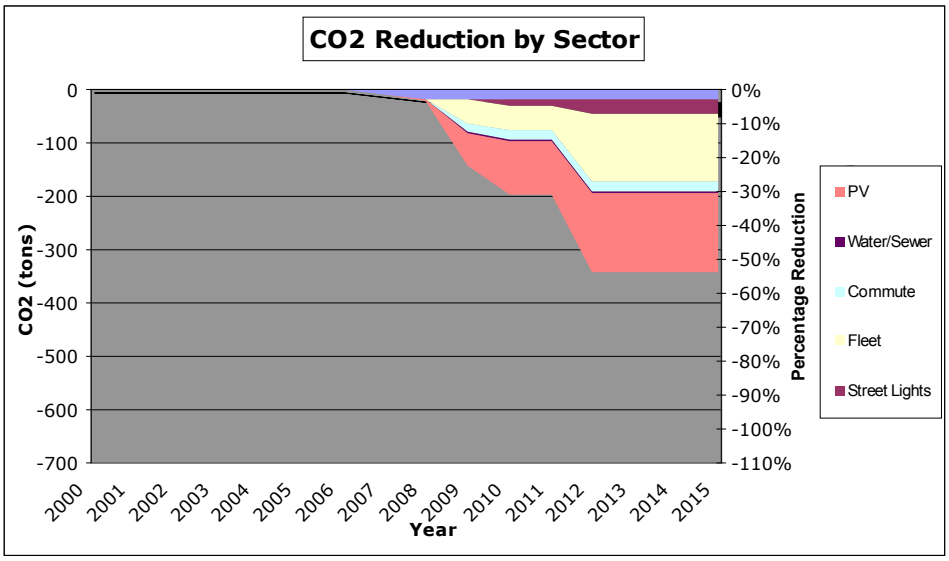
Annual Cash Flow	Plan D
2007	($1,264)
2008	$4,525
2009	($16,106)
2010	($14,694)
2011	($40,566)
2012	($38,816)
2013	($60,588)
2014	($56,149)
2015	($52,423)
2016	($32,892)
2017	($28,727)
2018	$21,215
2019	$25,880
2020	$53,686
2021	$28,039
2022	$17,304
2023	$89,656
2024	$95,892
2025	$102,509



Plan E:	343	Tons CO2 Avoided	52.1%	% Reduction
Community Benefit (over 25 year life of plan)			**Financial Metrics**	
$$$ Avoided Utility Company Payments	$1,806,418		SPB	20.9
$$$ Avoided Fuel Purchases	$2,025,116		IRR	2.0%
$$$ Invested Locally in GHG Projects	$3,947,030		NPV	($548,747)

Action Plan E: This plan includes all building efficiency projects and many of the measures of the previous plans for a total of 16 measures. This plan is more aggressive with PV projects, fleet purchases and pump efficiency measures. As with Plan D, the pump and fleet measures are replaced with the more aggressive strategies. An additional photovoltaic system is provided to provide energy for the plug in hybrid vehicles in the fleet replacement measure. The combination of measures yields challenging financial metrics, IRR is 2% and the NPV is strongly negative over the life of the plan. While the annual net cash flow is more challenging than Plan D, the plan significantly reduces vulnerability to future energy cost escalation (Figure 6). The resulting annual cash flow is the net income to the city (energy cost savings minus project debt service, replacement costs and associated O&M).

Annual Cash Flow	Plan E
2007	($1,264)
2008	$4,525
2009	($11,370)
2010	($33,418)
2011	($131,353)
2012	($128,884)
2013	($257,898)
2014	($250,912)
2015	($244,551)
2016	($237,885)
2017	($204,847)
2018	($178,885)
2019	($159,315)
2020	($151,446)
2021	($62,147)
2022	($220,118)
2023	$193,131
2024	($81,939)
2025	$213,270



1.4 Summary

The GHG emissions reduction of 20% by 2010 can be achieved by a number of paths documented in this report. Each path, or Action Plan, is comprised of up to 16 individual measures, each is evaluated for the financial costs and benefits they contribute to the overall strategy. The analysis model underpinning these results will be available for incorporating new information and technologies as they come available, as well as truing the analysis with monitored data. The comprehensive approach to addressing this goal allows the City to meet a number of related goals, including improving the long term financial health of Sonoma, reducing the budget vulnerability to future energy cost escalation, addressing the existing maintenance demands of aging equipment, and providing the public demonstration of commitment and progress in the highly visible challenge of greenhouse gas emissions reduction.

2.0 Introduction

Public jurisdictions (cities and counties) have adopted global warming pollution reduction targets and have committed to developing action plans. These detailed plans are required to provide a roadmap to meet the goals and a framework to track and verify the progress toward the goal over the life of the plan.

The Climate Protection Campaign provides these capabilities by using an analysis method developed for the Sonoma County cities and applied to the City of Sonoma. This method incorporates all measures across the various sectors (Building Efficiency, Fleet, Commute, Water/Sewer, Streetlights, and Photovoltaic), and provides an accurate emissions impact estimate and a comprehensive financial analysis. Furthermore, this analysis allows independent plans to be analyzed, providing the capability to compare the cost / benefits of competing paths to global warming pollution emissions reduction.

The first step, creating the inventory of emissions produced by the internal operations has been completed. The City of Sonoma emissions by sector are presented as a percentage of the total emissions in Figure 4 below.

The total emissions for 2000 are 659 tons of CO2e[8]. Solid waste provides a GHG credit as the waste facility utilized by the waste contractor is equipped to gather and utilize the methane produced[9]. There were no significant new sources of GHG emissions identified since the baseline year of 2000[10]. This assumption can be modified when energy usage data become available for the newly renovated police station and community meeting facility building.

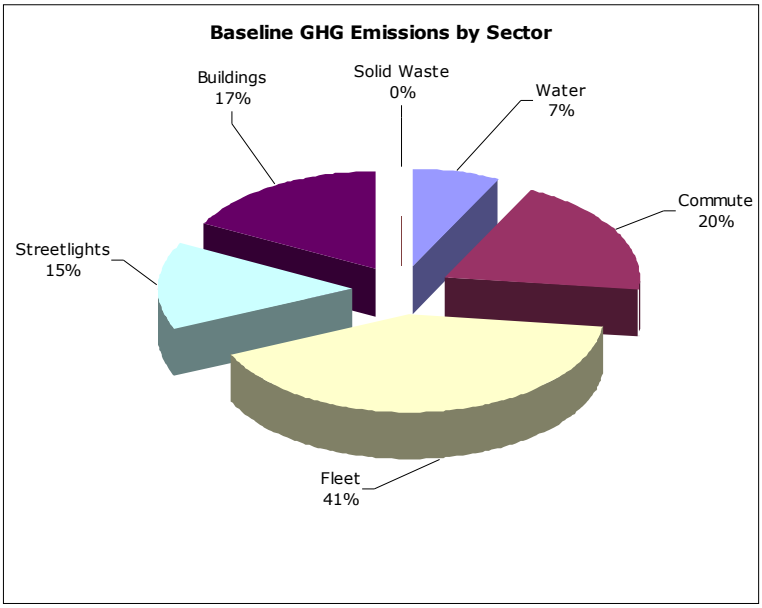


Figure 4: Baseline GHG emissions by sector as a percentage of the total

[8] The basis for the total emissions is provided in the Appendices.
[9] This approach is consistent with the ICLEI methodology for solid waste.
[10] The baseline has been modified to reflect the transfer of Police services to the County.

3.0 Methodology

3.1 Context

The City of Sonoma GHG emissions inventory for 2000, established in September 2003, provides the baseline for this work.[11] The specific actions and events affecting this baseline were identified by City Staff and factored into the inventory to establish the trend from 2000 to 2007.

The options for future action by the city comprised of measures applicable to building and equipment energy efficiency, fuel efficiency, alternative fuel options, and distributed energy generation projects, have been identified and quantified. These have been evaluated and presented as individual measures, and as groups of measures (plans). Each is assigned a status (completed, pending or future) to enable the trending and future results graphs.

The measures are grouped to create comprehensive GHG emissions reduction plans. Each of the plans is analyzed to provide profiles enabling the evaluation of the plans individually and in comparison to the other plan options.

Measure specific data such as capital cost, year of implementation, financing, energy and cost savings were processed to provide the following information for five action plans:

- Emissions reduction in tons CO2 avoided and as percentage of target
- CO2 reduction by sector
- Annual cash flow including debt service and incremental O&M costs
- Outstanding principal and debt service by year
- Simple Payback (SBP) for each plan
- Internal Rate of Return (IRR) for each plan
- Net Present Value (NPV) for each plan
- Avoided utility company payments (NPV over life of plan)
- Avoided fuel purchases (NPV over life of plan)
- Value invested locally in emission reduction projects
- Value of non-efficiency related capital expenses satisfied by each plan

Each measure included in this analysis has a set of inputs and assumptions. These are documented in the Appendices, and have been reviewed by staff. The details of each measure are provided, such as the vehicle and pump lists provided in the Measure Details section. The generally applied assumptions, such as the discount rate, interest rate, escalation rate for the cost of utility supplied power and fuel, and the CO2e conversion factors for energy and fuel have also been reviewed and adjusted by City Staff. The values are provided in Table 3. These general values can be overridden at the measure level if necessary. For example, the term of financing is set to 7 years as a default value. However, CEC loans are based on generating a net cash flow close to zero over the life of the loan with a maximum value of 10 times the annual cost savings. Therefore, the term of the loan is adjusted at the measure level based on the annual savings for that measure.

[11] GHG Inventory Report City of Sonoma , Gary Albright, City of Sonoma , September 2003.

3.2 Measure Identification

The list of measures has been generated from document reviews, past experience of other jurisdictions and a review of the Sonoma facilities funded by the ABAG Energy Watch efficiency program. All measures included in this analysis have been reviewed and approved for inclusion by City Staff. The following sources contributed to the information in this report.

- *Climate Protection Greenhouse Gas Emissions Inventories* (Countywide), September 2003.
- *GHG Inventory Report City of Sonoma,* September 2003.
- *Preliminary Audit Report: City of Sonoma, HDR/BVA and Energy Solutions (ABAG EW), August 14, 2007.*
- Individual data submissions from Staff, provided by City Manager.

3.3 Measure Assumptions: General Variables

This report is based on a set of general inputs for the financial analysis. Each measure utilizes these general inputs unless they are overridden at the measure level. The general inputs are provided in Table 3 below. The values used for each measure are provided in the Appendices. These inputs include the following:

- Term of Analysis
- Term of Finance
- Discount Rate
- Energy Inflation Rate
- Energy Cost
- Interest Rate
- Inflation Rate

The conversions in the table below are based on the best available information. The CO2e/kWh value is from PG&E based on their "fuel mix".[12] The values for natural gas, gasoline, diesel and biodiesel are consistent with the ICLEI values.[13] The value for ethanol is calculated using data from research published by Argonne Labs.[14] The value used for CO2e/kWh is different than the value used in the inventory completed in 2003, which used a more general number from ICLEI.[15] This analysis has modified the baseline results by using the current value to ensure an appropriate comparison.

[12] PG&E Power Content: Eligible Renewables: 13%, Coal: 2%, Large Hydro: 17%, Natural Gas 44%, Nuclear: 23%, Other; 1%, California Energy Commission, www.energy.ca.gov/consumer, May 2007.
[13] STAPPA/ALAPCO and ICLEI Clean Air and Climate Protection Software, State and Territorial Air Pollution Administrators and Association of Local Air Pollution Control Officials, International Council for Local Environmental Initiatives, released May 2003.
[14] Effects of Fuel Ethanol Use on Fuel-Cycle Energy and Greeenhouse Gas Emissions; M. Wang, C. Saricks, and D. D. Santini; Argonne Labs; January 1999.
[15] GHG Inventory Report City of Sonoma , Gary Albright, City of Sonoma , September 2003.

Master Inputs

11.15.07

Metric	Standard Default Values	Revised Values	Default Values Used in Analysis	Notes	
Term of Analysis (yrs)	25		25		
Term of Financing (yrs)	15	7	7		
Discount Rate	5.00%		5.00%		
Energy Inflation Rate	3.50%		3.50%	2007 Energy Cost	
Energy Cost ($/kWh)	$0.145		0.145	$0.145	
Energy Cost ($/Therm)	$1.000		1.000	$1.000	
Interest Rate	3.95%		3.95%		
Inflation Rate	3.00%		3.00%		
Exclude "Completed" from $$$ cost&benefit			yes		
Conversions					
CO2/kWh (lbs.)	0.489		0.489		
CO2/Therm (#/Therm)	12.34		12.34		
CO2e Gasoline	20.7		20.7	lbs/gal	
CO2e Diesel	21.0		21.0	lbs/gal	
BioDiesel	0		0	lbs/gal	
Ethanol	16.69		16.69	lb/gal for 100% ethanol	
$/gal Gasoline	$3.30		$3.30	$3.30	
$/gal Diesel	$3.30		$3.30	$3.30	
$/gal Biodiesel	$3.05	3.3	$3.30		
$/gal Ethanol	$4.00		$4.00		
CNG equivalent $/gal	$2.48		$2.48		
CNG conversion cost	$5,000		$5,000		
CNG Equipment	$150,000		$150,000		
Electric Vehicle Mileage	0.3		0.3	kWh/mile	mid size
Electric Vehicle Mileage	0.2		0.2	kWh/mile	subcompact
Target (% of 2000)	20.0%		20.0%		
TOU Factor	1		1	Used of PV financial analysis	
Hybrid increased eff	30%		30%	Likely to be revised at measure level	

Table 3: General Inputs

3.4 Measure Specific Variables

The general inputs can be adjusted for each individual measure as appropriate. The other key individual inputs are listed below. The values for each measure are provided in the Appendices.

- Category (Building, Fleet, Commute, PV, Water/Sewer)
- Status (Completed, Pending, and Future). Pending measures are defined as those provided by City Staff with identified funding.
- Financing: The cash flow is heavily dependent on whether or not the measures are financed. This funding decision is defined for each measure independently.
- Project Implementation Date
- Net Capital Cost
- Incremental Capital Cost associated with the cost premium associated with the improved efficiency. For Example: a hybrid compact vehicle is assigned a cost premium of $4000 over an equivalent standard vehicle.
- Rebates and incentives
- Annual O&M cost associated with the efficiency measure
- Incremental Replacement Cost
- Component Life
- Time of Use factor (Photovoltaic systems)

3.5 Financial Analysis Results

The analysis provides the financial information required for investment decisions. This includes the following:

- Non efficiency related capital costs satisfied by plans[16]
- Net Cash Flow for each year of the plans
- Debt load for each year of each plan
- Simple Payback for each plan
- Internal Rate of Return
- Net Present Value
- CO2e reduction for each plan

Financial Definitions[17]

Net Present Value (NPV):
NPV is the difference between the present value of cash inflows and the present value of cash outflows. NPV is used in capital budgeting to analyze the profitability of an investment or project. NPV analysis is sensitive to the reliability of future cash inflows that an investment or project will yield.

[16] Example: a 30 year old Air Conditioner needs to be replaced. The entire cost can be funded though energy efficiency resources (rebates and loans), but only a portion of the cost (30%) is a result of the efficiency enhancement.
[17] http://www.investopedia.com/terms, http://www.visitask.com

$$\mathrm{NPV} = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} - C_0$$

Where
t - the time of the cash flow
n - the total time of the project
r - the discount rate
C_t - the net cash flow (the amount of cash) at time t.
C_0 - the capital outlay at the beginning of the investment time ($t = 0$)

Internal Rate of Return (IRR):
The Internal Rate of Return (IRR) is the discount rate that generates a zero net present value for a series of future cash flows. This essentially means that IRR is the rate of return that makes the sum of present value of future cash flows and the final market value of a project (or an investment) equal its current market value.

Generally speaking, the higher a project's internal rate of return, the more desirable it is to undertake the project. As such, IRR can be used to rank several prospective projects under consideration. Assuming all other factors are equal among the various projects, the project with the highest IRR would probably be considered the best and undertaken first.

The IRR is based on the total investment and energy cost savings over the life of the investment, independent of the financing strategy for the investment.

3.6 Community Benefit

The investments in the specific measures have positive local consequences. The community benefits are quantified and presented in the following outcomes:

1) $$$ Avoided Utility Company Payments: This is the net present value (NPV) of all the avoided electricity and natural gas payments over the 25 year period of the analysis.
2) $$$ Avoided Fuel Payments: The NPV of the avoided gasoline and diesel fuel payments over the 25 year life of the analysis.
3) $$$ Invested Locally in GHG Projects: This is the total capital cost of the measures specified for the plan. This analysis does not attempt to separate labor, material, overhead or profit to more accurately identify the percentage of these investments likely to remain local. The inherent overstatement of this result is balanced to a significant degree by discounting the well-documented economic multiplier effect of local investment (no multiplier is used). Bio-diesel purchase is considered 100% local. In practice, this will depend on the supplier. Ethanol is not considered to be a local purchase.

3.7 Measure Evaluation

The decision to include a measure in the action plan is based on a comprehensive appraisal of that measure and its impact on the overall cost/benefits of the Action Plan. To aid in the selection process, each measure has been evaluated and scored for eight metrics listed below. While informative, the scoring of the measures is not binding on the selection process. The results of the Measure Evaluation are presented in the Appendices.

1) Cost: The measure is scored by the magnitude of the net capital cost, independent of other considerations.
2) Financial Metrics: The measure is scored by the internal rate of return (IRR) and Net Present Value (NPV). IRR and NPV are determined from the investment required for the measure (Net Capital Cost), the annual cost savings and the resulting annual cash flow.
3) Resolution of Existing Problems: This metric evaluates how the measure solves existing problems, such as a failing air conditioning system. The replacement of old mechanical units will save maintenance staff time and associated costs (maintenance savings are not calculated in the cash flows).
4) GHG Impact: The measure is scored on its impact on the reduction of GHG emissions, relative to the other measures under consideration.
5) Public Visibility: Some measures provide an additional benefit by demonstrating to the general public the actions of the jurisdiction to address global warming. Measures such as Photovoltaic systems are scored high for Public Visibility.
6) Employee Impact: The additional burden or inconvenience imposed on city staff is a consideration for any measure under consideration. This metric evaluates this impact. A photovoltaic system has no impact and receives a neutral score of 3. New fleet vehicles will require a change from "business as usual" and results in a lower score. The Commute measure creates transportation options for the City Staff and receives a higher score.
7) Community Impact: The additional benefit, burden or inconvenience imposed on the community is a consideration as well. This metric evaluates this impact. The improvement of public facilities, lighting or HVAC for example, would result in a favorable score. The imposition of additional fees or hardship on the community would result in an unfavorable score.
8) Energy Cost Stabilization: Energy cost variability is a concern for all jurisdictions. The price volatility of natural gas, and the spike in cost for electricity in 2000-2001 give reason to address this vulnerability. This metric evaluates the impact by measure on the city's long term energy cost volatility. The highest value is assigned to energy efficiency measures. Energy saved by efficiency has an effective cost of $0 into the future, as long as the efficiency measure is in place.

4.0 Results

Five plans have been created for consideration by the City of Sonoma. These plans consist of numerous measures to reduce GHG emissions, reduce energy costs, address equipment problems, and reduce the volatility of the city's annual energy costs. Summary information is provided below. The Action Plan Evaluation provided in the Appendices provides an analysis of the relative strengths of each combination of measures. Similar information for each measure is also provided.

4.1 GHG Impacts and Plan Financial Results

Table 4 below provides a comparison of each plan. The "% Reduction" is the amount of CO2e reduced as a percentage of the total city emissions. Plan A, photovoltaic projects only, provides a reduction of 23.5% below the year 2000 (baseline) emissions. Plan E identifies the measures necessary to reduce the city's emissions by approximately 52.1% below year 2000 emissions. The financial analysis is provided with each plan. The IRR and NPV results are based on the 25 year term of the analysis, from 2007 to 2032.

GHG Action Plan Summary					
Analysis	**Plan A**	**Plan B**	**Plan C**	**Plan D**	**Plan E**
% Reduction	23.5%	20.3%	23.6%	37.2%	52.1%
SPB	25.0	7.1	17.0	13.7	20.9
IRR	NA	28.3%	8.8%	13.6%	2.0%
NPV	($1,068,361)	$231,318	$113,184	$572,494	($548,747)
Annual Cash Flow	**Plan A**	**Plan B**	**Plan C**	**Plan D**	**Plan E**
2007	$0	($1,264)	($1,264)	($1,264)	($1,264)
2008	$0	$4,525	$4,525	$4,525	$4,525
2009	$0	($2,736)	($11,381)	($16,106)	($11,370)
2010	$13,140	($1,403)	($9,987)	($14,694)	($33,418)
2011	($77,172)	($453)	($27,642)	($40,566)	($131,353)
2012	($195,798)	$534	($26,062)	($38,816)	($128,884)
2013	($192,197)	$2,921	($23,053)	($60,588)	($257,898)
2014	($188,470)	$4,898	($20,422)	($56,149)	($250,912)
2015	($184,610)	$6,003	($18,628)	($52,423)	($244,551)
2016	($180,615)	$7,152	($4,581)	($32,892)	($237,885)
2017	($216,027)	$8,344	($2,627)	($28,727)	($204,847)
2018	($211,744)	$9,583	($587)	$21,215	($178,885)
2019	($207,311)	$10,870	$1,543	$25,880	($159,315)
2020	($179,853)	$35,073	$26,636	$53,686	($151,446)
2021	($136,644)	($13,734)	($21,234)	$28,039	($62,147)
2022	($101,564)	$37,901	($35,085)	$17,304	($220,118)
2023	($214,494)	$39,397	$33,927	$89,656	$193,131
2024	$125,860	$40,951	$36,581	$95,892	($81,939)
2025	$131,320	$42,564	$39,356	$102,509	$213,270

Table 4: Action Plan Financial Results

The financial analysis is provided with each plan. The critical metrics of Internal Rate of Return (IRR), and Net Present Value (NPV) provide important information to evaluate the worthiness of the investment from a cash flow perspective. It is important to note the large negative net cash flows for Plans in later years. These are incurred by substantial reinvestments in large photovoltaic (PV) systems (replacement of the associated inverters after 12 years), and the replacement of the energy efficient fleet after 10 years of service. The assumption is that the cost of inverters will increase at the generally assumed inflation rate of 3%. However, likely advances in technology, and improved economies of scale for the industry suggest this is overly conservative. The aggressive fleet measure assumes all vehicles are repurchased in one year (after a 10 year life). In practice, the purchases are phased which would improve the net cash flow for 2022 and decrease the cash flows for surrounding years.

Finally, the actual net cash flow is also provided for each plan in Table 4. Plan A is unique, as it is comprised of only photovoltaic projects with the first project completed in 2009. An expanded cash flow table is provided with each plan which breaks out the gross cash flow, annual debt service payment and outstanding principal for each year of the plan. This presentation allows a clear understanding of the impacts of a "financial decision" in 2007 over the life of the plan.

4.2 Action Plan Evaluations

The GHG Emission Reduction Action Plans involve more than CO2e reduction and cash flow. There are critical concerns that should be factored into the decision making process. These include the financial metrics of internal rate of return (IRR) and net present value (NPV) to evaluate the worthiness of the investment; the cost of implementing the measure, some measures come with a large price tag which will challenge liquidity; the degree to which the plan resolves existing problems, such as old, high maintenance air conditioning units; the visibility of the measures to the public, for example the photovoltaic systems are a physical example of actions taken the city and communicate action and commitment to the community. Other key considerations include the employee impacts of new equipment or procedures, which may generate internal opposition; and the impact on the variability of future energy costs and the associated budgetary vulnerability.

Each measure, and the plans as a whole are evaluated by the following considerations:

- Net Capital Cost
- Financial Metrics (IRR and NPV)
- Resolution of Existing Problems
- GHG Impact
- Public Visibility
- Employee Impact
- Community Impact
- Energy Cost Stabilization

The results of the evaluation are provided in the Appendices. The individual scores for each category (cost, financial metrics, etc.) are aggregated to provide an overall score for that measure. While the results provide important information to be considered when selecting measures, the scores are advisory only. A relatively low score does not preclude a measure, nor should a high score guarantee inclusion of the measure in the Action Plans. There will always be additional considerations that are not reflected in the evaluation process.

4.3 Energy Rate Escalation and Associated Budget Vulnerability

There is considerable discussion about the availability of fossil fuels in the near and middle term future (5 to 20 years). The "Peak Oil" movement suggests that we are at or near the point where our increased global demand for oil cannot be supplied from new petroleum discoveries while production from existing oil fields is waning. Similar arguments are made for natural gas supply vs. demand. If demand outstrips supply, simple economics indicate that the cost to consumers will escalate rapidly, until the global demand is sufficiently dampened and realigns with available supply. The concern is significant enough to have prompted a US government sponsored study to determine the impacts of demand exceeding supply in the near future.[18] This issue has important implications for local Sonoma County jurisdictions. Forty percent of PG&E power is generated by natural gas.[19] A spike in the cost of this energy source will result in significant increases in the cost of electrical power, as well as increased volatility in the cost of natural gas and fleet fuel used directly by the City.

The graphs presented on the following pages illustrate the budget impact of future energy cost escalations for fleet fuel and utility provided energy.

[18] Hirsch, Robert. et al. (February 2005) "Peaking of World Oil Production: Impacts, Mitigation, & Risk Management." SAIC.
[19] PG&E Power Content: Eligible Renewables: 13%, Coal: 2%, Large Hydro: 17%, Natural Gas 44%, Nuclear: 23%, Other; 1%, California Energy Commission, www.energy.ca.gov/consumer, May 2007.

All of the measures available to reduce GHG emissions also will reduce the City energy costs. These costs are a significant element of the municipal budget, and the potential volatility of their costs represents a threat beyond the control of City Staff. Figure 5 below provides the trends for the annual cost of fleet fuel and utility supplied electricity and natural gas based on four rate escalation scenarios. The measures contained in this analysis will reduce the vulnerability to energy price increases. These trend lines assume that the City takes no further action to reduce or increase its reliance on fleet fuel, and utility supplied electricity and natural gas.

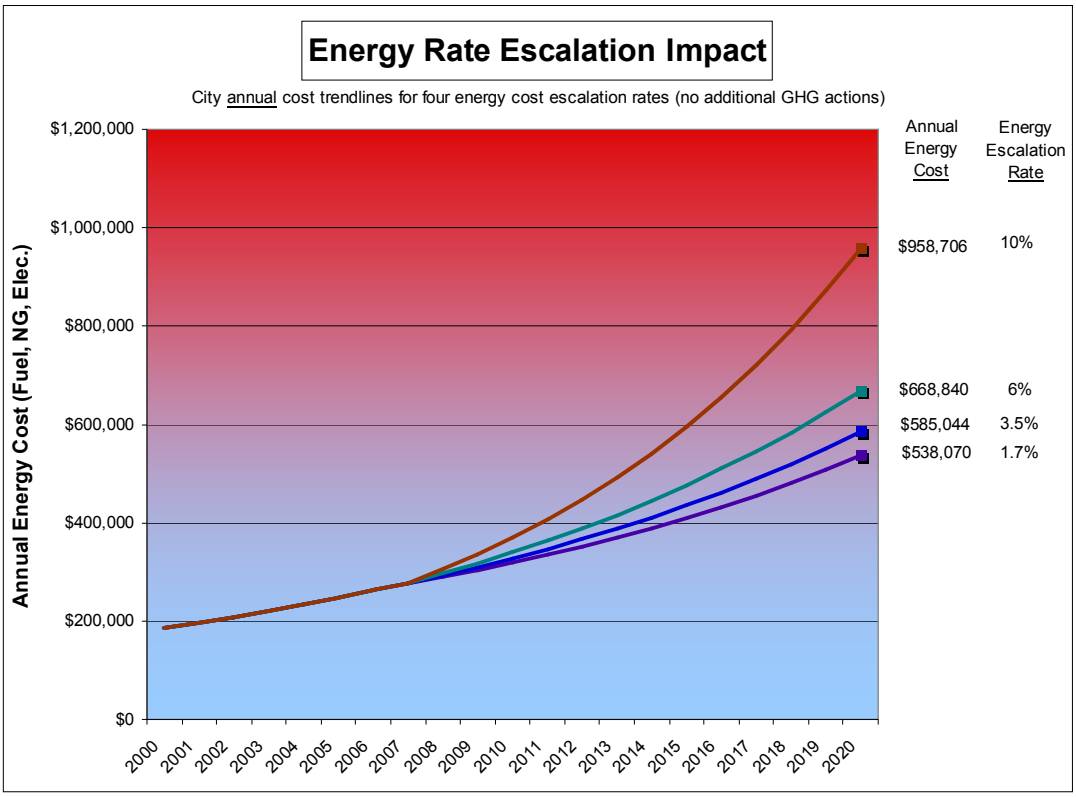


Figure 5: Energy Rate Escalation Scenarios

The future cost of vehicle fuel (gasoline and diesel) is much more volatile than the other energy sources. The cost of this resource has increased by 8% a year on average since 1987 (see the Appendices for further discussion on the cost trends of vehicle fuel). If fuel increases continue at the 8% rate, the future cost will follow the "Current Trend" line in Figure 6 below. However, if prices increase at twice the past rate (represented by the "2 X Current Trend" line) then the annual cost of vehicle fuel will exceed $700,000 by 2020. This trend is discussed in greater detail in the Appendices.

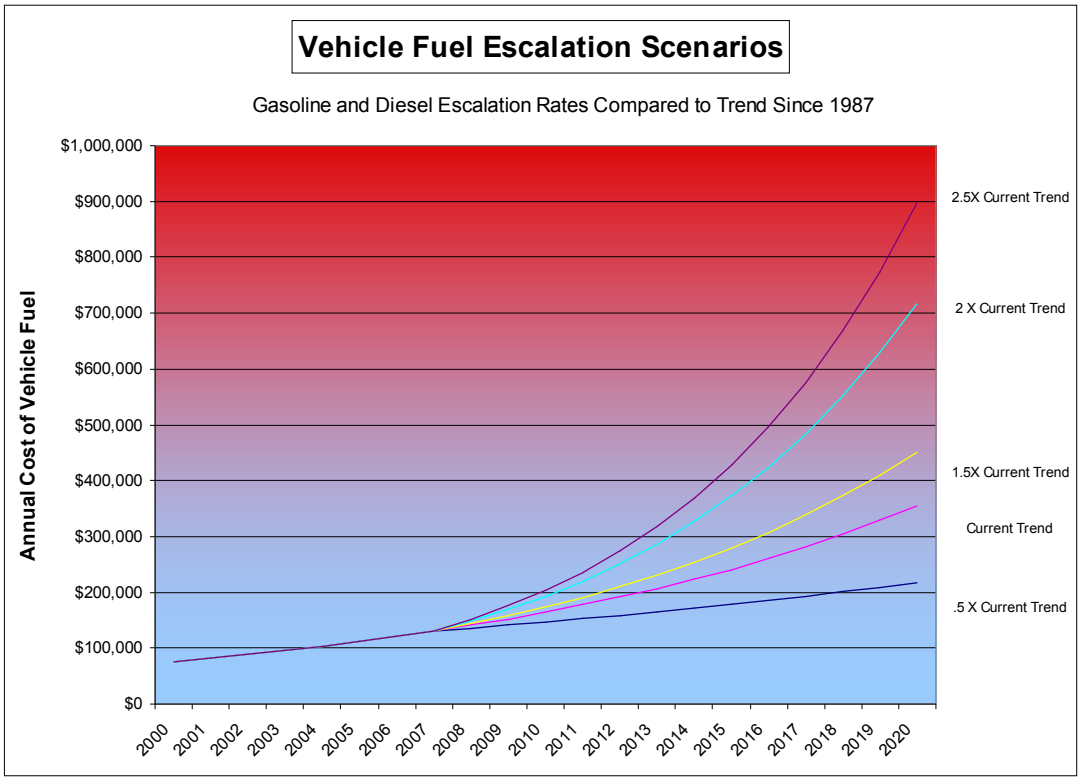


Figure 6: Annual Cost Trend of Vehicle Fuel Only

Energy efficiency projects and photovoltaic energy systems can play a significant role in moderating this vulnerability. Figure 7 below provides potential impact of energy efficiency strategies on the associated vulnerability. For example, under the 3.5% escalation rate scenario, the city would reduce its utility payments by nearly $270,375 per year ($585,044 - $314,669) in 2020 by implementing the aggressive Action Plan E. If there were a significant disruption in the supply of energy in California (represented as an energy escalation rate = 10% per year) the City would reduce payments by a significantly greater amount.

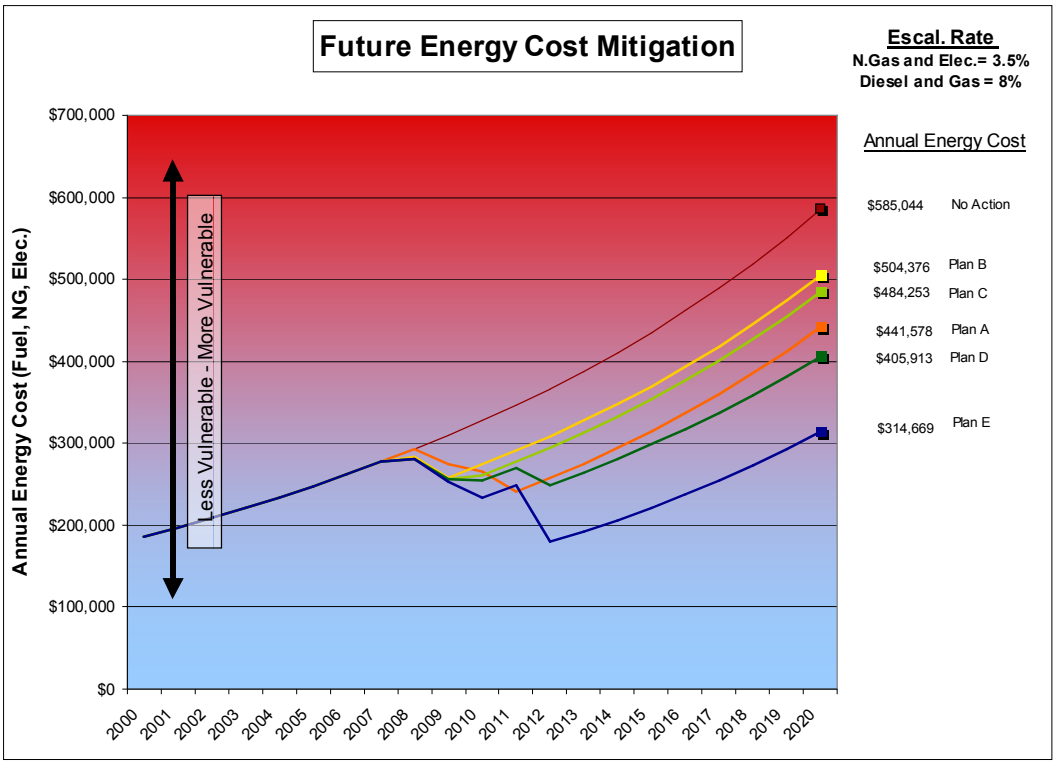


Figure 7: Annual Cost of Energy

The trend lines compare the outcomes for different approaches to energy savings with a 3.5% annual escalation of energy rates:

- No Action, at an utility energy escalation rate of 3.5% ($585,044 annual energy cost in 2020) is represented by the top line indicating the annual cost to the city if the city had not pursued any energy saving projects from 2000 to present, and takes no action in the future.
- Plan B, at an utility energy escalation rate of 3.5% ($467,883) is the annual energy cost including the energy savings achieved by the city staff actions from 2000 to present.
- Plan E ($314,669) is the same escalation scenario as above, but includes the energy efficiency and photovoltaic measures included in Plan E. This is a reduction of over $250,000 in energy budgeting uncertainty between Plan E and the "No Action" scenario for the annual utility escalation rate of 3.5%.

In summary, an aggressive energy strategy could significantly reduce the city's exposure to the rapidly escalating costs. The investments in energy efficiency and PV energy generation will reduce the uncertainty in future energy cost, which is important when developing long term budget projections.

4.4 Non Efficiency Related Capital Cost Satisfied by Plans

Many of the opportunities to reduce energy consumption, and thereby reduce greenhouse gas emissions, involve the replacement of old, poorly performing equipment. In many cases this equipment is at the end of its useful life and is scheduled to be replaced independently of this analysis. In these situations replacement costs are typically budgeted in the city's Capital Improvement Plan as expenditure in future years.

However, the energy efficiency packages identified in these plans can be financed using California Energy Commission energy efficiency loans. These loan packages are typically structured to have a net zero cash flow (energy savings = loan payment). The tables below provide the estimated capital investment satisfied by each plan. Plans B through E specify replacement of the City Hall heat pumps. The estimated cost to replace this equipment with high efficiency units is $14,168. By including this cost in the low interest energy efficiency loan the budgeted capital resources are released for other uses.

Plan A

Pending Capital Expense		Total Pending Capital Expense by Sector	
2007	$0	Buildings	$0
2008	$0	Fleet	$0
2009	$0	Water and Sewer	$0
2010	$0	Commute	$0
2011	$0	PV	$0
2012	$0	Streetlights	$0
2013	$0		
2014	$0		
2015	$0		

Plan B

Pending Capital Expense		Total Pending Capital Expense by Sector	
2007	$14,168	Buildings	$14,168
2008	$0	Fleet	$0
2009	$0	Water and Sewer	$0
2010	$0	Commute	$0
2011	$0	PV	$0
2012	$0	Streetlights	$0
2013	$0		
2014	$0		
2015	$0		

Plan C

Pending Capital Expense		Total Pending Capital Expense by Sector	
2007	$14,168	Buildings	$14,168
2008	$0	Fleet	$0
2009	$0	Water and Sewer	$0
2010	$0	Commute	$0
2011	$0	PV	$0
2012	$0	Streetlights	$0
2013	$0		
2014	$0		
2015	$0		

Plan D

Pending Capital Expense		Total Pending Capital Expense by Sector	
2007	$14,168	Buildings	$14,168
2008	$0	Fleet	$0
2009	$0	Water and Sewer	$0
2010	$0	Commute	$0
2011	$0	PV	$0
2012	$0	Streetlights	$0
2013	$0		
2014	$0		
2015	$0		

Plan E

Pending Capital Expense		Total Pending Capital Expense by Sector	
2007	$14,168	Buildings	$14,168
2008	$0	Fleet	$0
2009	$0	Water and Sewer	$0
2010	$0	Commute	$0
2011	$0	PV	$0
2012	$0	Streetlights	$0
2013	$0		
2014	$0		
2015	$0		

Table 5: Capital Expenses Satisfied by Plans

4.5 Plan Details

Plan A:	155	Tons CO2 Avoided	23.5%	% Reduction
Community Benefit (over 25 year life of plan)			**Financial Metrics**	
$$$ Avoided Utility Company Payments	$1,387,098		SPB	25.0
$$$ Avoided Fuel Purchases	$0		IRR	NA
$$$ Invested Locally in GHG Projects	$2,883,337		NPV	($1,068,361)

Plan A: This plan meets the GHG reduction goal utilizing only photovoltaic systems, replacing electricity purchased from the utility with solar generated electricity. A number of project funding methodologies are included and the total installed PV capacity would replace 64% of the total electricity (kWh) currently purchased from PG&E. These measures (See Plan Details) include systems utilizing IRS zero interest bonds, systems matched to water and sewage pump meters, and systems to offset building electricity consumption. The cash flow reflects the challenging economics of meeting the GHG goal utilizing only one strategy. The Plan Details section provides the specific measures included in each plan. The resulting annual cash flow is the net income to the city (energy cost savings minus project debt service, replacement costs and associated O&M).

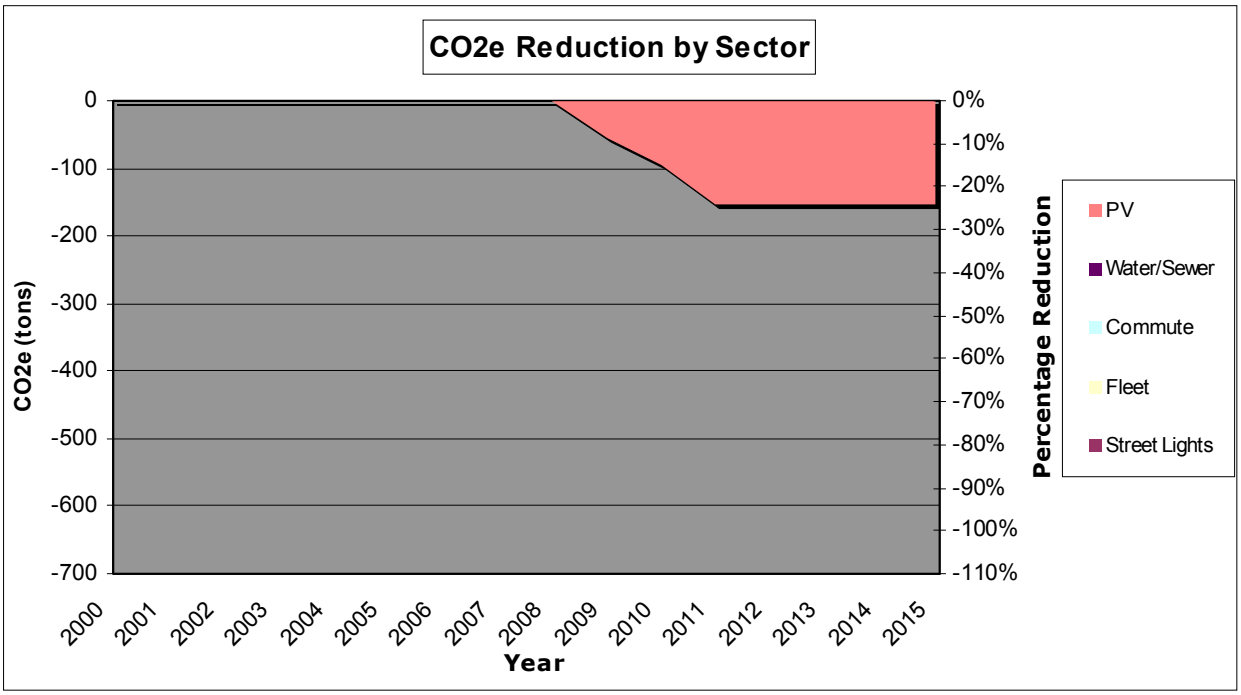


Figure 8: Plan A GHG Emissions Reduction by Sector

The tables below lists the measures included in Plan A, along with the measure status and the net cash flow.

Year	Cash Flow (gross)	Annual Debt Service Payments	Net Cash Flow	Outstanding Principal
2007	$0	$0	$0	$0
2008	$0	$0	$0	$0
2009	$0	$0	$0	$185,936
2010	$36,007	($22,867)	$13,140	$1,210,371
2011	$62,948	($140,121)	($77,172)	$2,720,066
2012	$141,344	($337,142)	($195,798)	$2,490,366
2013	$144,945	($337,142)	($192,197)	$2,251,594
2014	$148,672	($337,142)	($188,470)	$2,003,390
2015	$152,532	($337,142)	($184,610)	$1,745,382
2016	$156,527	($337,142)	($180,615)	$1,477,182
2017	$121,115	($337,142)	($216,027)	$1,198,389
2018	$125,398	($337,142)	($211,744)	$908,583
2019	$129,831	($337,142)	($207,311)	$607,331
2020	$134,422	($314,275)	($179,853)	$317,045
2021	$88,980	($225,624)	($136,644)	$103,945
2022	($72,962)	($28,602)	($101,564)	$79,449
2023	($185,892)	($28,602)	($214,494)	$53,985
2024	$154,462	($28,602)	$125,860	$27,515
2025	$159,922	($28,602)	$131,320	$0

Measure	Description	Implementation Date
Measure 10	PV6 150 kW -CREBS	2009
Measure 11	PV1-30kWac	2009
Measure 12	PV3-60kWac	2010
Measure 13	PV4- 200kWac	2011
Measure 14	PV2 Suppying 100% Wtr &Wste energy cost	2010

Plan B:	134	Tons CO2 Avoided	20.3%	% Reduction

Community Benefit (over 25 year life of plan)		Financial Metrics	
$$$ Avoided Utility Company Payments	$708,412	SPB	7.1
$$$ Avoided Fuel Purchases	$868,415	IRR	28.3%
$$$ Invested Locally in GHG Projects	$1,073,197	NPV	$231,318

Plan B: This plan includes a combination of 8 measures consisting of building efficiency (HVAC and lighting), photovoltaic and fleet fuel initiatives. The building measures in all plans are based on the energy analysis provided by the Association of Bay Area Governments Energy Watch program (ABAG EW). The implementation dates for all measure in this plan span from 2007 to 2011. The plan marginally exceeds the City target of 20% GHG emissions reduction by 2010. The projected reduction of 20.3% does not provide a margin of flexibility for changing conditions and unforeseen difficulties in implementing the plan. The resulting annual cash flow is the net income to the city, energy cost savings minus project debt service, replacement costs and associated O&M.

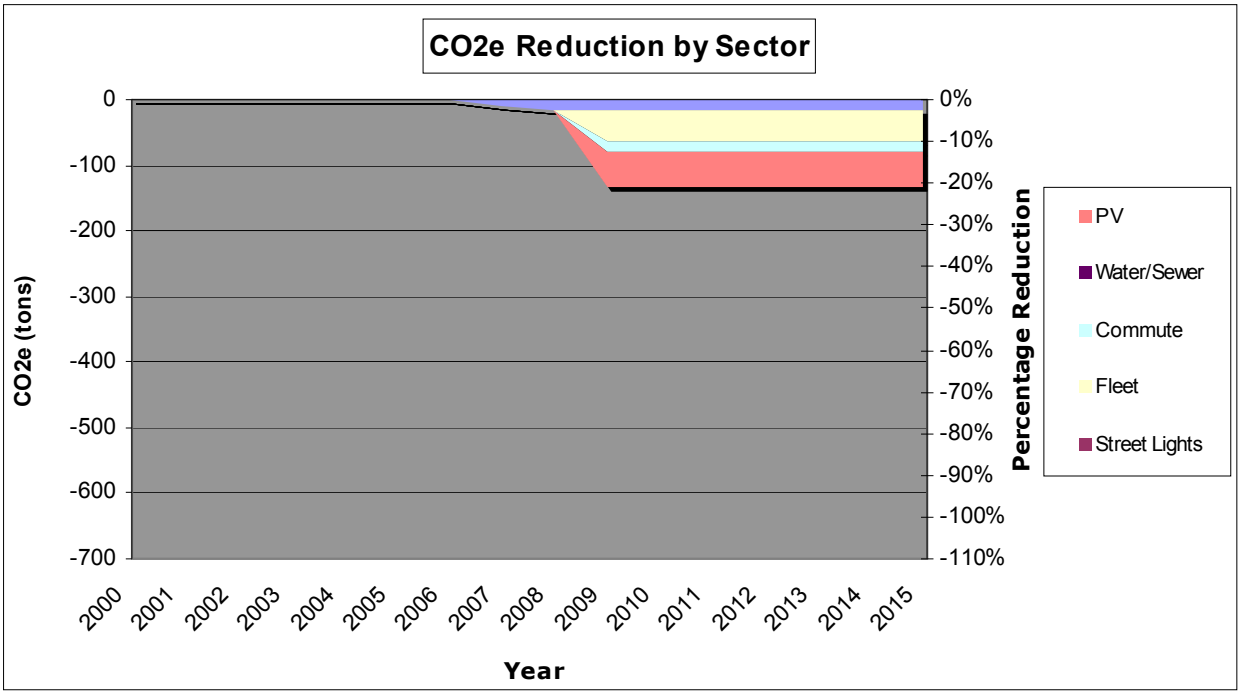


Figure 9: Plan B GHG Emissions Reduction by Sector

The tables below lists the measures included in Plan B, along with the measure status and the net cash flow.

Year	Cash Flow (gross)	Annual Debt Service Payments	Net Cash Flow	Outstanding Principal
2007	($1,264)	$0	($1,264)	$7,336
2008	$6,171	($1,646)	$4,525	$10,047
2009	($178)	($2,558)	($2,736)	$204,822
2010	$25,852	($27,254)	($1,403)	$185,658
2011	$26,802	($27,254)	($453)	$165,737
2012	$27,788	($27,254)	$534	$145,030
2013	$28,530	($25,609)	$2,921	$125,150
2014	$29,594	($24,696)	$4,898	$105,396
2015	$30,700	($24,696)	$6,003	$84,863
2016	$31,848	($24,696)	$7,152	$63,519
2017	$31,212	($22,867)	$8,344	$43,161
2018	$32,450	($22,867)	$9,583	$21,998
2019	$33,737	($22,867)	$10,870	$0
2020	$35,073	$0	$35,073	$0
2021	($13,734)	$0	($13,734)	$0
2022	$37,901	$0	$37,901	$0
2023	$39,397	$0	$39,397	$0
2024	$40,951	$0	$40,951	$0
2025	$42,564	$0	$42,564	$0

Measure Summary	Description	Implementation Date
Measure 1	City Hall HP Replacement	2007
Measure 2	City Hall Programmable Thermostats	2007
Measure 3	Carnegie and Visitor Cntr Prog. Thermostats	2007
Measure 4	Lighting Retrofit	2008
Measure 10	PV6 150 kW -CREBS	2009
Measure 11	PV1-30kWac	2009
Measure 19	Biodiesel B50	2009
Measure 20	Commute	2009

Plan C:	156	Tons CO2 Avoided	23.6%	% Reduction
Community Benefit (over 25 year life of plan)			**Financial Metrics**	
$$$ Diverted from Utility Company	$866,615		SPB	17.0
$$$ Diverted from Fuel Purchases	$995,066		IRR	8.8%
$$$ Invested Locally in GHG Projects	$1,455,320		NPV	$113,184

Plan C: This plan includes 13 measures. In addition to all of the measures of Plan B, Plan C includes a more aggressive biodiesel fuel approach (50% biodiesel), a fleet replacement strategy, and a pump efficiency measures. This plan significantly exceeds the City target of 20% GHG emissions reduction by 2010, yet maintains attractive financial metrics. The Internal Rate of Return approaches 9% and the Net Present Value exceeds $100,000 over the term of the analysis (25 years). The annual net cash flow (energy cost savings minus project debt service, replacement costs and associated O&M) is negative for several years. However, the magnitude appears quite reasonable given the IRR and NPV results.

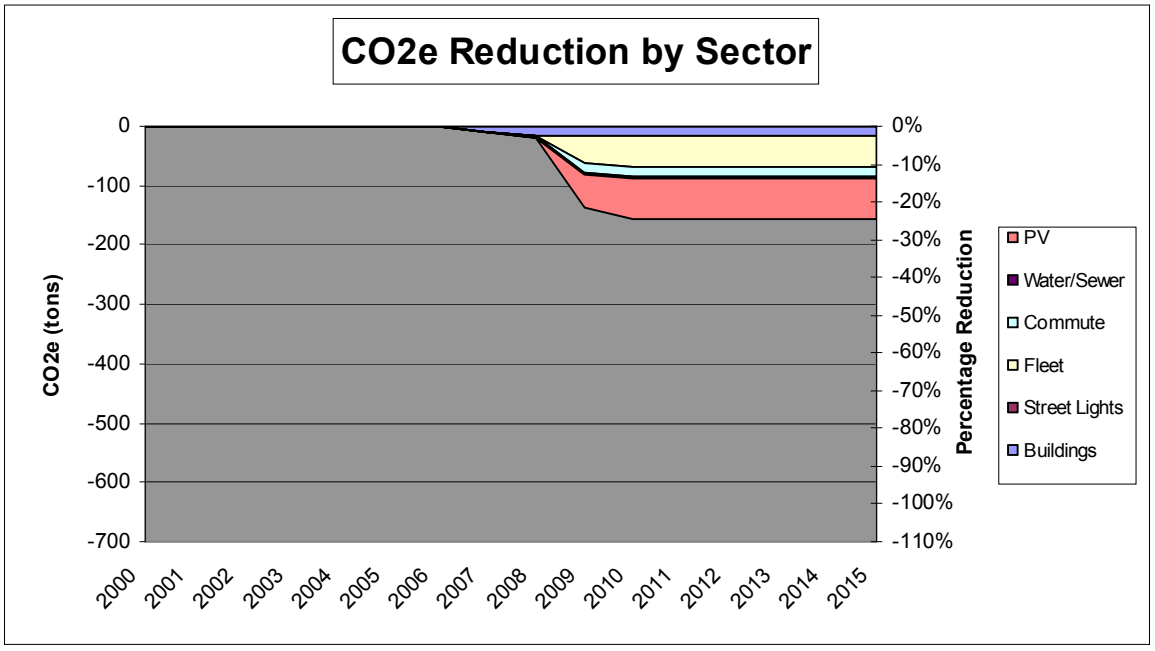


Figure 10: Plan C GHG Emissions Reduction by Sector

The tables below lists the measures included in Plan C, along with the measure status and the net cash flow.

Year	Cash Flow (gross)	Annual Debt Service Payments	Net Cash Flow	Outstanding Principal
2007	($1,264)	$0	($1,264)	$7,336
2008	$6,171	($1,646)	$4,525	$72,469
2009	$1,557	($12,939)	($11,381)	$259,329
2010	$27,648	($37,635)	($9,987)	$559,061
2011	$40,390	($68,032)	($27,642)	$513,112
2012	$41,969	($68,032)	($26,062)	$465,348
2013	$43,333	($66,386)	($23,053)	$417,343
2014	$45,052	($65,474)	($20,422)	$368,354
2015	$46,846	($65,474)	($18,628)	$317,430
2016	$48,718	($53,299)	($4,581)	$276,670
2017	$48,842	($51,469)	($2,627)	$236,129
2018	$50,882	($51,469)	($587)	$193,987
2019	$53,013	($51,469)	$1,543	$150,180
2020	$55,238	($28,602)	$26,636	$127,510
2021	$7,368	($28,602)	($21,234)	$103,945
2022	($6,482)	($28,602)	($35,085)	$79,449
2023	$62,529	($28,602)	$33,927	$53,985
2024	$65,183	($28,602)	$36,581	$27,515
2025	$67,958	($28,602)	$39,356	$0

Measure Summary	Description	Implementation Date
Measure 1	City Hall HP Replacement	2007
Measure 2	City Hall Programmable Thermostats	2007
Measure 3	Carnegie and Visitor Cntr Prog. Thermostats	2007
Measure 4	Lighting Retrofit	2008
Measure 9	Pump Measures 3 (2 units)	2008
Measure 10	PV6 150 kW -CREBS	2009
Measure 11	PV1-30kWac	2009
Measure 14	PV2 Suppying 100% Wtr &Wste energy cost	2010
Measure 17	Vehicle Replacement Strategy 1	2010
Measure 19	Biodiesel B50	2009
Measure 20	Commute	2009

Plan D:	245	Tons CO2 Avoided	37.2%	% Reduction
Community Benefit (over 25 year life of plan)			**Financial Metrics**	
$$$ Avoided Utility Company Payments	$992,228		SPB	13.7
$$$ Avoided Fuel Purchases	$2,025,116		IRR	13.6%
$$$ Invested Locally in GHG Projects	$1,643,870		NPV	$572,494

Plan D: This plan includes all building efficiency projects and many of the measures of Plan B and C for a total of 12 measures. This plan results in almost a doubling of GHG emissions reduction as compared to the City target of 20%. The pump and fleet measures of Plan C are replaced with a much more aggressive fleet replacement strategy and pump replacement measure, and a future streetlighting measure (2010). The combination of measures yields very impressive financial metrics, IRR exceeding 13% and a NPV of over $550,000 over the life of the plan. Furthermore the annual net cash flow is significantly more attractive than the previous plans. The Plan Details section provides the specific measures included in each plan. The resulting annual cash flow is the net income to the city (energy cost savings minus project debt service, replacement costs and associated O&M).

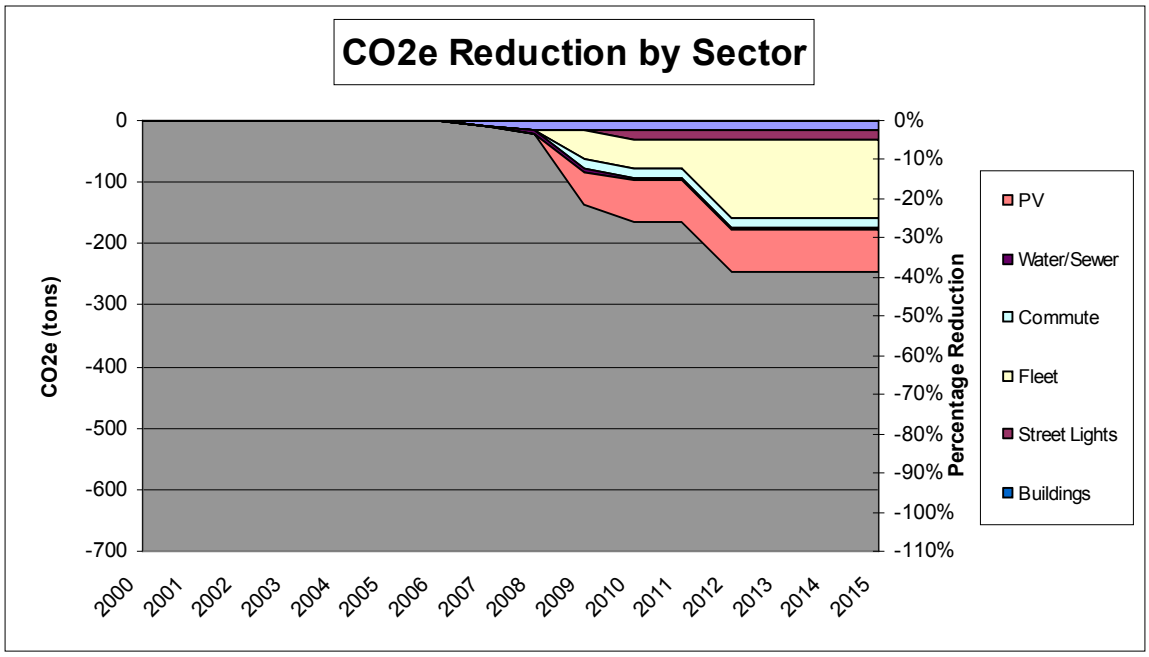


Figure 11: Plan D GHG Emissions Reduction by Sector

The tables below lists the measures included in Plan D, along with the measure status and the net cash flow.

Year	Cash Flow (gross)	Annual Debt Service Payments	Net Cash Flow	Outstanding Principal
2007	($1,264)	$0	($1,264)	$7,336
2008	$6,171	($1,646)	$4,525	$103,807
2009	$2,044	($18,150)	($16,106)	$286,693
2010	$28,152	($42,847)	($14,694)	$731,344
2011	$50,197	($90,763)	($40,566)	$669,469
2012	$51,948	($90,763)	($38,816)	$808,149
2013	$74,065	($134,653)	($60,588)	$705,418
2014	$77,592	($133,741)	($56,149)	$599,541
2015	$81,318	($133,741)	($52,423)	$489,482
2016	$85,256	($118,149)	($32,892)	$390,668
2017	$87,593	($116,319)	($28,727)	$289,780
2018	$91,999	($70,784)	$21,215	$230,443
2019	$96,664	($70,784)	$25,880	$168,761
2020	$101,603	($47,917)	$53,686	$127,510
2021	$56,641	($28,602)	$28,039	$103,945
2022	$45,906	($28,602)	$17,304	$79,449
2023	$118,259	($28,602)	$89,656	$53,985
2024	$124,494	($28,602)	$95,892	$27,515
2025	$131,111	($28,602)	$102,509	$0

Measure Summary	Description	Implementation Date
Measure 1	City Hall HP Replacement	2007
Measure 2	City Hall Programmable Thermostats	2007
Measure 3	Carnegie and Visitor Cntr Prog. Thermostats	2007
Measure 4	Lighting Retrofit	2008
Measure 5	Streetlighting HPS to LED A	2010
Measure 8	Pump Measures 2 (3 units)	2008
Measure 10	PV6 150 kW -CREBS	2009
Measure 11	PV1-30kWac	2009
Measure 14	PV2 Suppying 100% Wtr &Wste energy cost	2010
Measure 18	Vehicle Replacement Strategy 2 (aggressive)	2012
Measure 19	Biodiesel B50	2009
Measure 20	Commute	2009

Plan E:	343	Tons CO2 Avoided	52.1%	% Reduction
Community Benefit (over 25 year life of plan)			**Financial Metrics**	
$$$ Avoided Utility Company Payments	$1,806,418		SPB	20.9
$$$ Avoided Fuel Purchases	$2,025,116		IRR	2.0%
$$$ Invested Locally in GHG Projects	$3,947,030		NPV	($548,747)

Plan E: This plan includes all building efficiency projects and many of the measures of the previous plans for a total of 16 measures. This plan is more aggressive with PV projects, fleet purchases and pump efficiency measures, resulting in more than a doubling of GHG emissions reduction as compared to the City target of 20%. As with Plan D, the pump and fleet measures are replaced with the more aggressive strategies. The future streetlighting measure (2010) is expanded to include 100% of the city fixtures. An additional photovoltaic system is provided to provide energy for the plug in hybrid vehicles in the fleet replacement measure. The combination of measures yields challenging financial metrics, IRR is 2% and the NPV is strongly negative over the life of the plan. The annual net cash flow is more challenging than Plan D, but the plan significantly reduces vulnerability to future energy cost escalation (Figure 6). The Plan Details section provides the specific measures included in each plan. The resulting annual cash flow is the net income to the city (energy cost savings minus project debt service, replacement costs and associated O&M).

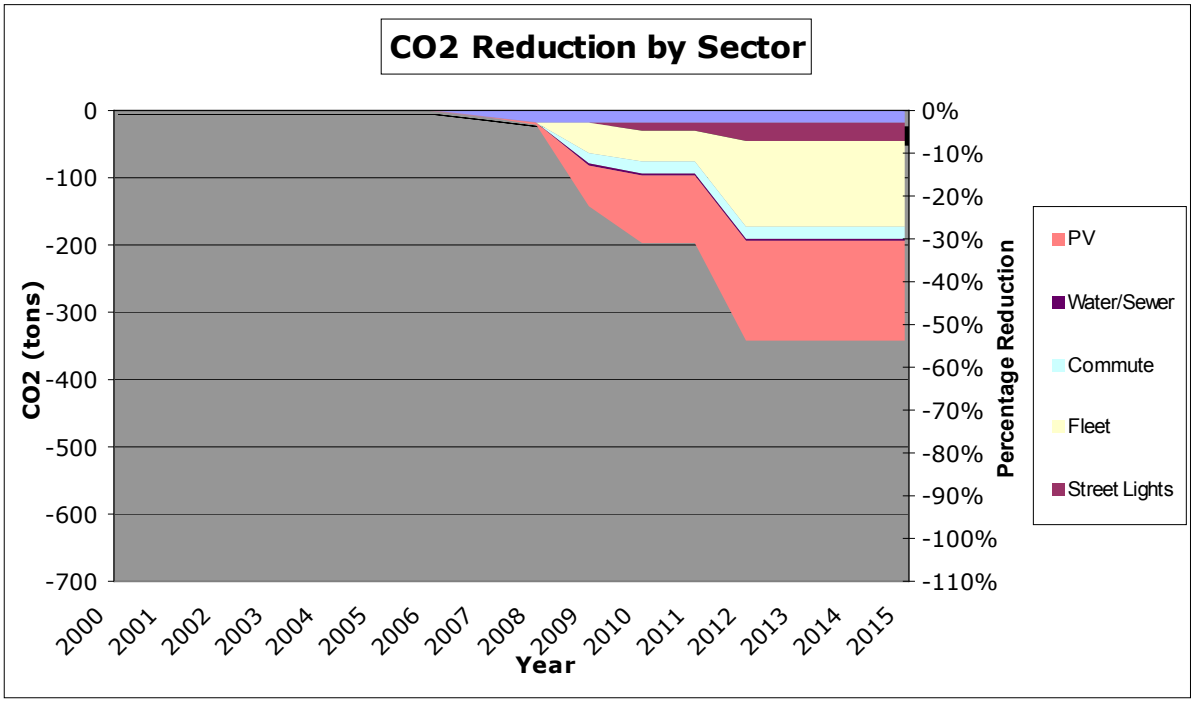


Figure 12: Plan E GHG Emissions Reduction by Sector

The tables below lists the measures included in Plan E, along with the measure status and the net cash flow.

Year	Cash Flow (gross)	Annual Debt Service Payments	Net Cash Flow	Outstanding Principal
2007	($1,264)	$0	($1,264)	$7,336
2008	$6,171	($1,646)	$4,525	$106,692
2009	($8,812)	($2,558)	($11,370)	$450,047
2010	$19,887	($53,305)	($33,418)	$1,599,641
2011	$58,520	($189,873)	($131,353)	$1,461,068
2012	$60,989	($189,873)	($128,884)	$3,039,346
2013	$162,718	($420,616)	($257,898)	$2,726,898
2014	$168,792	($419,704)	($250,912)	$2,403,021
2015	$175,153	($419,704)	($244,551)	$2,066,351
2016	$181,819	($419,704)	($237,885)	$1,716,382
2017	$186,976	($391,824)	($204,847)	$1,380,470
2018	$167,403	($346,288)	($178,885)	$1,076,824
2019	$186,973	($346,288)	($159,315)	$773,070
2020	$171,975	($323,421)	($151,446)	$480,186
2021	$153,308	($215,455)	($62,147)	$283,698
2022	($4,663)	($215,455)	($220,118)	$79,449
2023	$221,733	($28,602)	$193,131	$53,985
2024	($53,337)	($28,602)	($81,939)	$27,515
2025	$241,872	($28,602)	$213,270	$0

Measure Summary	Description	Implementation Date
Measure 1	City Hall HP Replacement	2007
Measure 2	City Hall Programmable Thermostats	2007
Measure 3	Carnegie and Visitor Cntr Prog. Thermostats	2007
Measure 4	Lighting Retrofit	2008
Measure 5	Streetlighting HPS to LED A	2010
Measure 6	Streetlighting HPS to LED B	2012
Measure 7	Pump Measures 1 (5 units)	2009
Measure 10	PV6 150 kW -CREBS	2009
Measure 11	PV1-30kWac	2009
Measure 12	PV3-60kWac	2010
Measure 14	PV2 Suppying 100% Wtr &Wste energy cost	2010
Measure 15	PV2 Suppying 100% Streetlighting Energy Cost	2012
Measure 16	PV2 Suppying 100% Fleet Electric Cnergy Cost	2008
Measure 18	Vehicle Replacement Strategy 2 (aggressive)	2012
Measure 19	Biodiesel B50	2009
Measure 20	Commute	2009

5.0 Measure Details

Table 6 below provides a complete list of the measures considered in this analysis along with the financial data and results for each. The individual measures are described in the Measure Results section of this report.

Measure	Description	Net Capital Cost	O&M incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 1	City Hall HP Replacement	6,072	$0	4,328	14,596	1.40	77.27%	$80,145	0.3%
Measure 2	City Hall Programmable Thermostats	903	$0	803	2,849	1.07	100.34%	$15,915	0.1%
Measure 3	Carnegie and Visitor Cntr Prog. Thermostats	361	$0	490	1,738	0.70	151.29%	$9,890	0.0%
Measure 4	Lighting Retrofit	4,067	$0	4,080	14,482	0.95	112.78%	$81,386	0.3%
Measure 5	Streetlighting HPS to LED A	157,050	($11,453)	0	29,435	13.71	8.43%	$64,855	0.6%
Measure 6	Streetlighting HPS to LED B	157,050	($11,453)	0	29,435	13.71	8.43%	$64,855	0.6%
Measure 7	Pump Measures 1 (5 units)	156,649	$0	2,344	8,321	63.49	-2.89%	($100,203)	0.2%
Measure 8	Pump Measures 2 (3 units)	93,759	$0	2,040	7,242	43.66	-0.53%	($46,659)	0.1%
Measure 9	Pump Measures 3 (2 units)	62,422	$0	1,593	5,655	37.22	0.55%	($26,156)	0.1%
Measure 10	PV6 150 kW -CREBS	0	$0	28,014	90,988	NA	NA	$585,460	1.7%
Measure 11	PV1-30kWac	185,936	$599	5,603	18,198	31.53	NA	($118,962)	0.3%
Measure 12	PV3-60kWac	720,834	$1,798	16,808	54,593	40.74	NA	($512,151)	1.0%
Measure 13	PV4- 200kWac	1,602,005	$4,001	37,402	121,482	40.69	NA	($974,662)	2.3%
Measure 14	PV2 Suppying 100% Wtr &Wste energy cost	319,124	$794	9,211	24,100	32.91	NA	($189,528)	0.5%
Measure 15	PV2 Suppying 100% Streetlighting Energy Cost	1,362,275	$3,402	40,088	103,284	32.28	-2.66%	($683,395)	2.0%
Measure 16	PV2 Suppying 100% Fleet Electric Energy Cost	96,644	$275	3,416	8,361	28.29	-2.51%	($51,316)	0.1%
Measure 17	Vehicle Replacement Strategy 1	8,000	$0	2,209	14,595	3.44	39.34%	$73,904	0.3%
Measure 18	Vehicle Replacement Strategy 2 (aggressive)	203,000	$0	18,109	162,165	10.65	16.67%	$474,848	3.1%
Measure 19	Biodiesel B50	11,000	$0	0	90,990	NA	NA	($10,476)	1.7%
Measure 20	Commute	0	$22,500	0	33,273	NA	NA	($421,235)	0.6%

Table 6: List of Measures

5.1 Measure Selection

Each Plan is comprised of measures from the tables above. The makeup of each plan is provided in the table below. A "y" in the column under the Action Plan (A –E) in the first five columns indicates that the measure is included in that plan. Action Plan A is comprised of 5 photovoltaic measures. Action Plan E is comprised of 16 individual measures.

Action Plan					Measure Summary	Description	Implementation Date
A	B	C	D	E			
n	y	y	y	y	**Measure 1**	City Hall HP Replacement	2007
n	y	y	y	y	**Measure 2**	City Hall Programmable Thermostats	2007
n	y	y	y	y	**Measure 3**	Carnegie and Visitor Cntr Prog. Thermostats	2007
n	y	y	y	y	**Measure 4**	Lighting Retrofit	2008
n	n	n	y	y	**Measure 5**	Streetlighting HPS to LED A	2010
n	n	n	n	y	**Measure 6**	Streetlighting HPS to LED B	2012
n	n	n	n	y	**Measure 7**	Pump Measures 1 (5 units)	2009
n	n	n	y	n	**Measure 8**	Pump Measures 2 (3 units)	2008
n	n	y	n	n	**Measure 9**	Pump Measures 3 (2 units)	2008
y	y	y	y	y	**Measure 10**	PV6 150 kW -CREBS	2009
y	y	y	y	y	**Measure 11**	PV1-30kWac	2009
y	n	n	n	y	**Measure 12**	PV3-60kWac	2010
y	n	n	n	n	**Measure 13**	PV4- 200kWac	2011
y	n	y	y	y	**Measure 14**	PV2 Suppying 100% Wtr &Wste energy cost	2010
n	n	n	n	y	**Measure 15**	PV2 Suppying 100% Streetlighting Energy Cost	2012
n	n	n	n	y	**Measure 16**	PV2 Suppying 100% Fleet Electric Energy Cost	2008
n	n	y	n	n	**Measure 17**	Vehicle Replacement Strategy 1	2010
n	n	n	y	y	**Measure 18**	Vehicle Replacement Strategy 2 (aggressive)	2012
n	y	y	y	y	**Measure 19**	Biodiesel B50	2009
n	y	y	y	y	**Measure 20**	Commute	2009
5	8	11	12	16			

Table 7: Plan Compositions

5.2 Measures Results

The measures considered for inclusion in the plans are described below. Each measure includes a table indicating which Action Plans include that measure. For example, Measure 3 – Programmable Thermostats is included in Plans B, C, D, and E as indicated by "y" under each plan. However, this measure is not included in Action Plan A.

Action Plan				
A	B	C	D	E
n	y	y	y	y

The description of each measure also includes a table listing the results of the measure: the cost of implementation, the annual savings, the GHG impact and the financial metrics of simple payback, internal rate of return (IRR) and net present value (NPV). Again using Measure 3-Programmable Thermostats as an example:

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 3	Carnegie and Visitor Cntr Prog. Thermostats	2007	$361	$0	$490	1,738	0.7	151.3%	$9,890	0.0%

Finally, each measure description includes the Selection Evaluation table to enable a comprehensive appraisal and relational comparison of the benefits of each opportunity. The complete table of measure evaluations is provided in the Appendices. The Selection Evaluation table for Measure 3 is provided below as an example:

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)											
Weighting		1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description		Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Measure 3	Carnegie and Visitor Cntr Prog. Thermostats	3.0	1.1	5.0	0.2	3.0	0.0	0.0	0.3	13	36

The measures considered in this analysis are listed in the following pages, with a brief description of each. The inputs, assumptions and results are provided for each measure in the Appendices.

Action Plan				
A	B	C	D	E
n	y	y	y	y

1-City Hall Heat Pump Replacement

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 1	City Hall HP Replacement	2007	$20,240	$0	$4,328	14,596	4.7	25.5%	$66,651	0.3%

The Association of Bay Area Governments Energy Watch program (ABAG EW) provided an analysis of the city facilities seeking energy efficiency opportunities. Recommendation EEM-1: Replace existing heat pumps at City Hall with new high-efficiency units provides the following summary.

> *The City Hall is conditioned by five split-system heat pumps. These units are old and inefficient, and are at or near the end of their useful life. The rated cooling efficiencies of these units are from 7.8 SEER to 10.0 SEER, while their average heating efficiencies (COP) range approximately from 2.30 to 2.70.* [20]

The report recommends replacing these heat pumps with new units with much higher cooling and heating efficiencies. A standard unit is rated 13 SEER. The energy efficient units recommended by ABAG EW range from between 15 and 19 SEER rating.

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
City Hall HP Replacement	2.9	3.0	4.0	1.4	4.0	1.0	1.0	3.1	20	62

[20] Preliminary Audit Report: City of Sonoma, Association of Bay Area Governments Energy Watch, August 14, 2007

Action Plan				
A	B	C	D	E
n	y	y	y	y

2-City Hall Programmable Thermostats

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 2	City Hall Programmable Thermostats	2007	$903	$0	$803	2,849	1.1	100.3%	$15,915	0.1%

The Association of Bay Area Governments Energy Watch program (ABAG EW) provided an analysis of the city facilities seeking energy efficiency opportunities. Recommendation EEM-2: Replace Manual Thermostats at City Hall with Programmable Thermostats provides the following summary.

> *The heat pumps serving the City Hall are currently controlled with manual thermostats. It is estimated that roughly half the time the cooling and heating setpoints during occupied period are left on unchanged during unoccupied periods.*
>
> *We recommend replacing the thermostats with programmable thermostats so that space temperatures during unoccupied periods can be set back automatically, thereby reducing cooling and heating loads. In the past programmable thermostats were generally not recommended for heat pumps. In its cooling mode, a heat pump operates like an air conditioner, so turning up the thermostat (either manually or with a programmable thermostat) will save energy. But when a heat pump is in its heating mode, setting back its thermostat can cause the unit to operate inefficiently, thereby canceling out any savings achieved by lowering the temperature setting. Recently, however, a number of companies have begun selling specially designed programmable thermostats for heat pumps, which make setting back the thermostat cost-effective. These thermostats typically use special algorithms to minimize the use of backup electric resistance heat systems.*[21]

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 22 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
City Hall Programmable Thermostats	3.0	1.9	5.0	0.3	3.0	2.0	0.0	0.6	16	45

[21] Preliminary Audit Report: City of Sonoma, Association of Bay Area Governments Energy Watch, August 14, 2007

Action Plan				
A	B	C	D	E
n	y	y	y	y

3-Carnegie and Visitor Center Programmable Thermostats

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 3	Carnegie and Visitor Cntr Prog. Thermostats	2007	$361	$0	$490	1,738	0.7	151.3%	$9,890	0.0%

The Association of Bay Area Governments Energy Watch program (ABAG EW) provided an analysis of the city facilities seeking energy efficiency opportunities. Recommendation EEM-3: Replace Manual Thermostats at Carnegie Library and Visitor Center with Programmable Thermostats provides the following summary.

> *The Carnegie Library and Visitor Center is heated and cooled by two split-system heat pumps that are currently controlled with manual thermostats. It is estimated that roughly half the time the cooling and heating setpoints during occupied period are left on unchanged during unoccupied periods.*
>
> *We recommend replacing the thermostats with programmable thermostats so that space temperatures during unoccupied periods can be set back automatically, thereby reducing cooling and heating loads.*[22]

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Carnegie and Visitor Cntr Prog. Thermostats	3.0	1.1	5.0	0.2	3.0	0.0	0.0	0.3	13	36

[22] Preliminary Audit Report: City of Sonoma, Association of Bay Area Governments Energy Watch, August 14, 2007

Action Plan				
A	B	C	D	E
n	y	y	y	y

4-ABAG EW Lighting Retrofit

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 4	Lighting Retrofit	2008	$4,067	$0	$4,080	14,482	0.9	112.8%	$81,386	0.3%

The Association of Bay Area Governments Energy Watch program (ABAG EW) provided an analysis of the city facilities seeking energy efficiency opportunities. Recommendation EEM-4: Lighting Retrofits in City Hall, Carnegie Library/ Visitor Center, and Corp Yard Shop provides the following summary.

> *As mentioned above, City Hall, the Carnegie Library/ Visitor Center, and Corp Yard Shop currently have a mix of T12 lamps and first generation (aka 700 series) T8 lamps. Retrofitting these fixtures with second generation (aka 800 series) T8 lamps is recommended and would result in an estimated savings of 28,000 kWh/year, the majority of which comes from retrofitting fixtures in the Corp Yard Shop.*[23]

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 22 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Lighting Retrofit	2.9	3.0	2.0	1.4	3.0	(1.0)	1.0	2.9	15	47

[23] Preliminary Audit Report: City of Sonoma, Association of Bay Area Governments Energy Watch, August 14, 2007

Action Plan				
A	B	C	D	E
n	n	n	y	y

5- Streetlighting HPS to LED (A)

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 5	Streetlighting HPS to LED A	2010	$157,050	($11,453)	$0	29,435	13.7	8.4%	$64,855	0.6%

Streetlighting consumes over 400,000 kWh per year, representing a substantial percentage of the city total. The broad demand for greater efficiencies in this sector is driving aggressive efforts to bring a new generation of streetlighting options to the market. The cities of Raleigh, NC, Ontario Canada and Oakland, CA have launched pilot installations to test more efficient products currently available. The analysis for this measure is based on the assumptions in the table below. A key step in the adoption of this measure will be the negotiation of a PG&E tariff that reflects the utilization of this new technology. The implementation of this measure is delayed until 2010 to allowing for the maturation of this new technology.

401,301	kWh: Streetlight usage from baseline worksheet
60,195	kWh saved with this measure
1047	Total number of City fixtures
50%	Percentage of fixtures in this measure
523.5	Number of fixtures affected by this measure
$300	Incremental cost per fixture
30%	Reduction in PG&E billing rate
$11,453	PG&E billing savings (expected due to saved maintenance and reduced kWh) Requires new PG&E tariff.
Lamp Life	(for implementation schedule, reduced maintenance)
24,000	hours (HPS)
4380	annual hours of operation per year
5.5	years of operation
70,000	hours (LED)
4380	annual hours of operation per year
16.0	years of operation

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	**1**	**5**	**4**	**4**	**2**	**2**	**3**	**3**	**Measure Score**	**Adjusted Measure Score**
Description	**Cost**	**Financial Metrics**	**Resolution of Existing Problem**	**GHG Impact**	**Public Visibility**	**Employee Impact**	**Community Impact**	**Energy Cost Stabilization**		
Streetlighting HPS to LED A	(0.0)	1.3	3.0	2.8	3.0	0.0	0.0	6.0	16	54

Action Plan				
A	B	C	D	E
n	n	n	n	y

6- Streetlighting HPS to LED (B)

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 6	Streetlighting HPS to LED B	2012	$157,050	($11,453)	$0	29,435	13.7	8.4%	$64,855	0.6%

Streetlighting consumes over 400,000 kWh per year, representing a substantial percentage of the city total. The broad demand for greater efficiencies in this sector is driving aggressive efforts to bring a new generation of streetlighting options to the market. The cities of Raleigh, NC, Ontario Canada and Oakland, CA have launched pilot installations to test more efficient products currently available. The analysis for this measure is based on the assumptions in the table below. A key step in the adoption of this measure will be the negotiation of a PG&E tariff that reflects the utilization of this new technology. The implementation of this measure is delayed until 2010 to allowing for the maturation of this new technology.

401,301	kWh: Streetlight usage from baseline worksheet
60,195	kWh saved with this measure
1047	Total number of City fixtures
50%	Percentage of fixtures in this measure
523.5	Number of fixtures affected by this measure
$300	Incremental cost per fixture
30%	Reduction in PG&E billing rate
$11,453	PG&E billing savings (expected due to saved maintenance and reduced kWh) Requires new PG&E tariff.
Lamp Life	(for implementation schedule, reduced maintenance)
24,000	hours (HPS)
4380	annual hours of operation per year
5.5	years of operation
70,000	hours (LED)
4380	annual hours of operation per year
16.0	years of operation

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Streetlighting HPS to LED B	(0.0)	1.3	3.0	2.8	4.0	(1.0)	0.0	6.0	16	54

Action Plan				
A	B	C	D	E
n	n	n	n	y

7-Pump Measures (1)

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 7	Pump Measures 1 (5 units)	2009	$156,649	$0	$2,344	8,321	63.5	-2.9%	($100,203)	0.2%

The city operates 5 pumps that consume more than 4,000 kWh annually each. This group of pumps consumes over 74,000 kWh per year. The approximate savings available for these five pumps is based on efficiency reports completed on similarly sized motor pump combinations. The estimated cost for this measure is derived from the costs associated with repairs of the pumps identified in the efficiency reports used as a reference. The first step in the implementation of this measure would be to complete pump testing, currently available through PG&E at little or no cost (CPUC funded efficiency program).

Included in Measure	Description	Total Annual Usage (kWh)	Estimated kWh Savings	Estimated Retrofit Cost	Estimated Rebate	Net Cost	Cost Savings
y	Booster Pump	28,637	6,578	$31,500	$329	$31,171	$954
y	Pump #1	21,714	4,987	$31,500	$249	$31,251	$723
y	Pump #6	14,129	3,245	$31,500	$162	$31,338	$471
y	Pump #4	5,328	1,224	$31,500	$61	$31,439	$177
y	Pump #3	4,276	982	$31,500	$49	$31,451	$142
n	Pump #5	1,196	275	$31,500	$14	$31,486	$40
n	Pump #2	0	0	$31,500	$0	$31,500	$0

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 22 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Pump Measures 1 (5 units)	0.0	(3.0)	3.0	0.8	3.0	0.0	0.0	1.7	5	11

Action Plan				
A	B	C	D	E
n	n	n	y	n

8-Pump Measures (2)

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 8	Pump Measures 2 (3 units)	2008	$93,759	$0	$2,040	7,242	43.7	-0.5%	($46,659)	0.1%

The city operates 3 pumps that consume more than 14,000 kWh annually each. This group of pumps consumes over 64,000 kWh per year. The approximate savings available for these pumps is based on efficiency reports completed on similarly sized motor pump combinations. The estimated cost for this measure is derived from the costs associated with repairs of the pumps identified in the efficiency reports used as a reference. The first step in the implementation of this measure would be to complete pump testing, currently available through PG&E at little or no cost (CPUC funded efficiency program).

Included in Measure	Description	Total Annual Usage (kWh)	Estimated kWh Savings	Estimated Retrofit Cost	Estimated Rebate	Net Cost	Cost Savings
y	Booster Pump	28,637	6,578	$31,500	$329	$31,171	$954
y	Pump #1	21,714	4,987	$31,500	$249	$31,251	$723
y	Pump #6	14,129	3,245	$31,500	$162	$31,338	$471
n	Pump #4	5,328	1,224	$31,500	$61	$31,439	$177
n	Pump #3	4,276	982	$31,500	$49	$31,451	$142
n	Pump #5	1,196	275	$31,500	$14	$31,486	$40
n	Pump #2	0	0	$31,500	$0	$31,500	$0

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Pump Measures 2 (3 units)	1.2	(3.0)	3.0	0.7	3.0	0.0	0.0	1.5	6	11

Action Plan				
A	B	C	D	E
n	n	y	n	n

9- Pump Measures (3)

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 9	Pump Measures 3 (2 units)	2008	$62,422	$0	$1,593	5,655	37.2	0.5%	($26,156)	0.1%

The city operates 2 pumps that consume more than 21,000 kWh annually each. This group of pumps consumes over 50,000 kWh per year. The approximate savings available for these pumps is based on efficiency reports completed on similarly sized motor pump combinations. The estimated cost for this measure is derived from the costs associated with repairs of the pumps identified in the efficiency reports used as a reference. The first step in the implementation of this measure would be to complete pump testing, currently available through PG&E at little or no cost (CPUC funded efficiency program).

Included in Measure	Description	Total Annual Usage (kWh)	Estimated kWh Savings	Estimated Retrofit Cost	Estimated Rebate	Net Cost	Cost Savings
y	Booster Pump	28,637	6,578	$31,500	$329	$31,171	$954
y	Pump #1	21,714	4,987	$31,500	$249	$31,251	$723
n	Pump #6	14,129	3,245	$31,500	$162	$31,338	$471
n	Pump #4	5,328	1,224	$31,500	$61	$31,439	$177
n	Pump #3	4,276	982	$31,500	$49	$31,451	$142
n	Pump #5	1,196	275	$31,500	$14	$31,486	$40
n	Pump #2	0	0	$31,500	$0	$31,500	$0

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Pump Measures 3 (2 units)	1.8	(2.9)	3.0	0.5	3.0	0.0	0.0	1.1	7	11

Action Plan				
A	B	C	D	E
y	y	y	y	y

10-PV-6: 150 kW - CREBS

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 10	PV6 150 kW -CREBS	2009	$0	$0	$28,014	90,988	0.0	NA	$585,460	1.7%

Clean Renewable Energy Bonds (CREBS) are IRS enabled tax free bonds for renewable energy allowing the installation of photovoltaic systems at no cost to the City. These can be installed on existing buildings and on parking shade structures. Under this scenario, the "rights" to the power are assigned to a third party and a power purchase agreement is established with the city. The rate is set marginally below the utility rate. At the end of the term of the contract the rights to the power revert back to the city for the remainder of the life of the system. This analysis is based on total of 150 kW, installed as numerous smaller systems (~30kW) on city owned facilities yet to be defined.

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
PV6 150 kW -CREBS	3.0	3.0	3.0	6.0	6.0	0.0	0.0	6.0	27	84

Action Plan				
A	B	C	D	E
y	y	y	y	y

11-PV-1: 30 kW

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 11	PV1-30kWac	2009	$185,936	$599	$5,603	18,198	31.5	NA	($118,962)	0.3%

This measure is a photovoltaic (30 kWac) system which would offset the kWh consumption of a city building, installed on the existing roof or as a parking shade structure. The low IRR and negative NPV reflect the diminishing CPUC incentives over the next few years. The current incentive programs will end prior to the implementation date of 2011. However, the CPUC may refund the PV incentive programs, which would improve the financial metrics of this opportunity.

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
PV1-30kWac	(0.6)	(3.0)	3.0	1.7	6.0	0.0	0.0	4.0	11	27

Action Plan				
A	B	C	D	E
y	n	n	n	y

12-PV-3: 60 kW

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 12	PV3-60kWac	2010	$720,834	$1,798	$16,808	54,593	40.7	NA	($512,151)	1.0%

This photovoltaic (60 kWac) system installation would also offset the kWh consumption of a city building, installed on the existing roof or as a parking shade structure. The low IRR and negative NPV reflect the diminishing CPUC incentives over the next few years. The current incentive programs will end prior to the implementation date of 2011. However, the CPUC may refund the PV incentive programs, which would improve the financial metrics of this opportunity.

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
PV3-60kWac	(3.0)	(3.0)	3.0	5.2	6.0	0.0	0.0	6.0	14	45

Action Plan				
A	B	C	D	E
y	n	n	n	n

13-PV-4: 200 kW

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 13	PV4- 200kWac	2011	$1,602,005	$4,001	$37,402	121,482	40.7	NA	($974,662)	2.3%

This measure is provided to allow a plan that meets the GHG goal using only photovoltaic systems, Measure 13 represents a total of 200 kW spread over a number of projects whose installation that would offset the kWh consumption of a city building, installed on the existing roof or as a parking shade structure. The low IRR and negative NPV reflect the diminishing CPUC incentives over the next few years. The current incentive programs will end prior to the implementation date of 2011. However, the CPUC may refund the PV incentive programs, which would improve the financial metrics of this opportunity. The measure is only included in Plan A.

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
PV4- 200kWac	(3.0)	(3.0)	3.0	6.0	6.0	0.0	0.0	6.0	15	48

Action Plan				
A	B	C	D	E
y	n	y	y	y

14- PV Supplying 100% Water and Waste Water Energy Costs

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 14	PV2 Suppying 100% Wtr &Wste energy cost	2010	$319,124	$794	$9,211	24,100	32.9	NA	($189,528)	0.5%

Photovoltaic (PV) systems are available for electricity generation to offset the energy consumption of water pumping. This strategy has been successfully used within other Sonoma County enterprise funds, providing a positive cash flow to the fund by financing the measure with an appropriately long term for repayment. The application of PV systems to water supply pumping situations is particularly attractive due the ability to schedule the majority of the pumping at night when energy rates are low (utilizing the capacity of the storage tanks). The PV systems generate energy during the day when it is most valuable. Therefore the energy produced is much more valuable than the energy purchased from the utility for that meter. This measure specifies a 40 kW system which is sized to offset 100% of the energy cost associated with the city pumps.

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
PV2 Suppying 100% Wtr &Wste energy cost	(3.0)	(3.0)	3.0	2.3	6.0	0.0	0.0	6.0	11	33

Action Plan				
A	B	C	D	E
n	n	n	n	y

15-PV Supplying 100% Streetlighting Energy Costs

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 15	PV2 Suppying 100% Streetlighting Energy Cost	2012	$1,362,275	$3,402	$40,088	103,284	32.3	-2.7%	($683,395)	2.0%

The streetlights consume energy during the night when energy costs are low. A photovoltaic system configured to offset this night usage would create its energy during the day when the energy produced is more valuable. The implementation of this measure would require a rules change within the CPUC to allow internal "wheeling" where energy produced anywhere with the city's meter network would be credited to any account to the benefit of the municipality. Such a rule change was included in legislation emerging from the CA Legislature in 2007. It failed to garner the required signature by the Governor for reasons unrelated to this issue. Industry watchers are expecting better success in the coming rounds. This measure specifies a 170 kW system that is sized to offset 100% of the energy cost associated with the city streetlighting. It would provide approximately 224,000 kWh. This measure is coordinated with the streetlighting efficiency measures. This measure is included only in the most aggressive Action Plan.

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
PV2 Suppying 100% Streetlighting Energy cost	(3.0)	(3.0)	3.0	6.0	6.0	0.0	0.0	6.0	15	48

Action Plan				
A	B	C	D	E
n	n	n	n	y

16-PV Supplying 100% Fleet Electrical Energy Costs

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 16	PV2 Suppying 100% Fleet Electric Cnergy Cost	2008	$96,644	$275	$3,416	8,361	28.3	-2.5%	($51,316)	0.1%

This photovoltaic system strategy is matched to measure 18, which includes plug-in electric vehicles. These vehicles would be charged during the night when energy costs are low. A photovoltaic system configured to offset this night usage would create its energy during the day when the energy produced is more valuable. The central charging meter would also serve the PV system. Therefore CPUC rule change would not be required. This measure specifies a 14 kW system that is sized to offset 100% of the energy cost associated with the city fleet charging. It would provide approximately 47,000 kWh. This measure is coordinated with the fleet efficiency measure. This measure is included only in the most aggressive Action Plan.

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
PV2 Suppying 100% Fleet electric energy cost	2.7	(3.0)	3.0	0.1	6.0	0.0	0.0	0.1	9	12

Action Plan				
A	B	C	D	E
n	n	y	n	n

17-Vehicle Replacement Strategy (1)

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 17	Vehicle Replacement Strategy 1	2010	$8,000	$0	$2,209	14,595	3.4	39.3%	$73,904	0.3%

Measure 17 is based on replacing two Ford Explorers with Ford Escape Hybrids, or an equivalent vehicle within the fleet vehicle rotation and replacement schedule. While the Explorer vehicles may not require replacement by the 2010 implementation date, there may be opportunities to shift the existing vehicles and enabling this strategy when other vehicles require replacement. The project costs are the incremental cost associated with the purchase of the hybrid version over the standard version of the SUV. The increasing cost of fuel results in very attractive financial metrics for this measure.

Strategy				
Original	Replacement	Fuel	MPG/ MPkWh	Incrementat Cost
Explorer	Escape Hybrid	Gasoline	30	$4,000

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Vehicle Replacement Strategy 1	2.8	3.0	3.0	1.4	6.0	(1.0)	0.0	1.6	17	50

Action Plan				
A	B	C	D	E
n	n	n	y	y

18-Vehicle Replacement Strategy (2)

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 18	Vehicle Replacement Strategy 2 (aggressive)	2012	$203,000	$0	$18,109	162,165	10.6	16.7%	$474,848	3.1%

Measure 18 is based on replacing fleet SUVs with Escape Hybrids, and replacing fleet trucks with Phoenix Electric sport utility trucks (SUT) or an equivalent vehicle within the fleet vehicle rotation and replacement schedule. While the specific vehicles may not require replacement by the 2012 implementation date, there may be opportunities to shift the existing vehicles and enabling this strategy when other vehicles require replacement. The project costs are the incremental cost associated with the purchase of the recommended version over the standard version of the existing vehicle. The increasing cost of fuel results in very attractive financial metrics for this measure.

The rapidly evolving battery technology is enabling new electric vehicle options for corporate and municipal fleets. See the appendices for a more detailed exploration of this topic and associated web links.

Strategy					
Original	Units	Replacement	Fuel	MPG/ MPkWh	Incremental Cost
Explorer	2	Escape Hybrid	Gasoline	30.0	$4,000
F150	2	Phoenix SUT	Electric	2.1	$15,000
F250	4	Phoenix SUT	Electric	2.1	$15,000
C250	3	Phoenix SUT	Electric	2.1	$15,000
Ranger	3	Phoenix SUT	Electric	2.1	$31,000
Ram 1500	2	Phoenix SUT	Electric	2.1	$15,000

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Vehicle Replacement Strategy 2 (aggr)	(0.9)	2.5	2.0	6.0	6.0	(2.0)	0.0	6.0	20	70

Action Plan				
A	B	C	D	E
n	n	n	n	n

Biodiesel B20

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 19	Biodiesel B50	2009	$11,000	$0	$0	90,990	NA	NA	($10,476)	1.7%

This measure, not utilized in any of the plans, changes the fuel mix for all diesel vehicles to a 20/80% (biodiesel/diesel) blend for all fleet vehicles currently using diesel fuel. Biodiesel is now readily available at a reasonable price allowing rapid implementation of this GHG reduction strategy. This analysis assumes $3.30 per gallon and $5,000 for infrastructure improvements (tanks, etc). Prices are assumed to escalate at the same rate as petroleum based diesel fuel (8% per year). This analysis also uses the ICLEI coefficient of 0 lbs CO2e per gallon. This figure is clearly optimistic, though the use of biodiesel fuel created from waste oil (currently available locally) would have close to zero emissions for the feedstock, but would still embody production and transportation energy. The units included in this measure are listed below.

Description	Miles/Year	MPG	Total Gallons	Biodiesel gallons	Diesel gals
Pierce Pumper 1994	9250	8	1,156	231	925
Pierce Pumper 1994	9250	8	1,156	231	925
Support 1985	9250	6	1,542	308	1233
Deere Backhoe 1998	600	1	600	120	480
Ford Dump 2004	9250	12	771	154	617
Dump 2005	9250	12	771	154	617
Sweeper 2000	15000	12	1,250	250	1000
Ford Utility 2002	9250	12	771	154	617
Ford F700 1992	9250	12	771	154	617

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description	Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Biodiesel B50	2.8	(3.0)	2.0	6.0	4.0	(1.0)	0.0	0.0	11	26

Action Plan				
A	B	C	D	E
n	y	y	y	y

19-Biodiesel B50

Measure	Description	Implementation Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 20	Commute	2009	$0	$22,500	$0	33,273	NA	NA	($421,235)	0.6%

This measure changes the fuel mix for all diesel vehicles to a 50/50% (biodiesel/diesel) blend for all fleet vehicles currently using diesel fuel. Some jurisdictions utilizing 100% biodiesel have experienced some problems, associated with inconsistent fuel quality. This lower concentration apparently eliminates this vulnerability. Biodiesel is now readily available at a reasonable price allowing rapid implementation of this GHG reduction strategy. This analysis assumes $3.30 per gallon and $5,000 for infrastructure improvements (tanks, etc). Prices are assumed to escalate at the same rate as petroleum based diesel fuel (8% per year). This analysis also uses the ICLEI coefficient of 0 lbs CO2e per gallon. This figure is clearly optimistic, though the use of biodiesel fuel created from waste oil (currently available locally) would have close to zero emissions for the feedstock, but would still embody production and transportation energy. For older models (1995 and earlier) a cost of conversion of the rubber hoses is added to the financial analysis. The units included in this strategy are listed below.

Description	Miles/Year	MPG	Total Gallons	Biodiesel gallons	Diesel gals	Cost
Pierce Pumper 1994	9250	8	1,156	578	578	$500
Pierce Pumper 1994	9250	8	1,156	578	578	$500
Support 1985	9250	6	1,542	771	771	$500
Deere Backhoe 1998	600	1	600	300	300	$0
Ford Dump 2004	9250	12	771	385	385	$0
Dump 2005	9250	12	771	385	385	$0
Sweeper 2000	15000	12	1,250	625	625	$0
Ford Utility 2002	9250	12	771	385	385	$0
Ford F700 1992	9250	12	771	385	385	$500

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 20 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	**1**	**5**	**4**	**4**	**2**	**2**	**3**	**3**	**Measure Score**	**Adjusted Measure Score**
Description	**Cost**	**Financial Metrics**	**Resolution of Existing Problem**	**GHG Impact**	**Public Visibility**	**Employee Impact**	**Community Impact**	**Energy Cost Stabilization**		
Commute	3.0	(3.0)	3.0	3.2	3.0	2.0	0.0	0.0	11	23

Action Plan				
A	B	C	D	E
n	n	n	n	n

Ethanol

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 21	Ethanol	2011	$30,000	$0	($3,974)	24,023	NA	NA	($175,200)	0.5%

This measure, not utilized in any of the plans, assumes the use of 85/15% mix of ethanol/gasoline (E85) in 15 trucks. Flex fuel versions of truck models are currently available. The implementation date of 2011 allows the phasing in of this measure as units are retired. This measure is coordinated with the fleet replacement strategies. The list of the units included in this strategy is provided in the table below.

Description	Est. Miles/Year	MPG	Total gallons	Ethanol (gals)	Gasoline (gals)
Ford F150 1998	3,000	14	214	182	32
Ford F250 2002	9,250	14	661	562	99
Ford F250 1997	9,250	13	712	605	107
GMC C250 1997	9,250	16	578	491	87
Ford Ranger 2005	9,250	12	771	655	116
GMC C250 1997	7,250	16	453	385	68
Ford F250 1996	7,250	13	558	474	84
Chevy 2500 1989	7,250	14	518	440	78
Dodge Ram 1500 2001	7,250	15	483	411	73
Dodge Ram 1500 2001	7,250	15	483	411	73
Ford F350 2003	7,250	12	604	514	91
GMC C250 1997	9,250	14	661	562	99
Ford F350 1998	9,250	12	771	655	116
Ford F150 1998	9,250	14	661	562	99
Ford Ranger 2004	9,250	14	661	562	99

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. The maximum adjusted measure score for any of the 22 City of Sonoma measures is 117. The minimum score for any of the 22 measures is 44. The average score of all 22 measures is 69. The median score is 66.

Selection Evaluation (6=favorable, 3= neutral, 0=not favorable)										
Weighting	**1**	**5**	**4**	**4**	**2**	**2**	**3**	**3**	**Measure Score**	**Adjusted Measure Score**
Description	**Cost**	**Financial Metrics**	**Resolution of Existing Problem**	**GHG Impact**	**Public Visibility**	**Employee Impact**	**Community Impact**	**Energy Cost Stabilization**		
Ethanol	5.4	0.0	2.0	2.3	4.0	2.0	3.0	0.0	19	44

Action Plan				
A	B	C	D	E
n	y	y	y	y

20- Commute

Measure	Description	Implem. Date	Net Capital Cost	O&M Incremental Cost	Annual Cost Savings	Annual CO2 Reduction	Simple Payback	IRR	Net Present Value	% of Total GHG
Measure 22	Commute	2009	$0	$22,500	$0	33,273	NA	NA	($421,235)	0.6%

The general assumptions of a transit demand management (TDM) program are based on the documented cost and impact of successful programs provided in published case studies. This analysis assumes a minimal investment of $22.5k per year resulting in an impact of 25% on the commuting patterns of city employees. The cost is based on a .25 FTE position (entry level admin, 1FTE=$50,000) and $10,000 per year in program costs. A general summary of commute programs is provided in the appendices. Further study is recommended to allow a more aggressive analysis of commute program impacts.

The table below provides the comprehensive evaluation of this measure. This analysis assigns values between 0 and 6 for eight important aspects of the measures. T The maximum adjusted measure score for any of the 22 City of Sonoma measures is 117. The minimum score for any of the 20 measures is 44. The average score of all 20 measures is 69. The median score is 66.

Selection Evaluation (higher value = favorable, lower = not favorable)										
Weighting	**1**	**5**	**4**	**4**	**2**	**2**	**3**	**3**	**Measure Score**	**Adjusted Measure Score**
Description	**Cost**	**Financial Metrics**	**Resolution of Existing Problem**	**GHG Impact**	**Public Visibility**	**Employee Impact**	**Community Impact**	**Energy Cost Stabilization**		
Commute	3.00	-3.00	3.00	3.18	3.00	2.00	0.00	0.00	11.18	22.73

6.0 Summary and Conclusions

The GHG emissions reduction of 20% by 2010 can be achieved by a number of paths documented in this report. Each path, or Action Plan, is comprised of up to 16 individual measures and each is evaluated for the financial, cost, and the other benefits they contribute to the overall strategy. The analysis model underpinning these results will be available for incorporating new information and technologies as they come available, as well as truing the analysis with monitoring data. The comprehensive approach to addressing this goal allows the City to meet a number of related goals, including improving the long term financial health of Sonoma , addressing the existing maintenance demands of aging equipment, and providing the public demonstration of commitment and progress in the highly visible challenge of greenhouse gas emissions reduction.

7.0 Appendices

7.1 Basis for 2000 GHG Inventory
7.2 Action Plan Evaluations
7.3 Vehicle Lists
7.4 Fleet Fuel Cost Trend
7.5 Carbon Credits
7.6 Electric Vehicles
7.7 Commute Programs

7.1 Basis for 2000 GHG Inventory

Greenhouse Gas Inventory

Source: GHG Inventory Report, City of Sonoma, September 2003, Gary Albright, Intern for City of Sonoma

	kWh	Therms	Energy Cost	Gasoline (gals/yr)	Diesel	eCO2 (tons)
Buildings						
City Hall	98,383	0	14,266			24.1
Court House		821	821			5.1
Carnegie Library Bldg	56,087	0	8,133			13.7
Firestation	45,404	711	7,295			15.5
Police Station	177,253	1,294	26,996			51.3
Police Radio Station	70	0	10			0.0
Laundry Room		65	65			0.4
Corporate Yard	20,082	0	2,912			4.9
Olsen Park	869	0	126			0.2
Nathanson Creek Park	1	0	0			0.0
Total	**398,149**	**2,891**	**60,623**			**115.2**
Streetlights						
Traffic Light	0	0	0			0.0
The Plaza	399,731	0	57,961			97.7
Parking Lot	1,570	0	228			0.4
Arnold Field	0	0	0			0.0
Misc Light	0	0	0			0.0
Total	**401,301**	**0**	**58,189**			**98.1**
Water/Sewer						
Booster Pump	28,637	0	4,152			7.0
Pump #1	21,714	0	3,149			5.3
Pump #6	14,129	0	2,049			3.5
Pump #4	5,328	0	773			1.3
Pump #3	4,276	0	620			1.0
Irrigation	1,392	0	202			0.3
Pump #5	1,196	0	173			0.3
Hertenstein Park	344	0	50			0.1
Carter Park	48	0	7			0.0
Madera Park	0	0	0			0.0
Pump #2	0	0	0			0.0
Buildings and Parks	119,255	0	17,292			29.2
Total	**196,319**	**0**	**28,466**			**48.0**
Commute						
Gasoline and Diesel			42,417	12,768	86	133.1
Total			**42,417**	**12,768**	**86**	**133.1**
Fleet						
Nat Gas Vehicles						0.0
Gasoline			59,010	17,882		185.2
Diesel			28,999		8,788	92.1
Total			**88,009**	**17,882**	**8,788**	**277.3**
Waste						
Paper Products						-6.5
Food Waste						2.0
Plant Debris						-6.5
Wood/Textiles						-2.0
Total						**-13.0**
Grand Total	**995,769**	**2,891**	**277,703**	**30,650**	**8,873**	**658.7**

7.2 Action Plan Evaluations

The GHG Emission Reduction Action Plans involve more than CO2e reduction and cash flow. There are critical concerns that should be factored into the decision making process. These include the financial metrics of internal rate of return (IRR) and net present value (NPV) used to evaluate the worthiness of the investment; the cost of implementing the measure, some measures come with a large price tag which will challenge liquidity; the degree to which the plan resolves existing problems, such as old, high maintenance air conditioning units; the visibility of the measures to the public, for example the photovoltaic systems are a physical example of actions taken the city and communicate action and commitment to the community. Other key considerations include the employee impacts of new equipment or procedures, which may generate internal opposition; and the impact on the variability of future energy costs and the associated budgetary vulnerability.

Each measure and the plans as a whole are evaluated by the following considerations:

- Measure Capital Cost:
- Financial Metrics (IRR and NPV)
- Resolution of Existing Problems
- GHG Impact
- Public Visibility
- Employee Impact
- Community Impact
- Energy Cost Stabilization

Table 8 below provides the evaluation results for each measure by individual criteria. The individual scores for each category (cost, financial metrics, etc) are summed to provide an overall score for that measure. While this table provides important information to be considered when selecting measures, the scores are advisory only. A relatively low score does not preclude a measure, nor should a high score guarantee inclusion of the measure in the Action Plans. There will always be additional considerations that are not reflected in the Selection Evaluation process. The “adjusted measure score” is a feature under development which will allow the weighting of the criteria.

Selection Evaluation (higher value = favorable, lower = not favorable)											
Weighting		1	5	4	4	2	2	3	3	Measure Score	Adjusted Measure Score
Description		Cost	Financial Metrics	Resolution of Existing Problem	GHG Impact	Public Visibility	Employee Impact	Community Impact	Energy Cost Stabilization		
Measure 1	City Hall HP Replacement	2.88	3.00	4.00	1.40	4.00	1.00	1.00	3.09	20.37	61.74
Measure 2	City Hall Programmable Thermostats	2.98	3.00	5.00	0.27	3.00	2.00	0.00	0.57	16.83	50.79
Measure 3	Carnegie and Visitor Cntr Prog. Thermostats	2.99	3.00	5.00	0.17	3.00	0.00	0.00	0.35	14.51	45.71
Measure 4	Lighting Retrofit	2.92	3.00	2.00	1.39	3.00	-1.00	1.00	2.91	15.22	47.20
Measure 5	Streetlighting HPS to LED A	0.00	1.27	3.00	2.82	3.00	0.00	0.00	6.00	16.08	53.59
Measure 6	Streetlighting HPS to LED B	0.00	1.27	3.00	2.82	4.00	-1.00	0.00	6.00	16.08	53.59
Measure 7	Pump Measures 1 (5 units)	0.00	-3.00	3.00	0.80	3.00	0.00	0.00	1.67	5.47	11.21
Measure 8	Pump Measures 2 (3 units)	1.21	-3.00	3.00	0.69	3.00	0.00	0.00	1.46	6.36	11.35
Measure 9	Pump Measures 3 (2 units)	1.81	-2.92	3.00	0.54	3.00	0.00	0.00	1.14	6.57	10.79
Measure 10	PV6 150 kW -CREBS	3.00	3.00	3.00	6.00	6.00	0.00	0.00	6.00	27.00	84.00
Measure 11	PV1-30kWac	-0.56	-3.00	3.00	1.74	6.00	0.00	0.00	4.00	11.18	27.40
Measure 12	PV3-60kWac	-3.00	-3.00	3.00	5.22	6.00	0.00	0.00	6.00	14.22	44.89
Measure 13	PV4- 200kWac	-3.00	-3.00	3.00	6.00	6.00	0.00	0.00	6.00	15.00	48.00
Measure 14	PV2 Suppying 100% Wtr &Wste energy cost	-3.00	-3.00	3.00	2.31	6.00	0.00	0.00	6.00	11.31	33.22
Measure 15	PV2 Suppying 100% Streetlighting Energy Cost	-3.00	-3.00	3.00	6.00	6.00	0.00	0.00	6.00	15.00	48.00
Measure 16	PV2 Suppying 100% Fleet Electric Energy Cost	2.68	-3.00	3.00	0.06	6.00	0.00	0.00	0.15	8.89	12.37
Measure 17	Vehicle Replacement Strategy 1	2.85	3.00	3.00	1.40	6.00	-1.00	0.00	1.58	16.82	50.16
Measure 18	Vehicle Replacement Strategy 2 (aggressive)	-0.88	2.50	2.00	6.00	6.00	-2.00	0.00	6.00	19.62	69.62
Measure 19	Biodiesel B50	2.79	-3.00	2.00	6.00	4.00	-1.00	0.00	0.00	10.79	25.79
Measure 20	Commute	3.00	-3.00	3.00	3.18	3.00	2.00	0.00	0.00	11.18	22.73

Table 8: Measure List and Evaluations

* Scoring: Higher Score = More Favorable

The table below compiles the scoring for each measure included in each plan and yields a relative score for each metric and plan. An aggregating algorithm has been applied to the measure scores to accommodate the different evaluation scoring methodologies for the metrics. This explains the different range of scores for the plans (Table 9) as compared to the individual measures (Table 8). As with the previous table, a higher score indicate more a more favorable evaluation for that metric or plan.

Plan Cumulative Scoring					
Metric \ Plan	A	B	C	D	E
Cost	-6.6	16.3	20.8	17.1	9.9
Financial Metrics	-3.5	-34.7	-35.5	-5.3	-11.2
Resolution of Existing Problem	6.6	15.4	18.0	16.7	20.7
GHG Impact	9.4	12.1	14.0	14.1	20.3
Public Visibility	6.6	10.6	12.5	11.0	14.5
Employee Impact	0.0	4.0	2.0	2.0	0.0
Community Impact	0.0	4.0	4.0	4.0	4.0
Energy Cost Stabilization	9.2	9.5	10.4	10.0	14.1
Total	21.8	37.2	46.4	69.6	72.2

Table 9: Evaluation Matrix

This analysis is intended to provide an overview of the effectiveness of each plan. While it should encourage a more comprehensive review of the cost/benefits of each strategy, these quantitative results are based on subjective judgments and are advisory only. They should be only one consideration in the selection of the most appropriate plan for the City of Sonoma.

7.3 Vehicle Lists

Vehicle Data									Included in Measure					
Vehicle No.	Dept.	Make	Year	Model	Status Year	Fuel Type	MPG	Miles/ Year	F3-CNG	F4-New1	F7-New2	F2-B20	F5-B50	F6-Ethnl
1	BLDG	Ford	1998	F150	active	gasoline	14	3000	no	no	yes	no	no	yes
2	GEN OPS	Ford	2001	F250	active	gasoline	13	3000	no	no	yes	no	no	no
3	FIRE	Pierce	1994	Pumper	active	diesel	8	9250	no	no	no	yes	yes	no
4	FIRE	Pierce	1994	Pumper	active	diesel	8	9250	no	no	no	yes	yes	no
5	FIRE	Pierce	1985	Ladder	active	diesel	6	9250	no	no	no	yes	yes	no
6	EMS	Ford	1997	Explorer	active	gasoline	14	9250	no	yes	yes	no	no	no
7	EMS	Ford	2002	F250	active	gasoline	14	9250	no	no	yes	no	no	yes
8	EMS	Ford	2001	Explorer	active	gasoline	14	9250	no	yes	yes	no	no	no
9	EMS	Ford	2001	Ambulance	active	gasoline	12	9250	no	no	no	no	no	no
10	EMS	Ford	1998	Ambulance	active	gasoline	12	9250	no	no	no	no	no	no
11	EMS	Ford`	1999	Ambulance	active	gasoline	12	9250	no	no	no	no	no	no
12	EMS	Ford	2002	Ambulance	active	gasoline	12	9250	no	no	no	no	no	no
13	EMS	Ford	2002	Ambulance	active	gasoline	12	9250	no	no	no	no	no	no
14	EMS	Ford	2004	Ambulance	active	gasoline	12	9250	no	no	no	no	no	no
15	EMS	Ford	2005	Ambulance	active	gasoline	12	9250	no	no	no	no	no	no
16	POLICE	Ford	1997	Taurus	inactive	gasoline	18	NA	no	no	no	no	no	no
17	POLICE	Ford	2001	Crn Vic	inactive	gasoline	15	NA	no	no	no	no	no	no
18	POLICE	Ford	2001	Crn Vic	inactive	gasoline	15	NA	no	no	no	no	no	no
19	POLICE	Ford	2001	Ranger	inactive	gasoline	14	NA	no	no	no	no	no	no
20	POLICE	Ford	2002	Taurus	inactive	gasoline	18	NA	no	no	no	no	no	no
21	POLICE	Ford	2003	Crn Vic	inactive	gasoline	15	NA	no	no	no	no	no	no
22	POLICE	Ford	2003	Crn Vic	inactive	gasoline	15	NA	no	no	no	no	no	no
23	POLICE	Ford	2003	Crn Vic	inactive	gasoline	15	NA	no	no	no	no	no	no
24	POLICE	Ford	2005	Taurus	inactive	gasoline	18	NA	no	no	no	no	no	no
25	POLICE	Ford	2005	Crn Vic	inactive	gasoline	15	NA	no	no	no	no	no	no
26	CEMETERY	Ford	1997	F250	active	gasoline	13	9250	no	no	yes	no	no	yes
27	CEMETERY	GMC	1997	C250	active	gasoline	16	9250	no	no	yes	no	no	yes
28	CEMETERY	Ford	1989	F700	active	gasoline	12	9250	no	no	no	no	no	no
29	CEMETERY	Deere	1998	Backhoe	active	diesel	1	600	no	no	no	yes	yes	no
30	CEMETERY	Ford	2004	Dump	active	diesel	12	9250	no	no	no	yes	yes	no
31	CEMETERY	Ford	2003	Utility	active	gasoline	12	9250	no	no	no	no	no	no
32	CEMETERY	Ford	2005	Ranger	active	gasoline	12	9250	no	no	yes	no	no	yes
33	CEMETERY	Ford	2005	Dump	active	diesel	12	9250	no	no	no	yes	yes	no
34	GAX TAX	Ford	2000	Sweeper	active	diesel	12	15000	no	no	no	yes	yes	no
35	PW	GMC	1997	C250	active	gasoline	16	7250	no	no	yes	no	no	yes
36	PW	Ford	1996	F250	active	gasoline	13	7250	no	no	yes	no	no	yes
37	PW	Ford	1997	1 Ton	active	gasoline	12	7250	no	no	no	no	no	no
38	PW	Chevy	1989	2500	active	gasoline	14	7250	no	no	no	no	no	yes
39	PW	Dodge	2001	Ram 1500	active	gasoline	15	7250	no	no	yes	no	no	yes
40	PW	Dodge	2001	Ram 1500	active	gasoline	15	7250	no	no	yes	no	no	yes
41	PW	Ford	2003	F350	active	gasoline	12	7250	no	no	no	no	no	yes
42	WATER	Ford	2002	F350	active	diesel	12	9250	no	no	no	yes	yes	no
43	WATER	GMC	1997	C250	active	gasoline	14	9250	no	no	yes	no	no	yes
44	WATER	Ford	1998	F350	active	gasoline	12	9250	no	no	no	no	no	yes
45	WATER	Ford	1992	F700	active	diesel	12	9250	no	no	no	yes	yes	no
46	WATER	Ford	1998	F150	active	gasoline	14	9250	no	no	yes	no	no	yes
47	WATER	Ford	2004	Ranger	active	gasoline	14	9250	no	no	yes	no	no	yes

7.4 Vehicle Fuel Cost Trends

Petrofuel Price Trends and Future

Jim Housman, PE (retired)
11/19/07

There are a number of factors that contribute to the cost of gasoline at the pump. According to the U.S. Energy Information Agency (EIA) the price of gasoline can be broken down as follows:

Crude Oil:	64%
Refining (including additives)	13%
Distribution and Marketing	9%
Taxes:	14%

It should be clear from the attached graph that the major factor driving gasoline prices is the price of crude oil. There have been two distinct issues driving the price of crude in the past five years, geo-political issues and geological issues.

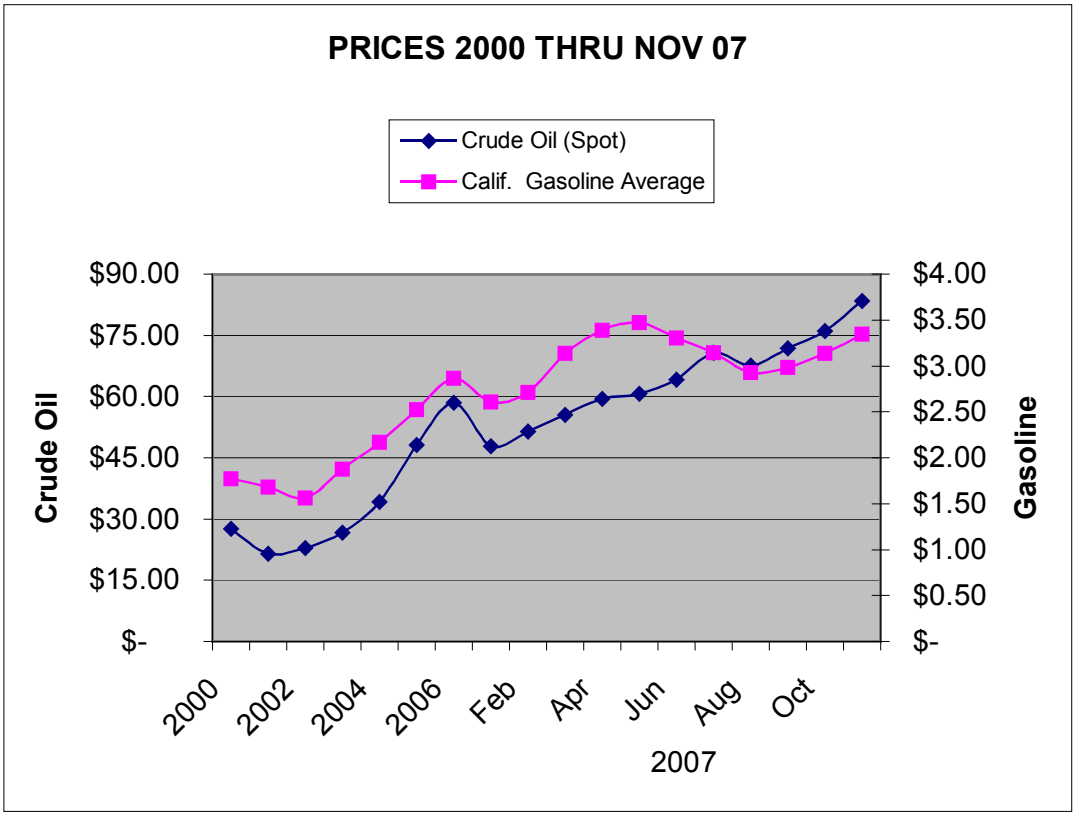
The geo-political issues driving oil prices are primarily the declining value of the dollar, the rapid growth in demand, primarily in Asia, and the economic uncertainty caused by military conflict. An additional geo-political factor is the shift in oil resources from the control (primarily) of privately owned multinational oil companies to being owned and managed by national oil companies. The motivation of shareholder owned companies is largely short term profits, driving the producers to produce the maximum amount of oil in the shortest time. National oil companies, while depending on oil revenue for investment capital, may be motivated to invest a significant portion of their income in non-oil related programs decreasing their ability to increase production as existing oil fields decline. Oil can also be used as a diplomatic tool, punishing enemies and rewarding friends. Short term decisions made by national oil companies for political reasons may have long term economic effects on oil using societies.

Geologically the oil industry is shifting from an environment where a relatively small number of oil fields are each producing very large quantities of oil to one where a very large number of oil fields are each producing a relatively small amount of oil. For example twenty years ago there were 15 oil fields in the world producing over one million barrels per day. Today there are only four, and at least one of those fields (Cantarell in Mexico) is in significant decline. Two thirds of the fields in the oil producing nations in the world are in decline. Not a single field discovered in the past ten years is capable of producing a million barrels per day. (reference 4)

In 1987, after the oil industry recovered from the turmoil caused by the Iran revolution, the price of gasoline in the United States averaged under 70 cents per gallon. In that same year the spot price of crude oil (the price quoted in the news) was about $13.40. In November of 2007 those prices were $3.40 for gasoline in California and $83.03 for crude oil.

In planning for future energy costs we can extrapolate these numbers to estimate gasoline cost in 2008 and future years.

In the simplest terms the cost of gasoline has grown, on average, at about 8% a year over the past twenty years. However if we look at just the past five years, from 2002 to 2007, the price of gasoline has escalated more like 17% each year. In 2012 the difference between those growth rates will be the difference between gasoline at $5.00 per gallon or $7.45 per gallon. Given the political and geological issues faced by the oil industry it would be prudent to assume that oil prices will continue their upward momentum.



Sources:

1. http://publications.uu.se/abstract.xsql?dbid=7625

2.http://tonto.eia.doe.gov/dnav/pet/pet_pri_wco_k_w.htm

3.http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_a_epm0_pte_cpgal_w.htm

4. http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp

5. http://www.simmonsco-intl.com/files/giantoilfields.pdf

7.5 Carbon Credits

Carbon Offsets/Green Tags
Prepared by Peter Spencer

The David Suzuki Organization defines a carbon offset as "an emission reduction credit from another organization's project that results in less carbon dioxide or other greenhouse gases in the atmosphere than would otherwise occur. Carbon offsets are typically measured in tons of CO2-equivalents (or 'CO2e') and are bought and sold through a number of international brokers, online retailers, and trading platforms."
http://www.davidsuzuki.org/Climate_Change/What_You_Can_Do/carbon_offsets.asp

A green tag is a specific type of carbon offset also referred to as Renewable Energy Certificates (RECs). According to the Environmental Protection Agency, "Renewable Energy Certificates represent the environmental, social, and other positive attributes of power generated by renewable resources."

The carbon offset is a generic term for all types of purchasable GHG reduction programs sold in the market. For example, CO2 emissions can be offset by paying a group to plant trees anywhere in the world. The green tag, a subset of carbon offsets, is specific to electricity generation. To offset CO2 emissions with a green tag, a purchase is made which supports renewable electricity generation and consumption somewhere else. That green-generated electricity becomes part of the total pool of power and thereby reduces emissions from overall electricity production.

Individuals and organizations can purchase carbon offsets to reduce climate impacts from their activities. When carbon emissions are too difficult or costly to avoid, it's possible to pay someone else to reduce GHG. Dozens of companies, both commercial and nonprofit, offer a variety of offset types and prices.

The most common type of offset involves trees, either reforestation or avoided deforestation. Other common offsets are renewable energy and energy conservation projects. Prices for offsets/green tags vary widely from $3.56 to $30.00 per metric ton. (See survey in appendix) These prices are low compared to many other mitigation measures.

Renewable energy offsets, sold as green tags, fund wind, solar, biomass, and biodiesel projects worldwide. For every megawatt of power produced by a renewable source, one green tag is issued to the producer. The green tags can be sold to raise profits from renewable energy generation thus making it more competitive in the market. Energy conservation offsets often involve purchasing a GHG emission allowance from a company on the Chicago Climate Exchange. This "retires" the allowance preventing others from purchasing it to emit GHG.

Verification and accounting systems for offsets differ and there are currently no accepted standards. There is a wide variation of GHG baseline calculations for activities and also for the calculations of GHG reductions from projects. However, many providers make a good effort to ensure their product's value and provide documentation. The Green-e program is the most accepted certification program and referenced by the EPA. (http://www.green-e.org/)

Arguments in favor of Carbon Offsets:

- Supports growth of the renewable energy industry

- Compensates for GHG emissions which are too difficult or costly to avoid
- Lowers cost of GHG reductions
- Provides a market-based system for GHG reduction
- Can benefit poor countries with investments
- Positive PR for organizations that reduce emissions
- Raises awareness and encourages public policy changes

Sources of supportive information:

An excellent resource for consumers with ratings for top providers:
A Consumer's Guide to Retail Offset Providers
Clean Air-Cool Planet:
http://www.cleanair-coolplanet.org/ConsumersGuidetoCarbonOffsets.pdf

EPA description of various green purchasing options:
Guide to Purchasing guide for Green Power
Environmental Protection Agency:
http://www.epa.gov/greenpower/pdf/purchasing_guide_for_web.pdf

Realistic assessment supportive of offsets with large number of links:
How the Retail Carbon Offsets Market Can Further Global Warming Mitigation Goals
EM Market Insights:
http://conserveonline.org/workspaces/climate.change/carbonmarkets/em_going_carbon_neutral.pdf

Arguments against Carbon Offsets:

Trees:
- Trees store carbon, but don't reduce total biological carbon brought to the earth's surface in fossil fuels
- Planting releases carbon from the soil
- An unrealistic amount of trees would need to be planted to be effective
- Most projects are planting monocultures causing ecosystem problems
- Predicting the carbon performance of trees is not possible
- Increasingly challenged by scientists as unsuccessful strategy

All methods:
- Don't address the fundamental problem of emissions
- Makes it easy to avoid measures reducing emissions
- Removes money from local economy
- Poor accountability
- No proof that there is an overall improvement in the climate with offset system
- Short-term solution with little direct benefit to offset purchasing organization
- May ignore local problems such as air pollution or need for more power plants
- Questionable future of unregulated and unproven strategies in new offset industry
- Doesn't create lasting benefit for organization

Ecobusinesslinks.com Carbon Offset Survey						
Carbon Offset Provider	**Price (US$/Metric**	**Non-profit**	**Projects Types**	**Project Choice**	**Offset Types**	**Product Certification/ Verification**
AtmosClear Climate Club **US**	$3.56[a] - $25.00	No	Methane	No	Car, Home	Environmental Resources Trust
Carbonfund.org **US**	$4.30[b] - 5.50	Yes	Renewables, Efficiency, Reforestation	Yes	Home, Car, Air, Events, Business	Green-e, Chicago Climate Exchange, Environmental Resources Trust
e-BlueHorizons **US**	$5.00	No	Renewables, Reforestation	No	Home, Car, Air	Chicago Climate Exchange, Environmental Resources Trust
Terrapass **US**	$7.35[c] - 11.00	No	Renewables, Efficiency	No	Car, Air, Events, Business	Green-e, Chicago Climate Exchange, Center for Resource Solutions
DriveNeutral.org **US**	$7.50 & up	Yes	Efficiency	No	Car	Chicago Climate Exchange
Native Energy **US**	$13.20	No	Renewables	Yes	Home, Car, Air, Events, Business	Green-e
The CarbonNeutral Company **UK**	$14.00-18.00	No	Renewables, Efficiency, Reforestation	Yes	Business, Home, Car, Air, Events	KPMG, Edinburgh Centre for Carbon Management, Independent Advisory Committee
Climate Friendly **Aus**	$16.00-19.00	No	Renewables	No	Home, Car, Air, Business	Office of the Renewable Energy Regulator, NSW Government, Ernst & Young.
Sustainable travel International **US, Switzerland**	$18.00	Yes	Renewables	No	Air, Car, Home, Hotel	See Myclimate
Bonneville Environmental Foundation **US**	$29.00	Yes	Renewables	No	Home, Air, Business, Event	Green-e
Myclimate **Switzerland**	$30.00	Yes	Renewables	No	Air, Events, Business	Designated Operational Entity
Global Cool **UK**	£20.00 ($39.48)	Yes	Renewables, Efficiency	No	n/a	CDM
Services for which independent product certification or verification information not available						
Carbon Offset Provider	**Price (US$/Metric ton CO2)**	**Non-profit**	**Projects Types**	**Project Choice**	**Offset Types**	**Product Certification/ Verification**
DrivingGreen **Ireland**	$8.00	No	Renewables	No	Car, Air, Events	n/a
Solar Electric Light Fund **US**	$10.00	Yes	Renewables	No	External Calculators	n/a
Carbon Clear **UK**	$17.00	No	Reforestation	No	Home, Car, Air, Babies	n/a

a: Atmos Clear - Low price for 25 Ton option at $89
b: Carbonfund.org - Low price for ZeroCarbon tags option: 18 Ton + 5 Ton match, pay $99 for $23 Ton
c: Terrapass - Low price when purchasing 204 metric ton of carbon offsets for $1,499.95
1. Offset Types: There are hundreds of potential offset types. We have limited our survey to just the most common.
2. Verification: "n/a" means we were unable to determine a third-party verification body. The projects may, however, be verified.
3. Choice: refers to whether customers may choose between project types and/or specific projects.
4. Price: prices change and exchange rates fluctuate. The data listed was first gathered from the respective websites July 21, 2006
5. Other offset providers may exist. This survey provides a cross section of the industry, projects may be added or removed over time.
6. Some information may be incomplete or has changed. We welcome updates.

Sources of Offset critical information:

The most complete, well-written analysis of climate science and offsets: **Carbon Trading: A Critical Conversation on Climate Change, Privatization and Power**

Dag Hammarskjöld Centre:
http://www.dhf.uu.se/pdffiler/DD2006_48_carbon_trading/carbon_trading_web.pdf

Excellent analysis from a sustainability perspective:
The International Challenge of Climate Change
United Kingdom, Environmental Audit Committee:
http://www.defra.gov.uk/environment/climatechange/pubs/eac/pdf/cc-govres.pdf

Scientific paper explaining why reforestation won't help climate change:
Planting trees will not cancel out climate change:
Nature:
http://www.scidev.net/pdffiles/nature/nature04486.pdf

Short negative view of green tags:
The wooly world of green tags
out of Kirby Mountain:
http://kirbymtn.blogspot.com/2006/04/woolly-world-of-green-tags.html

In-depth assessment of trading systems and their limitations:
Is the US Experience with Pollution Markets Really an Argument for Global Carbon Trading?
McGill International Journal of Sustainable Development, Law and Policy, fall 2005:
http://www.fern.org/media/documents/document_3657_3658.pdf

Good short summary of why offsets don't work:
Carbon 'offset' - no magic solution to 'neutralize' fossil fuel emissions
Forests and the European Union Resource Network:
http://www.fern.org/media/documents/document_884_885.pdf

Strong short letter opposing carbon trading:
We must reduce fossil fuel use, not trade carbon:
Financial Times:
http://www.fern.org/media/documents/document_3634_3635.pdf
(Source: http://www.ecobusinesslinks.com/carbon_offset_wind_credits_carbon_reduction.htm)

For the most complete and up to date list of green tag products and marketers, visit the Green Power Network, part of the U.S. Dept of Energy, Energy Efficiency and Renewable Energy Office.

http://www.eere.energy.gov/greenpower/markets/certificates.shtml?page=0

For a detailed report on the status of green power marketing, check out the following publication from the National Renewable Energy Laboratory:

http://www.eere.energy.gov/greenpower/resources/pdfs/40904.pdf

7.6 Electric Vehicles

Electric Vehicle Current Status

Jim Housman, P.E. (retired)

May 7, 2007

Battery powered electric vehicles pose opportunities for cost savings and enhanced convenience in an increasing number of applications where their unique properties can be used to advantage. While gasoline as a motor fuel has significantly higher energy density and lower cost per unit of energy, when the overall "well-to-wheel efficiencies of electrical power are taken into account it can be advantageous to operate electrical vehicles in place of their gasoline or diesel counterparts.

The majority of electric vehicles available today, not including hybrids, are classified as "Neighborhood Electric Vehicles" (NEV). In general these vehicles are limited to a top speed of 25 miles per hour and are only permitted on public roads with speed limits below 35 miles per hour. They have minimal requirements for lighting and passenger protection in keeping with their low speed nature. Some of the larger manufacturers of NEVs are listed on the following web site:

http://www.eere.energy.gov/afdc/afv/elec_vehicles.html

In a recent study (2001) the Department of Energy [24] evaluated the performance of 348 NEVs operated in 15 automotive fleets. The fleets included in the study belonged to military, commercial, municipal, rental and transportation organizations. The NEVs were found to be successful replacements for gasoline powered vehicles in most circumstances. Success was indicated by satisfied users, improved economy and reliability of the vehicles.

The study did find some areas where improvements could be made. Higher speed capability and improved range were listed as desirable. In addition users would have liked improved passenger protection, including solid doors and roll down windows. Both were lacking in the majority of the fleet vehicles. While the study found that 91% of the vehicles had operated without problems there were some reliability issues. Fourteen vehicles had battery packs replaced, Five had problems with switches and four controllers were replaced.

By a large majority the study found that fleet owners were satisfied with the performance of their vehicles. Some were used only on public roads, some were never used on public roads and some were used under both circumstances. Specific uses included police work, material handling, towing, personnel transportation and community shopping uses.

A large market currently exists for this type of vehicle permitting competitive pricing. The most sophisticated of the NEVs retail in the $10 to $15 thousand dollar range. At the higher end of this range will be found vehicles with features and styling that compare favorably with conventional automobiles but lacking only the gasoline engine performance. The simplest and least expensive NEVs, resembling golf carts can be purchased for less than $5000. Used but

[24] http://avt.inel.gov/pdf/nev/nevstudy.pdf

functional vehicles are generally available under $1000.[25] Because of the simplicity of the electric power train vehicle maintenance costs are a fraction of that required for gasoline or diesel engines. There is no oil to change, no sparkplugs, filters or coolant issues. The light weight of most electrical vehicles also means that brakes, tires and suspension components are very durable.

Currently one of the most conventional appearing NEVs is the Zenn. While still relying on traditional lead-acid battery technology the Toronto Canada based company has created an unusually sophisticated NEV using a small urban vehicle built in France and converted in Canada to electric power. Because of the volume production already in place with the basic car (originally diesel powered) Zenn has managed to price the vehicle just above the "golf cart" market while delivering a vehicle with both the style and convenience of a small gasoline powered vehicle.

The majority of NEVs currently on the market use technology that has not changed significantly for the past half century. They use lead-acid batteries, DC motors and simple control systems. A new regime of electrical vehicles are appearing in the market in the very near future, most likely prompted by the rapidly increasing price of fossil fuels and the increased awareness of Americans that our access to fossil fuels is becoming precarious. One of these new electrical vehicles, the Tesla roadster, is a technological showcase in the form of a high performance sports car. Another, the Phoenix SUT (sport utility truck), also uses state-of-the-art technology in a practical utility vehicle.

Both vehicles use sophisticated AC motors, Lithium ion batteries, heat pump HVAC systems, regenerative braking and computerized control systems. Both are advertising operating ranges of over 100 miles on a single charge and, based on the battery technology, charge times of under 30 minutes should be expected. Early test data on both vehicles describe performance equal to comparable gasoline powered vehicles. In the case of the Tesla roadster that means acceleration to 60 miles per hour in less than 6 seconds and a top speed of 130 miles per hour.[26] The Phoenix SUT boasts a 1000 pound payload, 90 mile per hour top speed and 60 mile an hour in less than 10 seconds

While these vehicles are especially designed for specific audiences they represent logical entry points for new technologies into an existing, mature, market. The Tesla roadster is aimed at the wealthy car enthusiast who is willing to pay above market price for the uniqueness of an electric powered performance car. The Phoenix is marketed to fleet purchasers who value their environmental image above the short term ownership cost. Success in these two markets will work as both test beds for these technologies in real operating environments and as bootstrapping operations to bring down the cost of these technologies as production volumes increase.

For the past one hundred years battery technology has been the limiting factor in keeping electric powered vehicles from competing with fossil fuel powered vehicles. For most of this time the only practical battery technology for use in electric cars was the same lead-acid battery used for starting power in conventional automobiles. The combination of high weight, slow re-charging, and low energy density prevented the development of electric vehicles even moderately competitive with liquid fueled vehicles. In the late 1990s electric car and hybrid-electric car

[25] http://www.eaaev.org/eaalinks.html

[26] http://www.teslamotors.com/

developers began investigating the advances made in battery technology for use in portable computers and other electronic devices.

The first of these technologies evaluated for vehicle use was the Nickel-Metal Hydride battery. This battery was promising enough to be used in the second generation EV1 electric car developed by General Motors for compliance with the proposed California Zero Emissions Standard. While not significantly lighter than the lead-acid battery it replaced, the increased energy-to-size ratio allowed for a significantly increased range for the EV1.

Since that time electric car enthusiasts have turned their attention to the Lithium ion battery. These batteries have both significantly better energy-to-weight and energy-to-volume characteristics. Early versions of these batteries were sensitive to high discharge rates and to certain manufacturing defects which resulted in a number of fires occurring in portable computers using this technology. Since that time changes in the cathode material, manufacturing improvements and the development of external control methods have potentially eliminated the problem. As a result a new wave of enthusiasm for electric vehicles is developing. Both the high performance Tesla Roadster sports car and the Phoenix Sport Utility Trucks (SUT) are designed around the latest versions of the Lithium ion battery.[27]

Phoenix Motorcars plans to sell approximately 500 Sport Utility Trucks in 2007 to selected fleet operators. One such operator is Pacific Gas and Electric, the northern California utility company. Phoenix plans to begin selling to individual users in 2008 and estimates that it will sell 6000 vehicles in that year. Pricing for the 2008 model year should be in the $40 to $50 thousand range. [4] First shipments of the Tesla Roadster are scheduled for August 2007.

Technological changes are appearing rapidly. Recently EEStor, a Texas company has announced a breakthrough battery/ultra-capacitor system that may leapfrog the Lithium ion battery technology with improved storage capacity, discharge rate and cost. Zenn motorcars has signed an exclusive agreement with EEStor to provide storage systems for their next generation of electric vehicles[28]. Regardless of the success of such efforts it is an indication of a growing interest in non-fossil fueled power systems.

For short distance, light load applications electric powered vehicles are the right choice for a large number of applications. The long charging times needed by lead-acid batteries limit the application of these vehicles to under fifty miles per day in most cases. For those fleet applications that can justify the high first cost Phoenix Motorcars SUTs are a practical vehicle available this year. With the rapid changes taking place in battery, motor and motor controller technologies look for increased choices in the zero emission vehicle market.

Further Reading

The GM EV1:
http://www.thejaffes.org/rory/ev1/ev1.pdf

[27] http://en.wikipedia.org/wiki/Altairnano

[28] http://www.technologyreview.com/Biztech/18086/page1/

The French postal service plans to order 10,000 electric vehicles:
http://www.autobloggreen.com/2007/04/18/the-french-postal-service-plans-to-order-10-000-electric-vehicle/

Nissan and NEC to produce electric-car batteries:
http://www.detnews.com/apps/pbcs.dll/article?AID=/20070413/UPDATE/704130433/1148/rss25

Electric car batteries might serve as reservoirs of green power?:
http://www.edn.com/index.asp?layout=blog&blog_id=1470000147&blog_post_id=1170007917

Basic battery technology:
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Battery data:
http://en.wikipedia.org/wiki/Nickel_metal_hydride_battery
http://en.wikipedia.org/wiki/Lithium_ion
http://en.wikipedia.org/wiki/Lead_acid

Specs on Altair nano battery:
http://www.altairnano.com/documents/NanoSafe_Datasheet.pdf

Johnson Controls reveals new hybrid-electric car batteries:
http://wistechnology.com/article.php?id=1485

Altairnano lithium ion battery system:
http://www.azonano.com/news.asp?newsID=1967

Safety of lithium ion batteries:
http://www.technologyreview.com/read_article.aspx?id=17250&ch=biztech

Lithium ion battery improvements:
http://www.technologyreview.com/read_article.aspx?id=16384&ch=biztech

7.7 Commute Programs

Commute Programs: Examples of Success

6/17/07

Jim Housman, PE

The United States of America consumes 9.2 million barrels of gasoline every day, approximately 25% of all the gasoline consumed in the world.[29] Yet the United States contains only 4.5% of the world's population. We drive bigger vehicles and we drive them farther each year than any other society. We have the cheapest gasoline of any nation that imports more petroleum than it exports (excepting China and Thailand)[30]. Americans are used to using their cars for virtually 100% of their transportation needs. We have built our cities, and even our small towns, around the assumption that everyone who wants to go anywhere will drive. Our driving has been cheap and convenient. But in recent years that has begun to unravel. As our homes have become farther away from our workplaces and as our need to import oil has increased driving has become more and more expensive and more irksome. And in spite of spectacular efforts to reduce pollution our driving has continued to be a major factor in environmental degradation.

Slowly over time these factors have been at the root of a change in behavior that is taking place all over the continent. In all 50 states, and in Canada, programs are arising to limit the number of automobiles on the road during peak driving hours. A number of states have established transportation demand management (TDM) legislation to reduce public road usage. In addition, local governments have established regional traffic mitigation programs to assist local employers in encouraging their workforce to stop driving to work alone. Often these programs enable groups of employers to share incentives and facilities to enhance the commuter experience while reducing costs for both employer and employee. California has no state wide traffic mitigation program, however the recently passed AB1431 (Vehicle Greenhouse Gas Emissions) will almost certainly address the effects of commuting on greenhouse gases.

The US Department of Transportation has created a program dubbed "Best Workplaces for Commuters" (BWC) to acknowledge those employers that have done the most to make alternate commute options work the best for their employees. As of June 2007 the site has over 1,400 employers listed as meeting the department's stringent standard for inclusion on the list. Typically to win acknowledgement employers must provide emergency ride home capabilities for transit and car/van pool commuters, provide some kind of subsidy or support for those not driving to work alone and commit to having 14% of employees participate in the program within 18 months. In addition to the BWC program the Internal Revenue Service permits employers to pay for certain commute benefits with pre-tax dollars, saving money for both employers and employees.[31]

29 http://www.eia.doe.gov/neic/quickfacts/quickoil.html

30 http://europe.theoildrum.com/node/2653

31 http://www.bwc.gov/

Commute programs exist at the federal, state, county and jobsite levels because they work. In a survey funded by the US Department of Transportation (DOT) in 2004 found that well designed commute programs reduced vehicle trips by an average of 15.3%.[32] That kind of reduction pays off. It pays off in savings to the employer, government at all levels and the employee.

Most employers are probably so accustomed to providing parking spaces for employees that it is not considered to be a real cost of doing business. Yet some employers must set aside more land for parking than is used for generating income. The Victoria (B.C.) Transport Policy Institute estimated in 2000 that parking lot construction costs can vary between $1500 (US) and $1900 (US) per space. That cost is in addition to the value of the unimproved land. When parking structures become necessary per space costs can exceed $9000 per space. In addition there are annual maintenance costs.[33] One estimate of the value to U.S. employers of this unproductive land placed the rental value nationwide at over 35 billion dollars.[34]

DOT estimates that current freeway construction costs exceed one-quarter million dollars per lane-mile with a continuing cost of about one percent of that amount for annual maintenance. While this cost is not apparent directly to the taxpayer it is there and as more roadways are constructed to accommodate peak traffic loads for commuters both the capital costs of construction and the annual maintenance costs are an increasing burden on taxpayers and on the local officials who must negotiate to find the funds.[35]

Commute costs to employees is more than the obvious. A UC Berkeley study in 1990 indicated that the average Bay Area one-way commute distance increased between 1980 and 1990 from 10.6 miles to 11.8 and the average duration from 27.7 minutes to 29.0 minutes. Over a 50 week working year that amounts to 5900 miles per year and 242 hours on the road. With per-mile driving costs approaching 50 cents employees are spending almost $3000 per year just to get to work. Since employers do not pay for the time that commuters sit in their cars in heavy traffic it is the individual worker whose time is wasted crawling through traffic. According to the Texas Transportation Institute California commuters who have recently moved to a metropolitan area spend, on average, 250 hours per year in commuter traffic.

There are great success stories in communities developing programs to reduce vehicle miles traveled (VMT). Boulder, Colorado has a program called Ride Arrangers that reports having saved 28 million VMT in 2006. Ride Arrangers has 6,000 people in their carpool database, 380 people vanpooling with a waiting list to fill 10 more vans. There are 4,000 "teleworkers" and 11,000 families enrolled in the "schoolpool" database. In the annual Bike to Work Day in 2006 there were 20,000 participants. [36]

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[32] Mitigating Traffic Congestion; Association for Commuter Transportation; PO Box 15542, Washington, DC 20003-0542;2004

[33] Todd Litman; Parking Management Strategies, Evaluation and Planning; Victoria Transport Policy Institute; 2006

[34] http://72.14.253.104/search?q=cache:biyCdgRbNHQJ:www.commuterchoice.gov/pdf/sanfran/bwc-present-sfa.ppt+sonoma+best+workplaces&hl=en&ct=clnk&cd=2&gl=us&lr=lang_en

[35] http://www.publicpurpose.com/hwy-fy$.htm

[36] Linda Dowlin, Denver TDM Manager; personal communication; 6/11/07

In the Bay area Contra Costa county reports that their SchoolPool program has reduced VMT by 4 million miles in 2002[8]. The San Mateo County Commute Alternatives Program has mailed 80,000 Commuter Checks to employees of 3,200 employers in the county since 1991.[37] C2HM Hill reports a 115,000 mile reduction in VMT in 2002 at a single worksite in Denver. In Seattle the University of Washington estimates that the UPASS program has eliminated 91 million vehicle trips since it was established in 1991[4]. These examples show that in a large variety of environments and over long periods of time employers, employees, taxpayers and the environment are benefiting from well designed commute programs.

Today, more than ever in the past, it makes sense to create programs allowing commuters to get out of their cars and find more appropriate ways to get to and from work. The ability of the modern passenger vehicle to take us anywhere we want, when we want is at its least beneficial when we are traveling the same path at the same time of day over many months and years. The rising cost of operation, the increasing time spent unproductively and the anger and frustration so often connected with present day commuting will continue to get worse in the future. We cannot pave the entire nation to enable every person to drive effortlessly where ever they want to go at any time of day. It follows that community leaders in every American community should be emulating the examples of those communities that have gained so much by instituting these programs.

37 http://www.smccap.org/index.jsp

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16. Accordia Northwest, Inc., Seattle WA; Commute Trip Reduction Program;
17. http://www.commuterchallenge.org/cc/daw99acordia.html
18. Sustainable Transportation Success Stories; Smart Communities Network; http://www.smartcommunities.ncat.org/transprt/trsstoc.shtml
19. Ride Solutions; Mid Ohio Regional Planning Commission; http://ridesolutions.morpc.org/
20. City of Palo Alto Way 2 Go Program; http://www.city.palo-alto.ca.us/transportation-division/commute-index.html
21. Washington D.C.; Capital Rideshare Program; http://capitolrideshare.com/index.htm

Examples of Successful Programs

			% of Transit Population Participating												
Program name	**Location**	**Demographics**	**Car pool**	**Van pool**	**Transit pass**	**Car/Van Parking**	**Guaran. Ride Home**	**Tele commute flextime**	**Work week**	**Shuttle**	**Bicycle/ Walk**	**Other**	**BWC(@)**	**% Participating**	**Control ($)**
Upass	U. of Washington	39,000 students	x		x	x							Yes		Univ.
SchoolPool	Contra Costa Cty, CA	157,000 students	x		x								No		County
Transportation Options	Aspen, CO	15,000 residents	x			x				x			Yes		Blanket
TNT/TMA	Lake Tahoe Basin	56,000 residents, large tourist influx			x							x	No		Govt
Vanpool Program	Bal Harbour Village, FL	3309 pop.		x									Yes		Govt
Calibre Transportation Benefits	Alexandria, VA	na	x		x			x			x	x	Yes		Corp
C2HM Hill Telework & Flextime	Denver, CO	na	5.0%		3.0%			8.0%			0.5%		No	16.5%	Corp
Georgia Power Smartride	Atlanta, GA	5,500 employees	7.0%	6.0%			x	20.0%		x			Yes	33.0%	Corp
Transit Plan	Hennepin County, MN	13,000 county employees	15.0%	2.0%	15.0%			8.0%					Yes	40.0%	Blanket
Johns Manville tbp	Denver, CO	est. 400 empl Denver only	x	0.5%	44.0%	x						0.5%	Yes	45.0%	Corp
Nike TRAC Program	Beaverton, OR	5,000 employees	10.0%		5.0%		x	5.0%			2.0%	Prizes	Yes	22.0%	Corp
Overlake Christian Church tbp	Redmond, Wash	109 employees	26.0%		1.0%			12.0%	8.0%		1.0%		No	48.0%	Corp
Simmons College tbp	Boston, MA	740 faculty & staff			27.0%		x			x		32.0%	Yes	59.0%	Corp
Swedish Medical Center tbp	Seattle, WA	758 staff & dr	19.0%	2.0%	23.0%	x	x	2.0%	x				Yes	46.0%	Corp
Texas Children's Hospital tbp	Houston, TX	758 staff & dr	10.0%		10.0%	x	x	x		x			Yes	20.0%	Corp
King County TOD	Seattle, WA	metro Seattle	x		x	x						car share	No		Blanket
Acordia Northwest Inc.	Seattle	118 employees	x	x	x		x	x					No		Corp
GO Boulder	Boulder, CO	County employees	x	x	x		x	x			x	4100 bikers, walkers, transit riders	No		Blanket
Commute Alternatives Program	San Mateo, CA county	City and surrounding area	x	x	x	x	x						Yes		Blanket
Ride Arrangers	Denver, CO	School, city & business employees	x	x			x	x			x		No		Blanket
GoGreen	Vancouver BC	906,000 pop	x	x	x			x			x		No		Blanket
Smart Commute Program	Westchester County, NY		x	x	x	x	x	x	x				Yes		Blanket
CTR	Redmond Wash	23,500 pop											No		Blanket
RideSolutions	Mid-Ohio Regional Planning Comm.	11 counties around Columbus, OH	x	x	x		x				x		No		Blanket
Employee Commute Program	Palo Alto		x	x	x		x			x	x		No		Blanket
Travel Reduction Program	Greater Tucson area	486669	x		x						x		No		Blanket
Capital Rideshare	Phoenix, AZ	4,000 state employees plus 50 companies.	x	x	x	x	x	x	x		x		No		Blanket
This program is an umbrella function for all Wash state programs															
Commute Trip Reductic	State of Wash														
This program is an umbrella function for all Wash state programs															
MassRides	State Of Mass.														
*Note corp participation is voluntary so financial benefits are at employer discretion															
$ Control refers to the type of organization sponsoring the program.															
Blanket refers to a government sponsorship organization that helps other organizations to form commute programs.															
@ BWC= Listed on federal program called "Best Workplace for Commuters"															