THE ENERGY ALLIANCE ASSOCIATION

Sustainability Services

Town of Windsor
Greenhouse Gas Emissions Reduction Action Plan Update

Final Report

July 24, 2012

Prepared by The Energy Alliance Association

Acknowledgements

This work was made possible by the Town of Windsor Staff. Without their important commitment, this work would not be possible. In addition, there were many individual contributors to the success of this project. Town Staff provided the key information required to develop the measures in these Action Plans. Kevin Thompson, Senior Planner, was a key figure in coordinating and collecting this data with the Town Staff. Town Manager, Matt Mullan provided the clear guidance necessary for appropriate plan development. Finally, ultimate appreciation goes to the Windsor Town Council for their vision for a stronger, more secure future for our community, expressed in many ways, including their support for this important work

Disclaimer: The Energy Alliance Association (TEAA) does not imply any guarantees. The information contained in this report is intended to support the Town in its efforts to understand the greenhouse gas emissions trend and opportunities for Town operations and employee commutes. All results are approximations using standard engineering methodologies, based on historical energy usage and best available information from Town Staff

Definition of Terms

CEC (California Energy Commission) The CEC is California's primary energy policy agency. They are responsible for forecasting future energy needs, promoting energy efficiency through appliance and building standards, and supporting renewable energy technologies.

CNG (Compressed Natural Gas) Compressed Natural Gas is a substitute to gasoline, diesel, or propane fuel for vehicles. It is made by compressed natural gas, mainly methane (CH4).

CO2e (Equivalent Carbon Dioxide) Equivalent Carbon Dioxide is the concentration of carbon dioxide that would cause the same level of radiative forcing as a given type and concentration of greenhouse gas such as methane, perfluorocarbons, and nitrous oxide.

GHG (Greenhouse Gas) Greenhouse gases are the gases in the atmosphere which reduce the loss of heat into space and therefore increase global temperatures. Greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, ozone, and chlorofluorocarbons.

ICLEI (International Council for Local Environmental Initiatives) ICLEI was formed in 1990 and is an international association of local governments and national and regional local government organizations that have made a commitment to sustainable development.

MIRR (Modified Internal Rate of Return) MIRR is a budgeting metric used to evaluate the financial return on an investment under consideration. A larger MIRR indicates stronger investment potential.

kWh (kilowatt-hour) A kilowatt-hour is the energy unit for electricity. One kilowatt hour is the amount of energy expended by a one thousand watt load drawing power for one hour.

Metric Ton A metric ton equals 2,204.6 lbs. A short ton equals 2000 lbs.

Net Capital Cost The net capital cost is the capital cost of a project minus incentives and rebates.

NPV (Net Present Value) Net present value is a standard method for the financial appraisal of long-term projects. It measures the excess or shortfalls of cash flows, in present value terms, once financing charges are met. NPV indicates how much financial value an investment or project adds to the value of the business, firm or institution.

O&M (Operations and Maintenance) Operations and maintenance refers to the maintenance cost incurred by a unit of equipment. The O&M costs in this analysis are the additional operation costs associated with the efficiency measure beyond the utility and fuel costs (which are handled separately).

PV (Photovoltaic) Photovoltaic cells convert light energy into electricity. Also called solar power.

RPC (Renewable Portfolio Standard) Established in 2002 and accelerated in 2006, California's Renewables Portfolio Standard (RPS) is one of the most ambitious renewable energy standards in the country. The RPS program requires electric corporations to increase procurement from eligible renewable energy resources by at least 1% of their retail sales annually, until they reach 33% by 2020[1].

California Low Carbon Fuel Standard Established by Executive Order in 2007 this regulation requires a reduction of 10% in emissions (lbs. CO2e/gal) from vehicle fuels by 2020.

[1]California Public Utilities Commission, http://www.cpuc.ca.gov/PUC/energy/Renewables/

Table of Contents

1.0 Executive Summary 6
Background 7
Methodology 11
Results 12
Summary 18
2.0 Introduction 19
Energy Cost Trend 20
3.0 Results 23
4.0 Methodology 26
Context 26
Measure Identification 27
Measure Assumptions: General Variables 27
Incremental Capital Cost of Efficiency Measures 29
Measure Specific Variables 29
Financial Analysis Results 29
Financing Methods 31
Community Benefit 31
California Low Carbon Fuel Standard 31
Utility Electric Power Content 32
Non Efficiency Related Capital Cost Satisfied by Plan 33
5.0 Plan Details 34
Measure Details 36
Measure Results 36
6.0 Summary and Conclusions 44
7.0 Appendices 45
7.1 Basis for 2000 GHG Inventory and Trends 46
7.2 2011 GHG Inventory 48
7.3 Photovoltaic System Production Assumptions andExample Calculations 50
7.4 Measure Inputs 51
7.5 Vehicle Lists 53

List of Tables

Table 1: GHG Action Plan Financial Results 12
Table 2: Measures 1-11 15
Table 3: Measures 12-21 (Completed) 15
Table 4: Measures 22-26 (Awaiting Data for Analysis) 16
Table 5: Annual Electric Energy Use by Sector (kWh) 20
Table 6: Annual Natural Gas Use by Sector (Therms) 20
Table 7: GHG Action Plan Financial Results 23
Table 8: General Inputs 28
Table 9: PG&E Emission Factors (actual and estimated) 32
Table 10: Action Plan Results 34
Table 11: Action Plan Cash Flow Analysis 34
Table 12: Action Plan Measures 35
Table 13: Measure Results 36
Table 14: Calculation of GHG Emissions Trends 47

List of Figures

Figure 1: Town of Windsor GHG inventory as a percentage of the 2000 total 7
Figure 2: Annual Electric Energy Use by Sector (kWh) 8
Figure 3: Annual Natural Gas Use by Sector (Therms) 8
Figure 4: Water and Waste Water Energy Consumption Allocations 9
Figure 5: Town of Windsor Energy Costs and Energy Cost Target 9
Figure 6: Annual Vehicle Fuel Cost Trend Scenarios 10
Figure 7: Annual Cost of Fuel and Energy 13
Figure 8: The Town's Annual Carbon Trend 14
Figure 9: Town's Carbon Density by Population (Emissions per Windsor Resident) 14
Figure 10: GHG Reduction by Sector as a Percentage of the Total Reduction 17
Figure 11: GHG Inventory as a Percentage of the 2000 Total Emissions Reduction 19
Figure 12: Water and Waste Water Energy Consumption Allocations 21
Figure 13: Town of Windsor Energy Costs and Energy Cost Target 21
Figure 14: Annual Vehicle Fuel Cost Trend Scenarios 22
Figure 15: Annual Cost of Fuel and Energy 24
Figure 16: Annual GHG Emissions 25
Figure 17: Annual GHG Emissions per Resident 25
Figure 18: GHG Reduction by Sector as a Percentage of the Total Reduction 35

1.0 Executive Summary

The Town of Windsor is a family-oriented community with a wide variety of recreational opportunities, well-planned business areas, and a historical downtown. The Windsor area was primarily agricultural throughout most of the 1900s, with wine grapes, hops, and prunes as the primary crops. The Town's population and economic growth grew rapidly from the early 1980s, when housing development blossomed, bringing new families and businesses into this area, with incorporation occurring on July 1, 1992. The population of Windsor grew to 26,801 by 2010[2], a 1.5% annual increase since 2000.

The Town of Windsor has implementing the ICLEI program to reduce the greenhouse gas (GHG) emissions from Town controlled sources. This program has five steps, referred to as "Milestones". Milestone 1 specifies creating a GHG inventory (completed in 2003). Milestone 2 sets a reduction target (26.2% below 2000 by 2010). Subsequent to setting this target date, several important statewide initiatives have been enacted. These include AB 32, SB375, the Renewable Portfolio Standard, and the Low Carbon Fuel Standard. They have an implementation date of 2020. Therefore the target date for this analysis has been revised to 2020 to match these initiatives and to allow more time to implement the Town's energy reduction projects.

Milestone 3, Milestone 4 and Milestone 5 specify the development of the action plan, execution of the plan and the monitoring of the results. This Action Plan update addresses these last three milestones by updating the Action Plan containing the specific measures needed to meet the target, modifying the original action plan for new opportunities and changing circumstances, and by providing a track record of success through a review and reporting of energy and fuel use.

This analysis and resulting GHG emissions reduction plan incorporate many opportunities in the various contributing sectors (Building Efficiency, Fleet, Commute, Water/Sewer, Streetlights, and Distributed Generation).These opportunities have been reviewed by the Town Staff utilizing the best available information at the time of research.

The results provide the anticipated emissions reduction with the corresponding financial analysis including the Modified Internal Rate of Return (MIRR) and Net Present Value (NPV) of each plan[3]. 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.

The intent of this work is to ensure the Town's efforts to reduce emissions and energy costs continue to be responsive to changing conditions and evolving opportunities. This work provides a comprehensive path forward with individual project detail and the overall costs and benefits. This critical information is intended for use by Policy Makers as they allocate staff time and resources to this important energy cost and greenhouse gas reduction goal.

[2] Town of Windsor 2010 population 26,801, US Census Bureau, 2011.http://quickfacts.census.gov/qfd/states/06/0685922.html

[3] These financial metrics are described in detail within the Methodology section of this report.

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 Town of Windsor emissions by sector are presented as a percentage of the total emissions in Figure 1 below.

The total emissions for baseline year 2000 are 1857 metric tons of CO2e. There were significant increases of GHG emissions since the baseline year of 2000 identified from billing data. These are discussed in the methodology section and have been incorporated into this analysis.

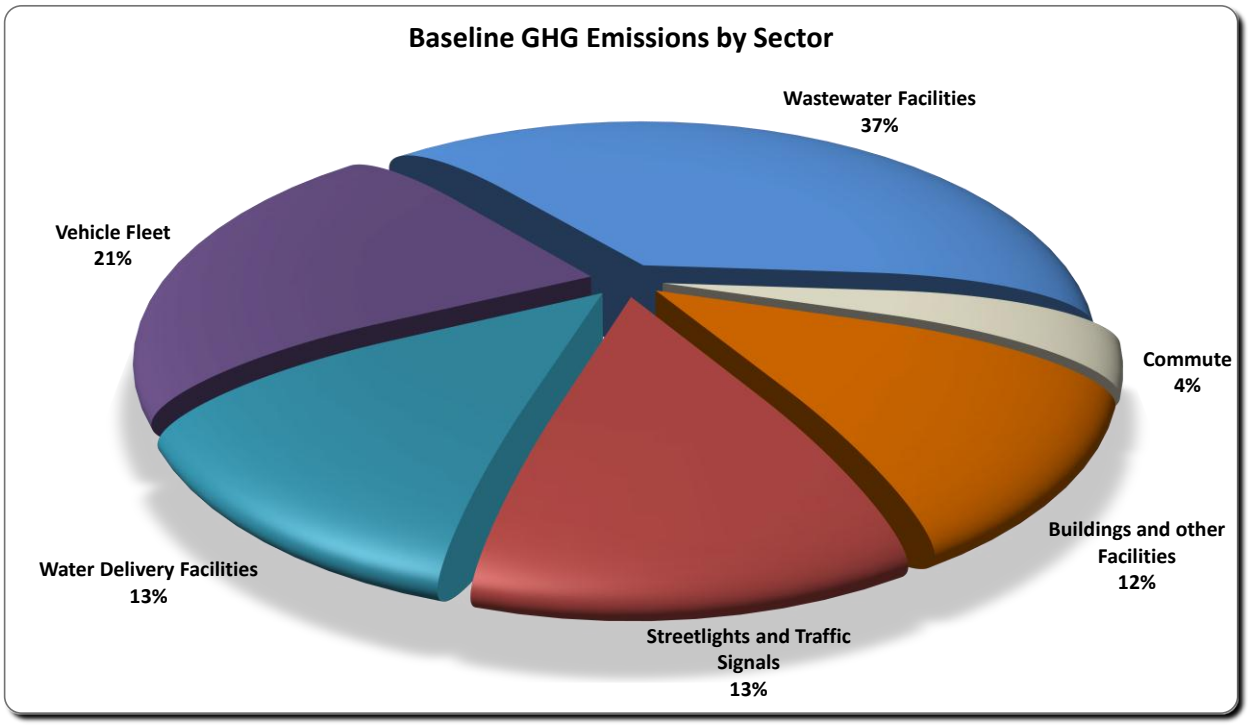

Figure 1: Town of Windsor GHG inventory as a percentage of the 2000 total

The GHG emissions associated with utility fuels (electricity and natural gas) are a significant portion of total emissions. The tables below provide a summary of the PG&E billing data by fuel type and end use (Sector) for this period.

PG&E Billing Data	Electric Annual Use					
	2000	2001	2002	2003	2004	2005
Sectors Total	7,377,843	7,253,627	7,220,055	7,393,407	8,117,110	8,203,965
Building and other facilities	1,308,120	959,852	715,907	980,499	1,141,133	1,071,281
Streetlights and traffic signals	963,939	974,609	959,120	866,781	908,851	931,713
Water delivery facilities	2,503,182	2,197,766	2,075,563	1,533,251	1,742,909	1,805,161
Wastewater facilities	2,602,602	3,121,400	3,469,465	4,012,876	4,324,217	4,395,810

PG&E Billing Data	Electric Annual Use					
	2006	2007	2008	2009	2010	2011
Sectors Total	9,007,303	8,079,718	8,005,746	7,564,395	7,693,570	7,416,207
Building and other facilities	1,109,099	1,251,187	1,018,646	1,132,262	895,329	759,362
Streetlights and traffic signals	969,757	995,512	1,022,002	1,100,964	1,109,368	1,104,327
Water delivery facilities	1,639,170	1,343,792	1,296,528	785,756	950,868	567,156
Wastewater facilities	5,289,277	4,489,227	4,668,570	4,545,413	4,738,005	4,985,362

Figure 2: Annual Electric Energy Use by Sector (kWh)

PG&E Billing Data	Natural Gas Annual Use					
	2000	2001	2002	2003	2004	2005
Sectors Total	17,530	15,729	17,285	19,802	17,345	17,957
Building and other facilities	17,530	15,729	17,285	19,802	17,345	17,957
Streetlights and traffic signals	0	0	0	0	0	0
Water delivery facilities	0	0	0	0	0	0
Wastewater facilities	0	0	0	0	0	0

PG&E Billing Data	Natural Gas Annual Use					
	2006	2007	2008	2009	2010	2011
Sectors Total	20,125	18,525	21,559	17,886	20,414	22,272
Building and other facilities	20,125	18,525	21,559	17,886	20,414	22,272
Streetlights and traffic signals	0	0	0	0	0	0
Water delivery facilities	0	0	0	0	0	0
Wastewater facilities	0	0	0	0	0	0

Figure 3: Annual Natural Gas Use by Sector (Therms)

The water delivery and wastewater GHG emissions are a significant portion of the total emissions. Figure 4 below identifies the constituent sources and their percentages of the total water delivery and wastewater segment. This figure provides the percentages for 2011, the latest data available for this analysis.

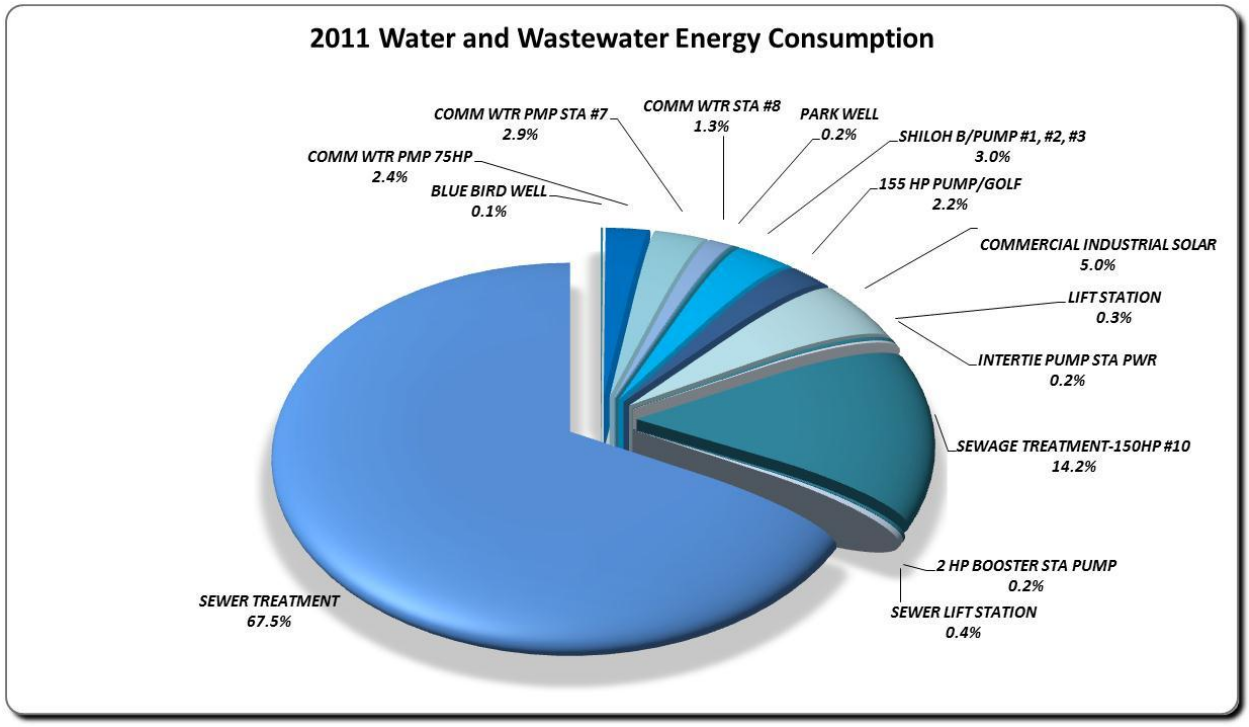

Figure 4: Water and Waste Water Energy Consumption Allocations

Many of the measures available to reduce GHG emissions also will reduce the Town fuel, electricity and natural gas costs. Figure 5 below provides the anticipated benefits of this effort by displaying PG&E electric and natural gas cost savings that would be associated a 26.2% (GHG goal) reduction in energy consumption between 2000 and 2011.

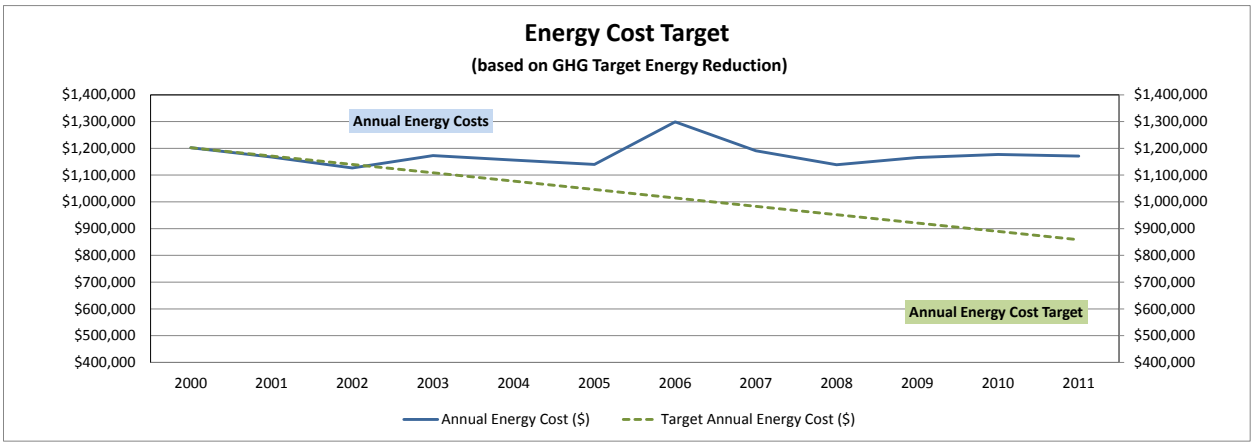

Figure 5: Town of Windsor Energy Costs and Energy Cost Target

The annual energy costs are a significant element of the municipal budget. The potential volatility of these costs represents a threat beyond the control of Town Staff. The fuel, electricity and natural gas related measures contained in this analysis would reduce this vulnerability to energy and fuel price increases. The volatility of vehicle fuel cost is particularly acute when considering the potential impact on municipal budgets. Figure 6 below illustrates the magnitude of this vulnerability under scenarios ranging from below average increases (4%) to extreme volatility (20%) representing a condition of resource scarcity.

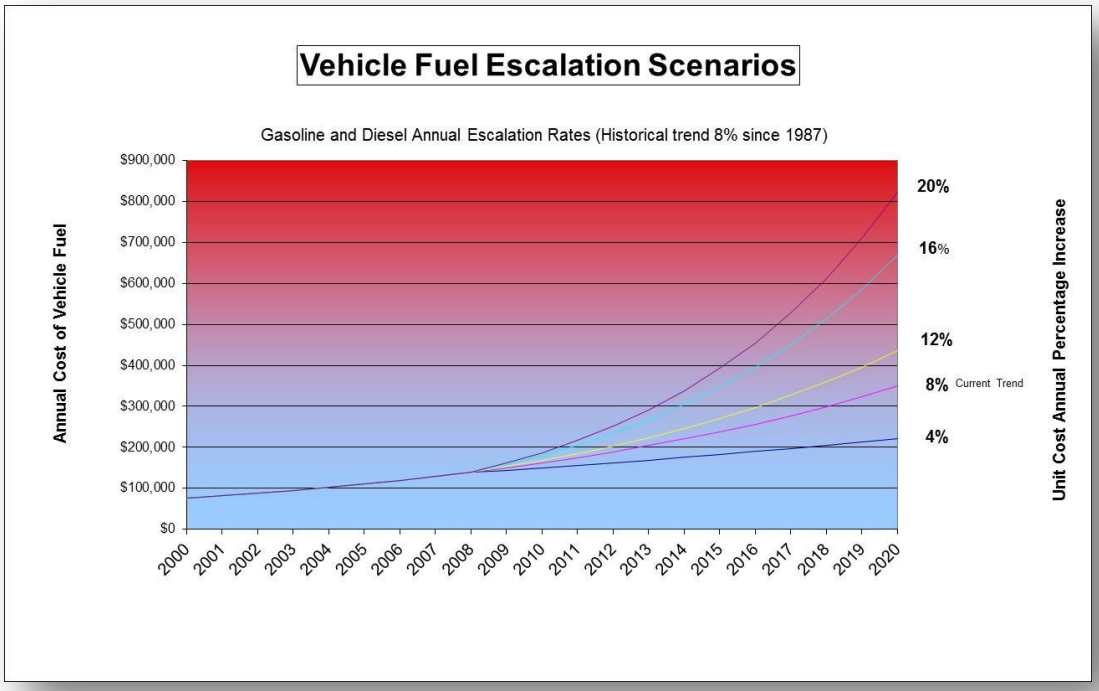

Figure 6: Annual Vehicle Fuel Cost Trend Scenarios

Methodology

The Windsor GHG emissions inventory for 2000 was established in 2003[4] and provides the baseline for this work. The specific actions and events affecting this baseline from 2000 to 2011, either positive or negative, are factored into the inventory and the resulting future trend is based on an annual estimated 1% population growth. The 2000 baseline and trend into the future details used in this analysis are available in the appendices.

The options for future action by the Town 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 based on best available information at the time of the analysis. These have been evaluated and presented as individual measures, and as a group of measures (the action plan). Each measure was assigned a status (completed or future) and an implementation date to enable the calculation of cash flows over the life of the plan and the creation of energy cost trend graphs.

The measures were grouped to create a comprehensive GHG emissions reduction plan. Measure specific data such as capital cost, year of implementation, financing, energy and cost savings were processed to provide the following information for the overall action plan. Explanations of the terms below are provided in the Methodology Section (page 26).

- Emissions reduction in tons CO2e avoided and as percentage of baseline
- CO2e reduction by sector
- Annual Cash Flow including debt service, replacement cost and incremental O&M[5] costs
- Outstanding principal and debt service by year
- Simple Payback (SPB)
- Modified Internal Rate of Return (MIRR)
- Net Present Value (NPV)
- Avoided utility company payments (NPV over life of plan)
- Avoided fuel purchases (NPV over life of plan)
- Value invested locally in emission reduction projects

[4]GHG Inventory Report Town of Windsor, Amy Boncszewski, intern for the Town of Windsor, September 2003.
[5] Operation and Maintenance costs do not include fuel and energy costs which are handled separately.

Results

Table 1 below summarizes the costs and benefits of the Action Plan. In addition to the GHG savings, the table provides the net annual cash flow calculated from the project cost, loan payments and annual energy cost savings. The Action Plan estimates a reduction of 26.2% below the year 2000 (baseline) emissions by 2020. A large part of the required reduction is due to the increase in Town staff and equipment since 2000 increasing GHG emissions significantly.

The financial analysis provided below includes the critical metrics of Modified Internal Rate of Return (MIRR) and Net Present Value (NPV)[6]. These provide important information to evaluate the worthiness of the investment from a cash flow perspective. These metrics are also provided for each measure within the Measures Details section below. Both the NPV and the MIRR can be improved with the addition of water and wastewater improvements due to be identified by a comprehensive system survey to improve efficiency.

GHG Action Plan Summary	
Financial Results	
CO2e Emissions Saved in 2020 (metric tons)	487
Net Reduction below 2000	26.2%
Number of Projects	11
Net Capital Cost	$544,375
Modified Internal Rate of Return (MIRR)	6.3%
Net Present Value (NPV)	($51,310)
Financing	Utility On Bill Financing (OBF)
Net Annual Cash Flow	
2012	($23,800)
2013	($8,592)
2014	($40,607)
2015	$13,333
2016	$12,002
2017	$14,050
2018	$16,170
2019	$18,364
2020	$20,637
2021	$22,990
2022	$25,425
2023	$27,947
2024	$66,872
2025	$69,575

Table 1: GHG Action Plan Financial Results

[6] NPV and MIRR are calculated independently of the net cash flow displayed. See Methodology Section for details.

The Action Plan consists of numerous measures to reduce GHG emissions, reduce energy costs, address equipment problems, and reduce the uncertainty of the Town's future annual energy costs. Figure 7 below illustrates the impact on energy costs achieved by actions to reduce energy consumption. The power purchase agreement (PPA) assumed in this analysis helps satisfy the GHG emissions reduction goal, but add an estimated 1% over the annual cost of the utility supplied energy displaced by the systems.

The results reflect the anticipated increase in Windsor population and associated city services, and annual increases in the cost of utility energy (electric and natural gas) and vehicle fuel. The current cost of energy and the assumed energy escalation rate are provided in the General Inputs (Table 8) in the Methodology Section.

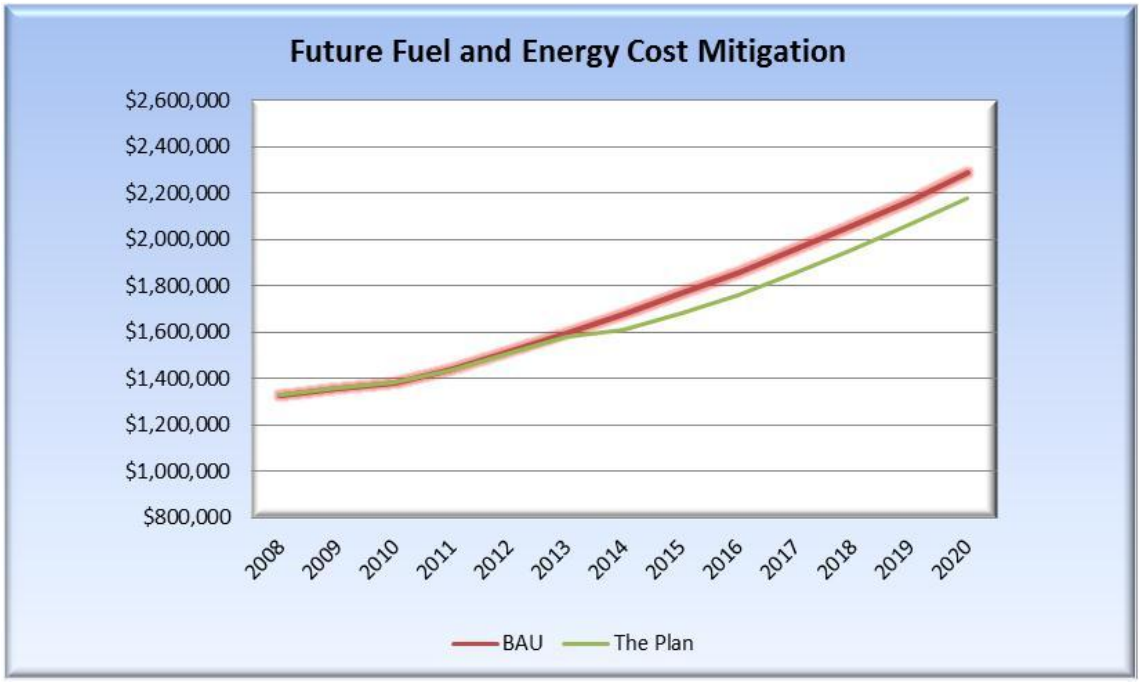

Figure 7: Annual Cost of Fuel and Energy

The reduction in greenhouse gas emissions over time is presented in Figure 8 below. These trends are based on the following key considerations:

1) Timely implementation of the measures contained in the Action Plan
2) Reduction of the kWh emissions factor over time per the Renewable Portfolio Standard[7]
3) The impact of the CA Low Carbon Fuel Standard[8]

[7]Renewable Portfolio Standard (RPS) is a statewide requirement of electric corporations to increase procurement from eligible renewable energy resources by at least 1% of their retail sales annually, until they reach 33% by 2020. This RPS eligible content requirement is in addition to the existing non carbon energy sources of large hydro and nuclear in the current PG&E power mix.

[8]California Low Carbon Fuel Standard Established by California Executive Order in 2007, this regulation requires a reduction of 10% in GHG emissions from vehicle fuels by 2020.

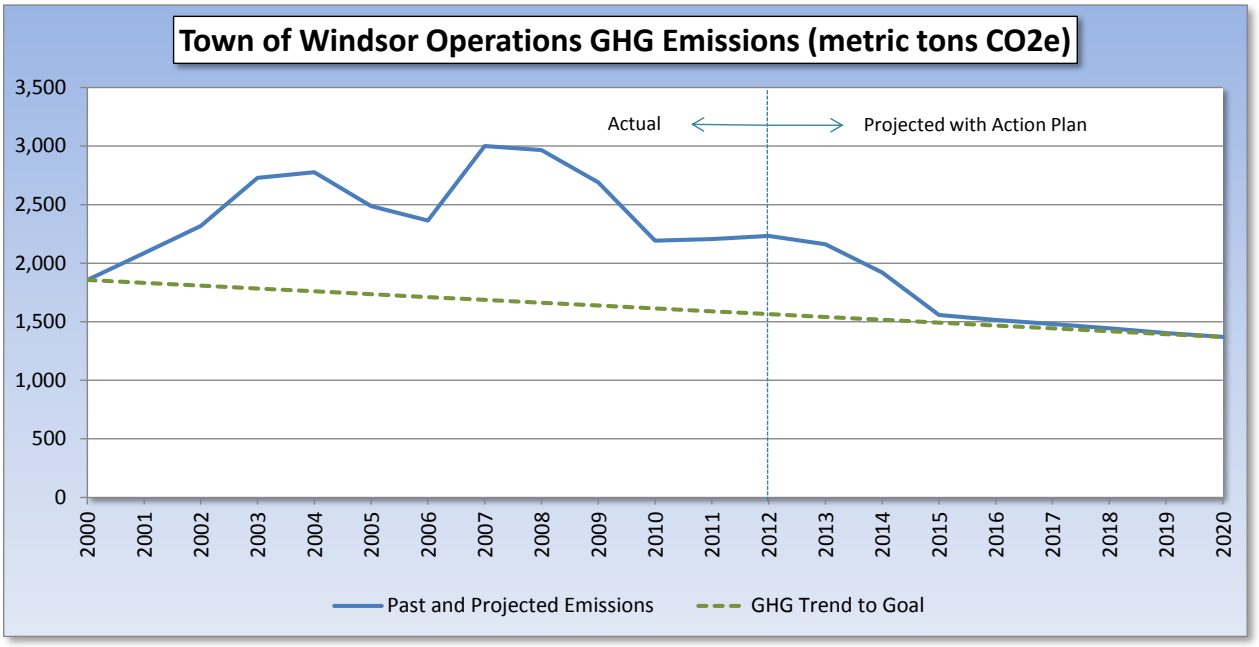

Figure 8: The Town's Annual Carbon Trend

The Carbon Density Trend (tons CO2e / person) is provided in Figure 9 below, based on the past and projected population of the Town of Windsor. These results are also heavily influenced by the utility emissions factor reductions due to the RPS and the CA Low Carbon Fuel Program.

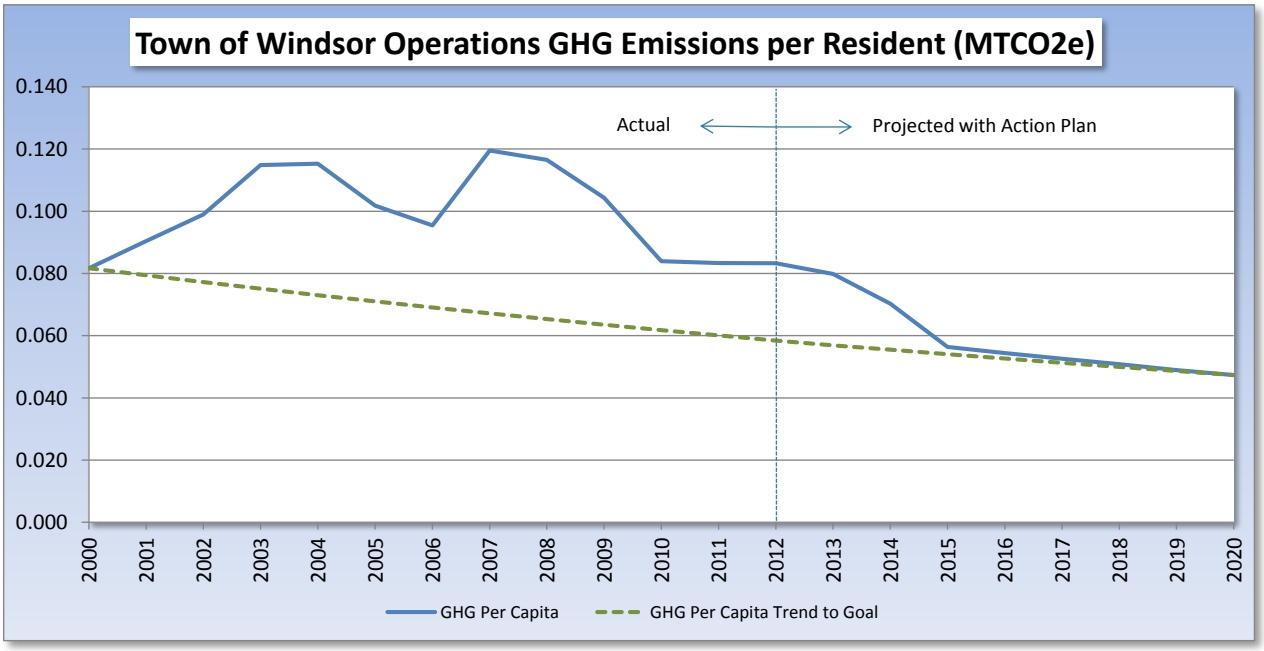

Figure 9: Town's Carbon Density by Population (Emissions per Windsor Resident)

Action Plan Details

The measures used in this analysis are provided in Table 2. Measures 9-11 incorporate the use of a power purchase agreement (PPA)[9] to fund the photovoltaic (PV) systems. This eliminates most of the upfront costs but adds to the annual cost of energy assuming the contract specifies a buy back rate of 1% higher than the PG&E rate. Note: Measure 1 has been completed since the initiation of this analysis.

Measure Number	Measure Name	Implementation Date
1	Pool Solar	2012
2	Pumps 2 (3 sites)	2013
3	Streetlighting HID to LED (178 Fixtures)	2013
4	Streetlighting HID to LED (178 Fixtures)	2013
5	Streetlighting HID to LED (178 Fixtures)	2013
6	Streetlighting HID to LED (180 Fixtures)	2015
7	New Fleet A	2014
8	Town Green Lighting (100 fixtures)	2013
9	PV 750 kWdc Wastewater Treatment Building (PPA)	2013
10	PV 860 kWdc (PPA)	2014
11	PV 860 kWdc (PPA)	2014

Table 2: Measures 1-11

The measures that have been completed are listed in Table 3.

Measure Number	Measure Name	Implementation Date
12	PV 60 kWac	2005
13	Community Center Lighting	2006
14	Senior Center Lighting	2006
15	Biodiesel 5%	2008
16	Cool Roof	2010
17	WstWtr SolarBee™	2010
18	Soffit Lighting (TEAA)	2010
19	Pond 5 Intertie Project	2011
20	PG&E LED Street Lights (104 Fixtures EECBG)	2012
21	Pump Retrofit: 6090 Shiloh Road	2012

Table 3: Measures 12-21 (Completed)

[9]A power purchase agreement is a long-term agreement between a power provider (the solar company) and a customer. The customer agrees to purchase energy from the provider at a fixed rate for the term of the agreement. This rate increases every year by an agreed percentage. The life of the agreement may be in the range of 20 years. At the end of the contract period the customer typically has the option to purchase the system at its value at that time.

The future measures that have been identified but not yet quantified are listed in Table 4. More information on the measures is available in the Measure Details section of the report.

Measure Number	Measure Name	Implementation Date
22	Community Center HVAC	2011
23	Wastewater Blowers	2014
24	Wastewater Scata Controls	2014
25	PC Server Optimization	2014
26	Water Reclamation Efficiency Improvement	2014

Table 4: Measures 22-26 (Awaiting Data for Analysis)

Action Plan	487	Tons CO2 Avoided	26.2%	Reduction Below 2000 by 2020
Community Benefit (over 25 year life of plan)		**Investment Results**		
$$$ Avoided Utility Company Payments	$802,185	Net Capital Cost	$544,375	
$$$ Avoided Fuel Purchases	$48,097	MIRR	6.3%	
$$$ Invested Locally in GHG Projects	$10,509,045	NPV	($51,310)	

The Action Plan includes a total of 11 measures implemented from 2012 to 2015. By 2020 the Action Plan is estimated to reduce GHG emission 26% below the emission in the baseline year of 2000. The measures include three PV systems totaling just under 2 megawatts, all of which are assumed to be power purchase agreements. These systems do not reduce the Town's energy costs, but make a substantial reduction in GHG emissions. The identification and implementation of other more cost effective measures (water/waste water equipment retrofits, aggressive fleet vehicle replacements, and employee commute reductions) would reduce the required size of this system and improve both the MIRR and NPV of the plan.

The plan also includes multiple street lighting measures using LED technologies. Solar Pool, New Fleet, Town Green Lighting, and Pump measures all contribute to the savings of this comprehensive strategy. The largest contributor to the Town's reduction is the reduction of the emissions factor for electricity due to the CPUC mandated Renewable Portfolio Standard.[10]

The resulting annual cash flow is the net income/cost to the Town (energy cost savings minus project debt service, replacement costs and associated O&M costs).

Year	Net Cash Flow
2012	($23,800)
2013	($8,592)
2014	($40,607)
2015	$13,333
2016	$12,002
2017	$14,050
2018	$16,170
2019	$18,364
2020	$20,637
2021	$22,990
2022	$25,425
2023	$27,947
2024	$66,872
2025	$69,575

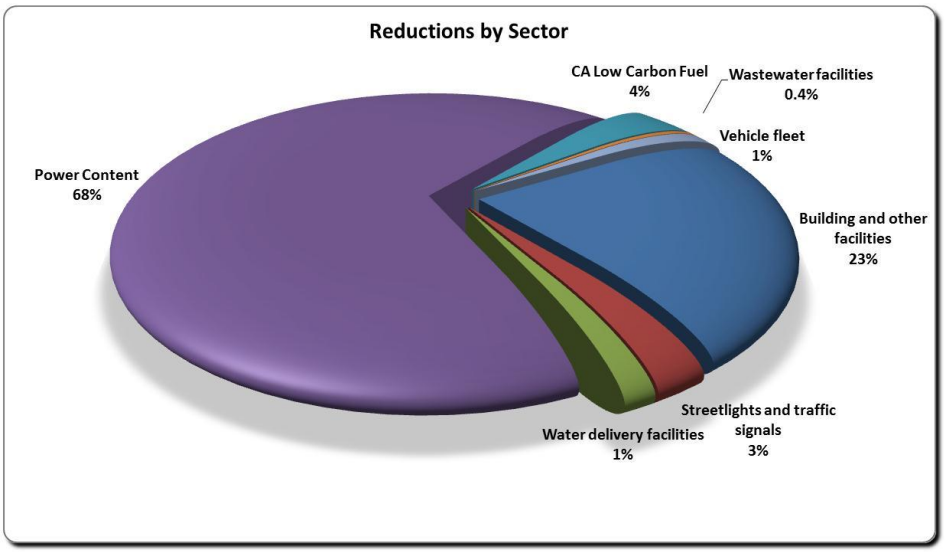

Figure 10: GHG Reduction by Sector as a Percentage of the Total Reduction

[10] The Renewable Portfolio Standard (RPS) a statewide requirement of electric corporations to increase procurement from eligible renewable energy resources by at least 1% of their retail sales annually, until they reach 20% by 2020.

Summary

The Town has experienced significant growth over the period covered by this analysis. From 2000 to 2010 there has been a 17.8% increase in the Town's population. The associated expansion of Town services has resulted in a 10% increase in GHG emissions from 2000 to 2011 adding to the challenge of meeting the Town's goal of 26% below 2000 levels by 2020 for Town controlled facilities and equipment. Anticipated town growth adds to the challenge.

This aggressive goal can be achieved by the measures outlined in this report. Fortunately, a large portion of the total GHG reduction (68%) will result from the implementation of the CPUC mandated Renewable Portfolio Standard (RPS) and the Low Carbon Fuel Standard. The implementation of the measures will contribute the remaining 32% of the total reduction.

This Action Plan has a very high reliance on photovoltaic (PV) systems which assume power purchase agreements to fund the projects. These will achieve GHG reductions but increase the annual cost of energy for the town. The identification and implementation of other more cost effective measures (water/waste water equipment retrofits, aggressive fleet vehicle replacements and employee commute initiatives) would reduce this reliance on PV and would provide a more balanced approach to emissions reduction as well as lower annual energy costs.

New technologies such as LED lighting, and innovative financing options including PG&E's On-Bill-Financing provide excellent opportunities for the implementation of energy cost and GHG reduction projects. There are also significant new fleet options available now or on the near horizon. These opportunities should be monitored and incorporated when available.

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 Town to meet a number of related goals, including improving the long term financial health of Windsor, reducing the budget vulnerability to future energy cost escalation, addressing the existing maintenance demands of aging equipment, and providing the public a demonstration of commitment and progress in the highly visible challenge of greenhouse gas emissions reduction.

The ultimate achievement of the 26.2% reduction goal will result in energy cost containment, significant relief to the general fund, and will meet the Town's obligation in the global effort to reduce greenhouse gas emissions. The leadership exhibited by the Town of Windsor will be a valuable example for other cities considering a similar path into the future.

2.0 Introduction

Public jurisdictions (cities and counties) have committed to developing action plans to reduce GHG emissions from government controlled sources. These detailed plans are an essential tool to provide a roadmap to accomplish the goals and provide a framework to track and verify the progress made over the life of the plan.

This report provides these capabilities by using an analysis method developed for California cities and applied to the Town of Windsor. This method incorporates available measures across the various sectors (Building Efficiency, Fleet, Commute, Water and Wastewater, Streetlights, and Photovoltaic Systems), and provides an emissions impact estimate and a comprehensive financial analysis.

The first step, creating the inventory of emissions produced by the internal operations was completed in 2003. The Town of Windsor emissions by sector are presented as a percentage of the total emissions in Figure 11 below.

The total emissions for 2000 are 1,857 metric tons of CO2e[11]. There were a number of significant new sources of GHG emissions since the baseline year of 2000 as identified from billing data. These additional GHG emissions push the total to 2,207 metric tons CO2e in 2011. The details of this addition are discussed in the methodology section and have been incorporated into this analysis.

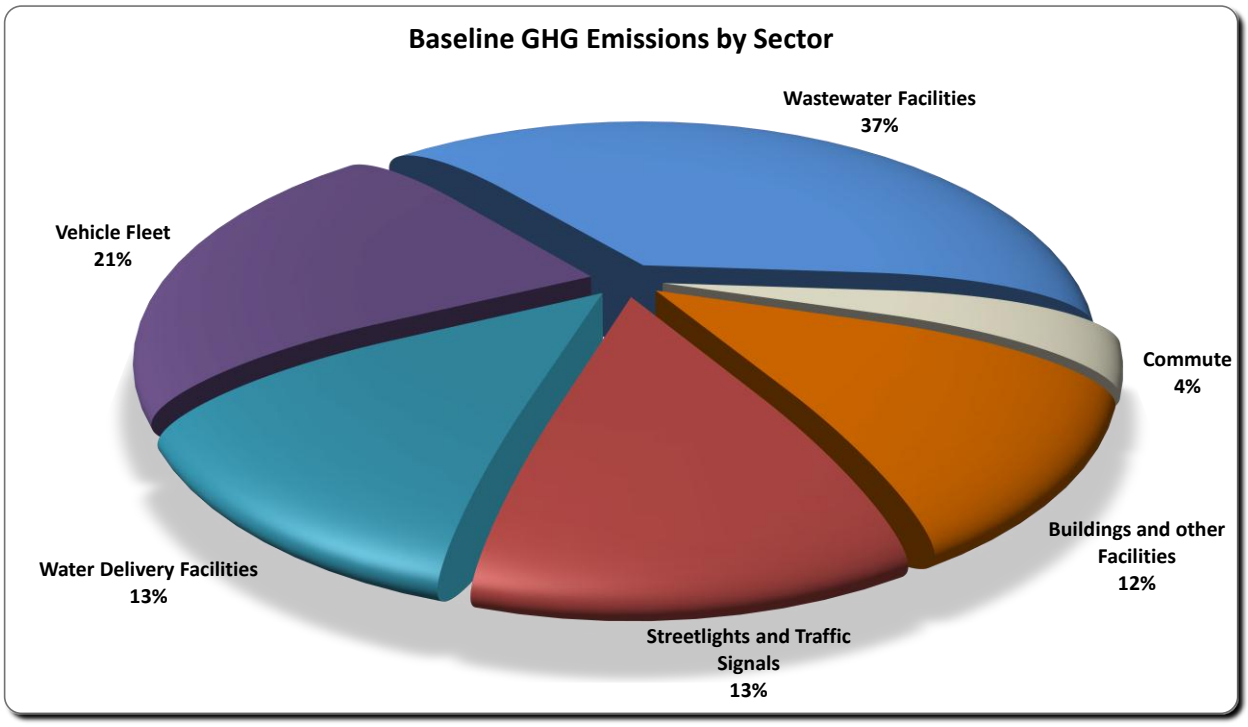

Figure 11: GHG Inventory as a Percentage of the 2000 Total Emissions Reduction

[11] The basis for the total emissions is provided in the Appendices.

Energy Cost Trend

Many of the measures available to reduce GHG emissions also will reduce the Town fuel, 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 Town Staff.

The tables below provide a summary of the PG&E billing data by fuel type and end use (Sector) for this period. The GHG emissions associated with utility fuels (electricity and natural gas) are a significant portion of total emissions. .

PG&E Billing Data	Electric Annual Use					
	2000	2001	2002	2003	2004	2005
Sectors Total	7,377,843	7,253,627	7,220,055	7,393,407	8,117,110	8,203,965
Building and other facilities	1,308,120	959,852	715,907	980,499	1,141,133	1,071,281
Streetlights and traffic signals	963,939	974,609	959,120	866,781	908,851	931,713
Water delivery facilities	2,503,182	2,197,766	2,075,563	1,533,251	1,742,909	1,805,161
Wastewater facilities	2,602,602	3,121,400	3,469,465	4,012,876	4,324,217	4,395,810

PG&E Billing Data	Electric Annual Use					
	2006	2007	2008	2009	2010	2011
Sectors Total	9,007,303	8,079,718	8,005,746	7,564,395	7,693,570	7,416,207
Building and other facilities	1,109,099	1,251,187	1,018,646	1,132,262	895,329	759,362
Streetlights and traffic signals	969,757	995,512	1,022,002	1,100,964	1,109,368	1,104,327
Water delivery facilities	1,639,170	1,343,792	1,296,528	785,756	950,868	567,156
Wastewater facilities	5,289,277	4,489,227	4,668,570	4,545,413	4,738,005	4,985,362

Table 5: Annual Electric Energy Use by Sector (kWh)

PG&E Billing Data	Natural Gas Annual Use					
	2000	2001	2002	2003	2004	2005
Sectors Total	17,530	15,729	17,285	19,802	17,345	17,957
Building and other facilities	17,530	15,729	17,285	19,802	17,345	17,957
Streetlights and traffic signals	0	0	0	0	0	0
Water delivery facilities	0	0	0	0	0	0
Wastewater facilities	0	0	0	0	0	0

PG&E Billing Data	Natural Gas Annual Use					
	2006	2007	2008	2009	2010	2011
Sectors Total	20,125	18,525	21,559	17,886	20,414	22,272
Building and other facilities	20,125	18,525	21,559	17,886	20,414	22,272
Streetlights and traffic signals	0	0	0	0	0	0
Water delivery facilities	0	0	0	0	0	0
Wastewater facilities	0	0	0	0	0	0

Table 6: Annual Natural Gas Use by Sector (Therms)

The water delivery and wastewater GHG emissions are a significant portion of the total emissions. Figure 12 below identifies the constituent sources and their percentages of the total water delivery and wastewater segment. This figure provides the percentages for 2011, the latest data available for this analysis.

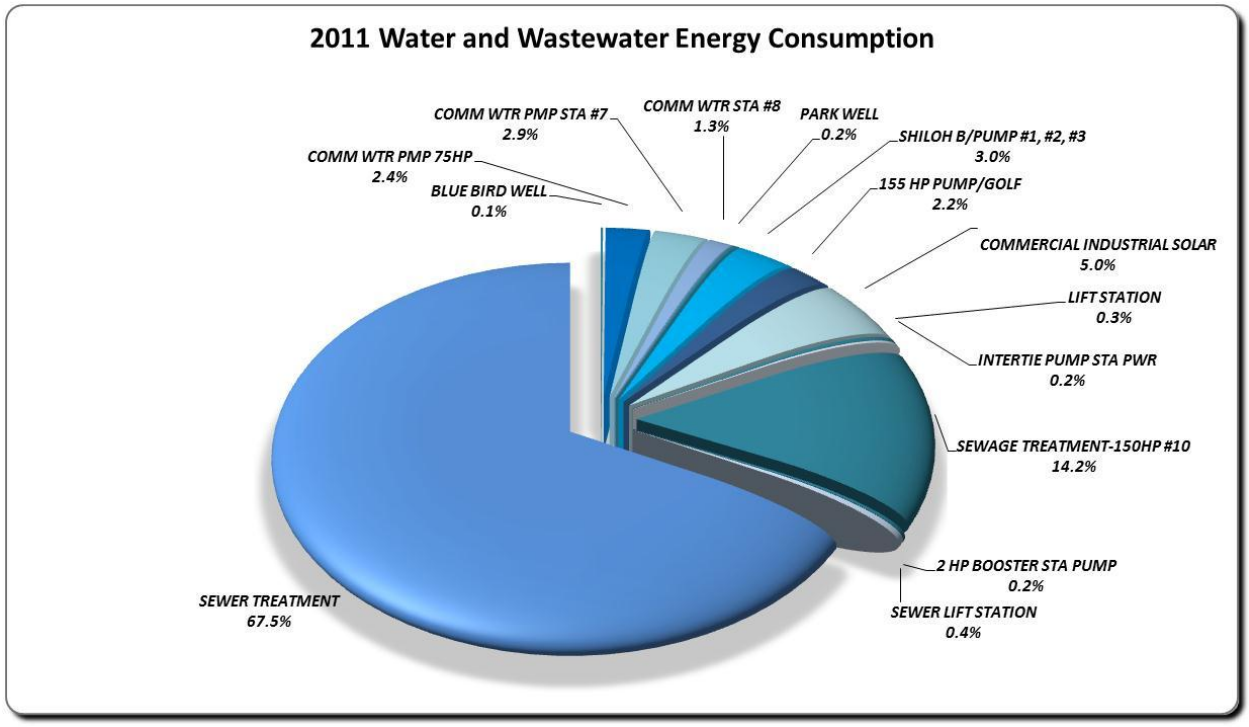

Figure 12: Water and Waste Water Energy Consumption Allocations

Many of the measures available to reduce GHG emissions also will reduce the Town fuel, electricity and natural gas costs. Figure 13 below provides the anticipated benefits of this effort by displaying PG&E electric and natural gas cost savings that would be associated a 26.2% (GHG goal) reduction in energy consumption between 2000 and 2011.

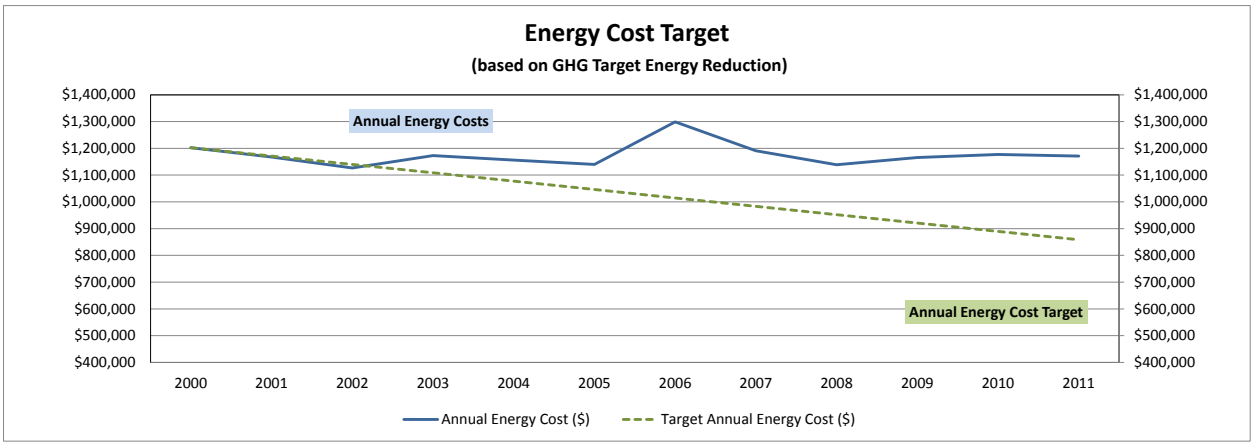

Figure 13: Town of Windsor Energy Costs and Energy Cost Target

The annual energy costs are a significant element of the municipal budget. The potential volatility of these costs represents a threat beyond the control of Town Staff. The fuel, electricity and natural gas related measures contained in this analysis would reduce this vulnerability to energy and fuel price increases. The volatility of vehicle fuel cost is particularly acute when considering the potential impact on municipal budgets. Figure 14 below illustrates the magnitude of this vulnerability under scenarios ranging from below average increases (4%) to extreme volatility (20%) representing a condition of resource scarcity.

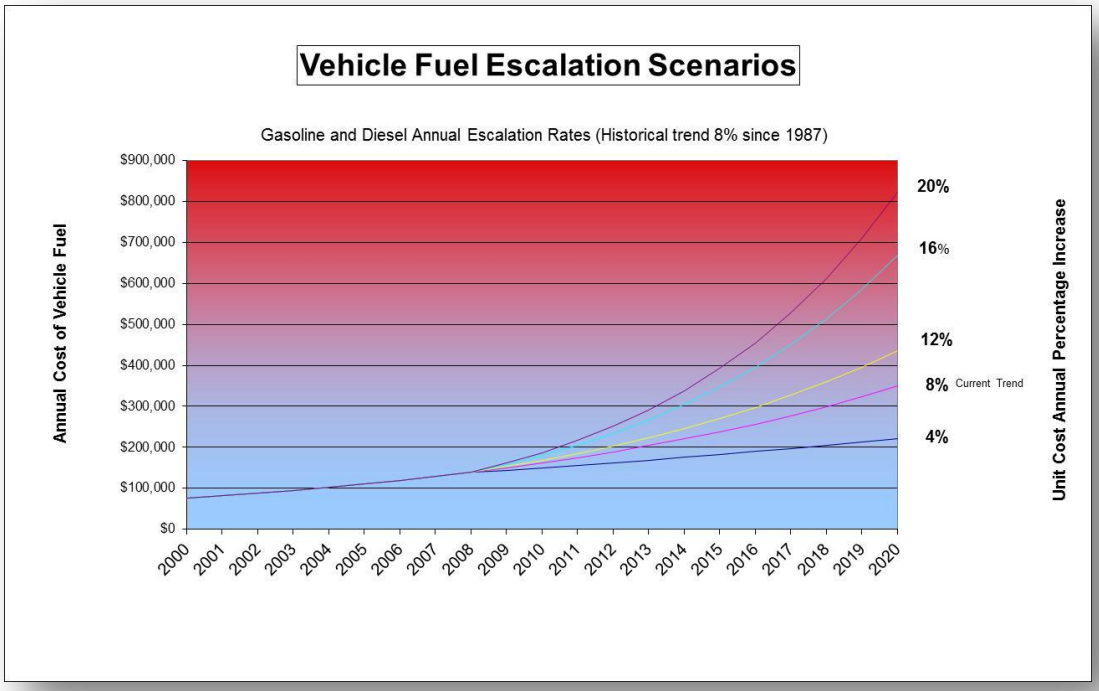

Figure 14: Annual Vehicle Fuel Cost Trend Scenarios

3.0 Results

Table 7 below summarizes the costs and benefits of the Action Plan. In addition to the GHG savings, the table provides the net annual cash flow calculated from the project cost, loan payments and annual energy cost savings. The Action Plan estimates a reduction of 26.2% below the year 2000 (baseline) emissions by 2020. A large part of the required reduction is due to the increase in Town staff and equipment since 2000 projected city population growth of (1% per year from 2012 to 2020) with its associated increase in Town services.

GHG Action Plan Summary	
Financial Results	
CO2e Emissions Saved in 2020 (metric tons)	487
Net Reduction below 2000	26.2%
Number of Projects	11
Net Capital Cost	$544,375
Modified Internal Rate of Return (MIRR)	6.3%
Net Present Value (NPV)	($51,310)
Financing	Utility On Bill Financing (OBF)
Net Annual Cash Flow	
2012	($23,800)
2013	($8,592)
2014	($40,607)
2015	$13,333
2016	$12,002
2017	$14,050
2018	$16,170
2019	$18,364
2020	$20,637
2021	$22,990
2022	$25,425
2023	$27,947
2024	$66,872
2025	$69,575

Table 7: GHG Action Plan Financial Results

The financial analysis provided in Table 7 includes the critical metrics of Modified Internal Rate of Return (MIRR) and Net Present Value (NPV)[12]. These provide important information to evaluate the worthiness of the investment from a cash flow perspective. These metrics are also provided for each measure within the Measures Details section below. Both the NPV and the

[12] See methodology section for details (page 25)

MIRR can be improved with the addition of water and wastewater improvements due to be identified by a comprehensive system survey to improve efficiency.

The Action Plan consists of numerous measures to reduce GHG emissions, reduce energy costs, address equipment problems, and reduce the uncertainty of the Town's future annual energy costs. Figure 15 below illustrates the impact on energy costs achieved by actions to reduce energy consumption. The power purchase agreements (PPA) assumed in this analysis help satisfy the GHG emissions reduction goal, but add an estimated 1% over the annual cost of the utility supplied energy displaced by the systems.

The results reflect the anticipated increase in Windsor population and associated city services, and annual increases in the cost of utility energy (electric and natural gas) and vehicle fuel. The current cost of energy and the assumed energy escalation rate are provided in the General Inputs (Table 8) in the Methodology Section.

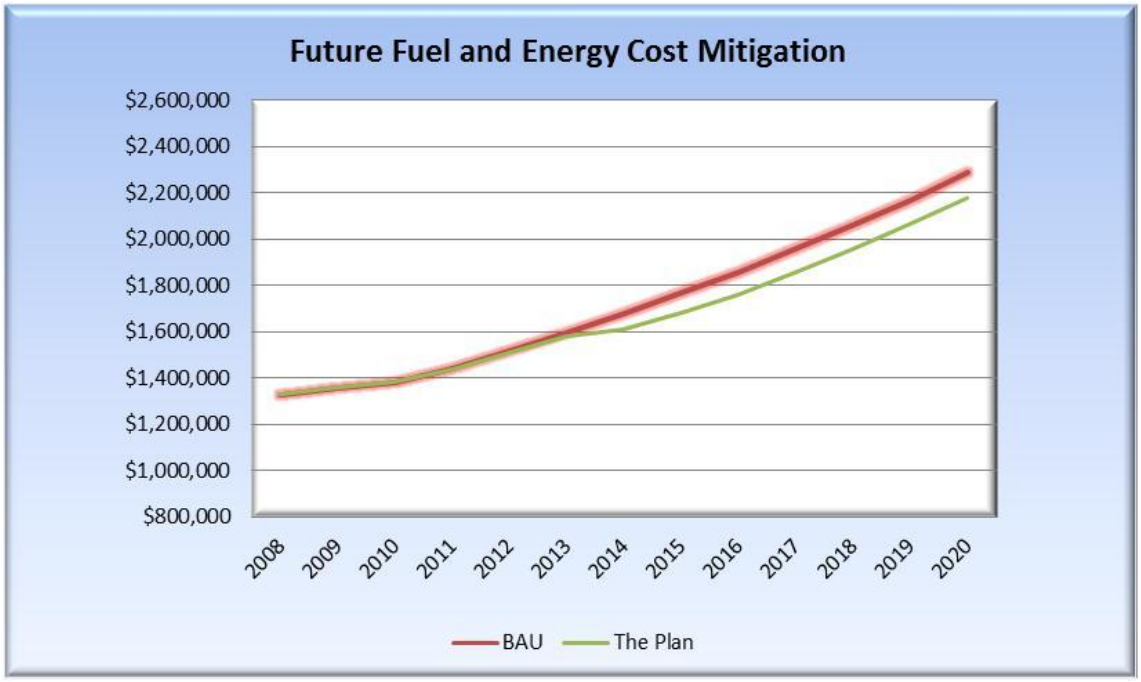

Figure 15: Annual Cost of Fuel and Energy

The reduction in greenhouse gas emissions over time is presented in Figure 16 below. These trends are based on the following key considerations:

1) Timely implementation of the measures contained in the Action Plan
2) Reduction of the kWh emissions factor over time per the Renewable Portfolio Standard[13]
3) The impact of the CA Low Carbon Fuel Standard[14]

[13]Renewable Portfolio Standard (RPS) is a statewide requirement of electric corporations to increase procurement from eligible renewable energy resources by at least 1% of their retail sales annually, until they reach 33% by 2020. This RPS eligible content requirement is in addition to the existing non carbon energy sources of large hydro and nuclear in the current PG&E power mix.

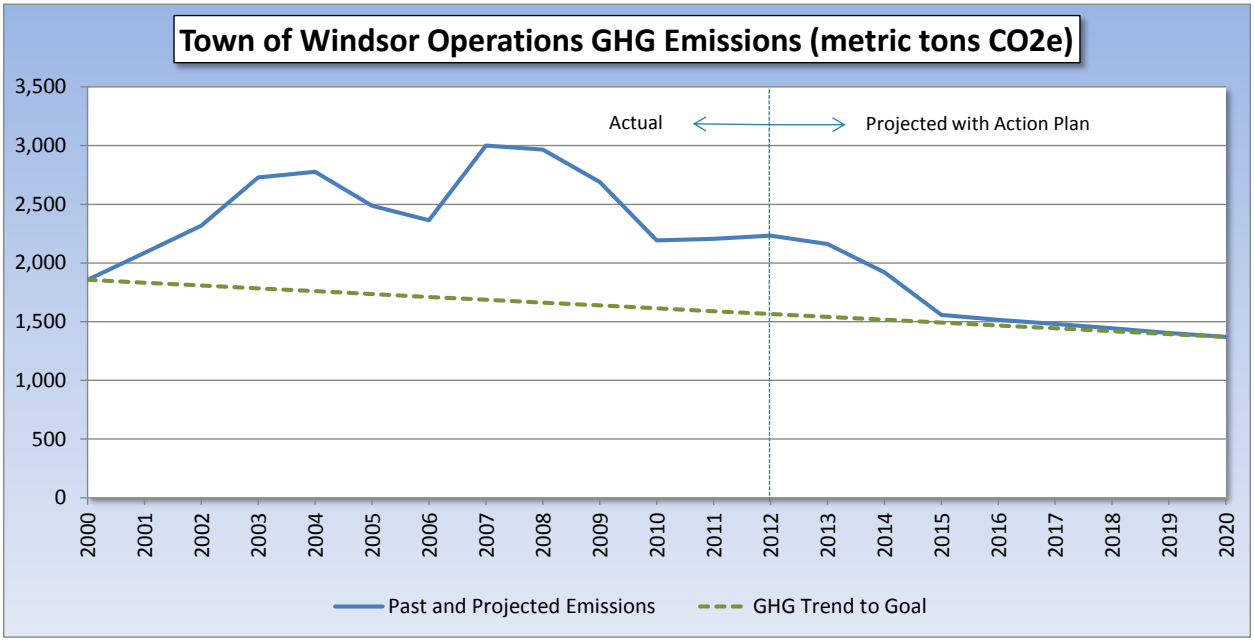

Figure 16: Annual GHG Emissions

The Carbon Density Trend (tons CO2e / person) is provided in Figure 17 below, based on the past and projected population of the Town of Windsor. These results are also heavily influenced by the utility emissions factor reductions due to the RPS and the CA Low Carbon Fuel Program.

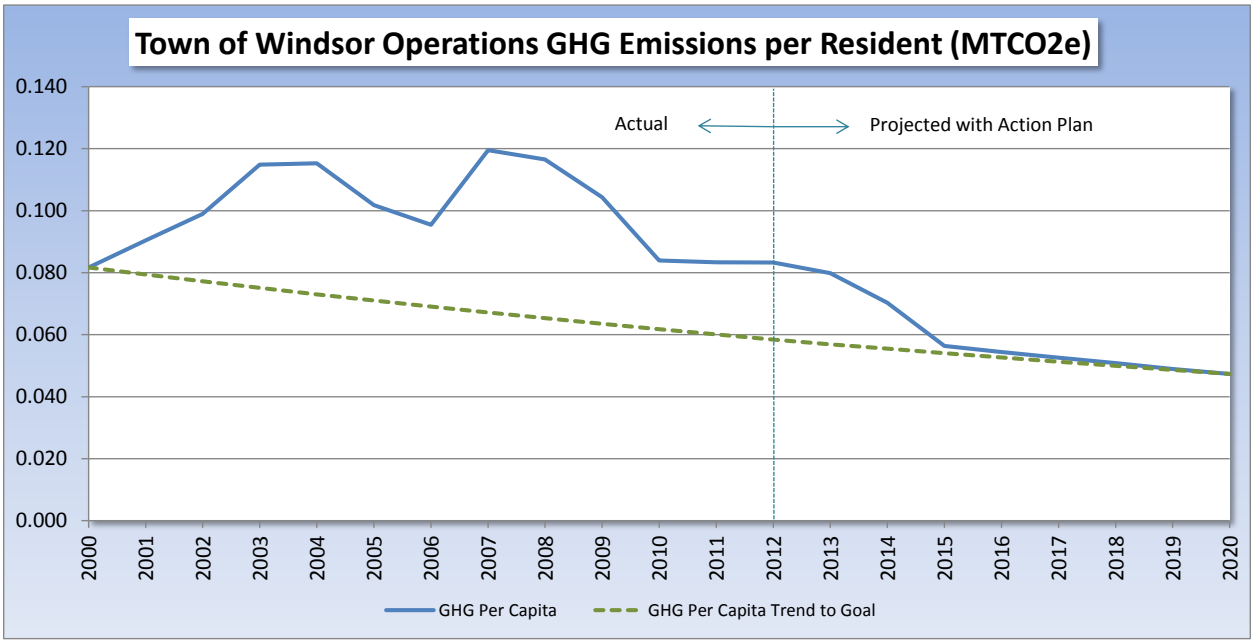

Figure 17: Annual GHG Emissions per Resident

[14]California Low Carbon Fuel Standard Established by California Executive Order in 2007, this regulation requires a reduction of 10% in GHG emissions from vehicle fuels by 2020.

4.0 Methodology

Context

The Windsor GHG emissions inventory for 2000 was established in 2003 and provides the baseline for this work. The specific actions and events affecting this baseline from 2000 to 2011, either positive or negative, are factored into the inventory. The future trend is based on past performance and an estimated population growth of 1% annually. The supporting data is available in Appendix 7.1.

Numerous options for future action are available to the Town. These are comprised of measures applicable to building and equipment energy efficiency, fuel efficiency, alternative fuel options, and distributed energy generation projects. They have been identified and quantified based on best available information at the time of this report, and presented as individual measures and as a group of measures (Action Plan). Each measure is assigned a status (completed or future) and an implementation date to enable the calculation of cash flows over the life of the plan and the creation of energy cost trend graphs.

The measures are grouped to create a comprehensive GHG emissions reduction plan. Measure specific data such as capital cost, year of implementation, financing, energy and cost savings were processed to provide the following information for the plan:

- Emissions reduction in tons CO2 avoided and as percentage of the GHG target
- CO2e reduction by sector
- Annual cash flow including debt service and incremental O&M[15] costs
- Outstanding principal and debt service by year
- Simple Payback (SPB)
- Modified Internal Rate of Return (MIRR)
- Net Present Value (NPV)
- Avoided utility company payments (NPV over life of plan)
- Avoided fuel purchases (NPV over life of plan)
- Value invested locally in emission reduction projects

Each measure included in this analysis has a set of inputs and assumptions. These are documented in Appendix 7.4. The details of each measure are provided in the Measure Details section (vehicle replacement and pump retrofit lists for example). The generally applied assumptions such as the discount rate, interest rate, fuel cost escalation rate, and the CO2e conversion factors (emission factor) for energy and fuel have also been reviewed and adjusted by Town Staff. The values used in the analysis are provided in Table 8. These general values were adjusted at the measure level where necessary.

[15]Operation and Maintenance costs do not include fuel and energy costs which are handled separately.

Measure Identification

The list of measures has been generated from document reviews, information from town staff, and past experience of other jurisdictions. All measures included in this analysis have been reviewed and approved for inclusion by Town Staff. The following sources contributed to the information in this report.

- *Climate Protection Greenhouse Gas Emissions Inventories*, Climate Protection Campaign, September 2003.
- *Draft Plan: Town of Windsor Building Energy Efficiency and Greenhouse Gas Emission Reduction, Climate Protection Campaign, September 2006*
- *Town Council Agenda Report, Peter Chamberlin and Kevin Thompson, July 19, 2006* Individual data submissions from Staff, coordinated by Kevin Thompson, Associate Planner.
- *PG&E Tariff Based Street Lighting Calculator,* The Energy Alliance Association, 2012
- *TEAA Identified lighting retrofits*, The Energy Alliance Association, 2012
- *TEAA PV Analysis,* The Energy Alliance Association, 2012
- *Town of Windsor Energy Cost and GHG Summary, July 18, 2012,* The Energy Alliance Association, 2012

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 8 below. These inputs include the following:

- Term of Analysis
- Term of Finance
- Discount Rate
- Energy Inflation Rate
- Energy Cost
- Interest Rate
- Inflation Rate
- Fuel Emissions Factors

The conversions in the table below are based on the best available information. The emissions factors for natural gas, gasoline, and diesel are consistent with the LGOP values.[16] The value used for CO2/kWh is based on the PG&E fuel mix.

[16]Local Government Operations Protocol, For the Quantification and Reporting of Greenhouse Gas Emission Inventories, Version 1.1 May 2010

General Inputs		
Input Types	**Default Values Used in**	**Notes**
Term of Financing (yrs)	10	
Discount Rate (nominal)	5.00%	
MIRR Reinvestment Interest Rate (%)	10.00%	
kWh Energy Cost Escalation Rate	3.50%	
Nat Gas Energy Cost Escalation Rate	2.32%	
Vehicle Fuel Cost Inflation Rate	8.00%	
Interest Rate	3.95%	
Inflation Rate (CPI)	3.48%	
Term of MIRR and NPV	10	
Emissions Factors		
Electricity (lbs CO2/kWh)	0.449	PG&E's Power Content 2011
Natural Gas (lbs CO2/Therm)	11.665	Local Government Operations Protocol, V1.1, May 2010
Gasoline (lbs CO2/gal)	19.356	Local Government Operations Protocol, V1.1, May 2010
Diesel (lbs CO2/gal)	22.509	Local Government Operations Protocol, V1.1, May 2010
LNG (lbs CO2/gals)	9.833	Local Government Operations Protocol, V1.1, May 2010
CNG Fleet (lbs CO2/therms)	11.581	Local Government Operations Protocol, V1.1, May 2010
BioDiesel (lbs CO2/gal)	1.025	lbs/gal (recycled: calculated as 25% methanol and 75% recycled feedstock)
Ethanol (lbs CO2/gal)	12.232	Local Government Operations Protocol, V1.1, May 2010
Propane Fleet (lbs CO2/gal)	12.324	Local Government Operations Protocol, V1.1, May 2010
Unit Cost		
Energy Cost ($/kWh)	$0.16	Bundled Rate from 2011 Billing Data
Energy Cost ($/Therm)	$1.00	
Gasoline Cost ($/gal)	$3.78	
Diesel Cost ($/gal)	$3.78	
CNG Cost ($/Therm)	$1.00	
Ethanol Cost (100%) ($/gal)	$4.72	
Biodiesel Cost ($/gal)	$4.16	
Electricity Fleet Cost ($/kWh)	$0.16	
Propane Fleet ($/gal)	$1.00	
LNG Cost ($/gal)	$1.27	
Other		
PPA Initial % Increase over Utility kWh	1.00%	
PPA Energy Cost Escalation Rate	3.50%	

Table 8: General Inputs

Incremental Capital Cost of Efficiency Measures

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 this analysis may include only the incremental cost for exceeding the efficiency of a standard unit or approach. The cost assumed for the fleet replacements and aged HVAC units are common examples where this issue comes into play. The use of incremental costs is documented in the Measure Details section when this method is applied.

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 Appendix 7.4.

- Category (Building, Fleet, Commute, PV, Water/Waste Water)
- Status (Completed and Future).
- Financing Strategy[17]
- Project Implementation Date
- Net Capital Cost
- Incremental Capital Cost
- Rebates and Incentives
- Annual O&M Cost
- Incremental Replacement Cost
- Component Life
- Time of Use Factor (Photovoltaic systems)

Financial Analysis Results

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

- Net Cash Flow for each year
- Debt load for each year
- Simple Payback
- Modified Internal Rate of Return
- Net Present Value
- CO2e reduction

[17] The net annual cash flow is heavily dependent presence of financing and the method used (CEC loan, Utility OBF). This funding decision is defined for each measure independently.

Financial Definitions[18]

Simple Pay Back (SPB):
Simple pay back is determined by dividing the capital cost by the annual cost savings for an investment. While not effective in determining the value of the investment, it does provide the length of time before the initial investment is repaid. Given the various implementation dates for actions analyzed in each plan, the SPB for the Action Plan is calculated by summing the net cost for each measure regardless of implementation date and comparing this value to the sum of the positive cash flows in subsequent years.

Net Present Value (NPV):
Net Present Value (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.

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

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 ($t = 0$)

Modified Internal Rate of Return (MIRR):
The Modified Internal Rate of Return (MIRR) is the discount rate that generates a zero net present value for a series of future cash flows. MIRR assumes that positive cash flows are reinvested at the firm's cost of capital and the initial outlays are financed at the firm's financing cost. This essentially means that MIRR 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 modified internal rate of return, the more desirable it is to undertake the project. As such, MIRR 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 MIRR would probably be considered the best and undertaken first if evaluated on only investment value. A municipality is also evaluating the repair of failing equipment and the overall reduction in greenhouse gas emissions when considering which plan of action to adopt.

The MIRR is based on the total investment and energy cost savings over the life of the investment, independent of the financing strategy for the investment.[19]

[18] http://www.investopedia.com/terms, http://www.visitask.com
[19] The MIRR and NPV for the Action Plan is calculated from the cash flows of the individual measures included, independent of the implementation date of each measure. This strategy results in a first year "investment" required for the MIRR calculation and a subsequent annual cash flow (the return on investment).

Financing Methods

There are three basic methods of project financing utilized in this analysis. The general terms for each are provided in Table 8: General Inputs. However specific terms for a measure may be defined at the measure level of the analysis. The funding methods are:

1) Standard financing at the interest rate and term defined at the general level or the measure specific level.
2) Power Purchase Agreement where the project is housed on city property and is owned by the vendor. The city agrees to purchase the power for the term of the contract.[20]
3) Grant Funding assumes the net impact on the general fund for these projects is zero. The Federal Stimulus funded projects are assumed to receive 100% of the funding from this program.

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). Biodiesel purchase (where present) is considered 100% local. In practice, this will depend on the supplier. Ethanol is not considered to be a local purchase.

California Low Carbon Fuel Standard

In the January 2007 State of the State, Governor Schwarzenegger asserted California's leadership in clean energy and environmental policy by establishing a Low-Carbon Fuel Standard (LCFS) by Executive Order. This first-in-the-world greenhouse gas (GHG) standard for transportation fuels will spark research in alternatives to oil and reduce GHG emissions.[21] The target GHG reduction is 10%. This analysis assumes this goal will be met over a 12 year period. This would reduce the carbon density for gasoline from 19.356 lbs. CO2e/gallons to 17.421 lbs. CO2e/gallon with a similar reduction for Diesel.

[20] See PV projects utilizing the PPA option for more discussion of the assumed terms of power purchase agreements.
[21] California Energy Commission, http://www.energy.ca.gov/low_carbon_fuel_standard, March 2009

Utility Electric Power Content[22]

The sources of the energy procured by the utility determine the carbon density (lbs. CO2 per kWh) of the electricity produced by the utility and used by the Town. This "Power Content" is identified by the utility and reported by the CPUC on an annual basis. The RPS program requires investor-owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable energy resources to 33% of total procurement by 2020. These "eligible renewables" as defined by the CPUC are in addition to the non-carbon resources (large hydro and nuclear) that are currently in the PG&E power mix.[23]

As the power content (carbon density) decreases the emissions associated with electrical energy use decreases. Also as the carbon density decreases, the CO2 reductions per kWh displaced by photovoltaic and energy efficiency measures also decreases. Therefore a kWh saved in 2011 will save more CO2 than a kWh saved in 2020 if the Power Content is more "green" in 2020. This dynamic is factored into the analysis which is time dependent for both the implementation date of the measure and the reporting date for the emissions reduction.

The emissions factors for years 2000 through 2020 are provided in Table 9 below. The values for 2011 through 2020 are based on anticipated values provided by PG&E. These values reflect information from the CPUC GHG Calculator[24] .

PG&E Emissions Factor Over Time (lbs CO2/kWh)		
2000	0.566	Historical and Current PG&E Emissons (PG&E GHG Emission Factor Guidance 4/8/11)
2001	0.566	
2002	0.566	
2003	0.620	
2004	0.566	
2005	0.489	
2006	0.456	
2007	0.636	
2008	0.641	
2009	0.575	
2010	0.445	
2011	0.449	
2012	0.453	PG&E Projected Emissions (*PG&E GHG Emission Factor Guidance* 4/8/11)
2013	0.431	
2014	0.412	
2015	0.391	
2016	0.370	
2017	0.349	
2018	0.328	
2019	0.307	
2020	0.290	

Table 9: PG&E Emission Factors (actual and estimated)[25]

[22] Power Content will determine the utility Emissions Factor used in this analysis.
[23] California Public Utilities Commission, http://www.cpuc.ca.gov/PUC/energy/Renewables/index.htm, 2012
[24] CPUC GHG Calculator provides an independent forecast of PG&E's emissions factors based on emissions reductions to comply with AB 32.

Non Efficiency Related Capital Cost Satisfied by Plan

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 many cases these "reliability projects" can be financed using the utility On-Bill Financing (OBF) and the California Energy Commission energy efficiency loans. These loan packages are structured to have a net zero cash flow (energy savings = loan payment) for a term up to 10 years. When combined with other efficiency measures, failing equipment such as boilers can be replaced with little or no cost impact on the general fund.[26]

[25] CPUC/PG&E GHG Emission Factor Guidance, updated 4/8/2011 by Xantha Bruso
[26] Town of Windsor Energy Cost and GHG Summary (ECGSR), On-Bill-Finance Opportunity Issue, The Energy Alliance Association, July 18, 2012.

5.0 Plan Details

Action Plan Results	
487	Metric Tons CO2e Avoided
26.2%	Reduction Below 2000 Level by 2020
Community Benefits (over 25 years)	
$802,200	Avoided Utility Payments
$48,100	Avoided Vehicle Fuel Purchases
$10,509,000	Invested Locally in GHG Projects
Investment Details	
$544,400	Net Capital Cost
Utility OBF	Financing
6.3%	Modified Internal Rate of Return (MIRR)
($51,310)	Net Present Value (NPV)

Table 10: Action Plan Results[27]

This Action Plan includes a total of 11 measures implemented from 2012 to 2015. In 2020 the Action Plan results in a 26.2% GHG emissions reduction below the baseline year of 2000. Measures include three PV systems totaling just under 2 megawatts, all of which are slated to be power purchase agreement. These PV projects also add to the local investment total and do not add to the net capital cost as they are funded using power purchase agreements (PPA). The plan also includes multiple street lighting measures using LED technologies. Solar Pool, New Fleet, Town Green Lighting, and Pump measures all contribute to the emissions reductions. The resulting annual cash flow provided below is the net income/cost to the Town (energy cost savings minus project debt service, replacement costs and associated O&M costs).

Cash Flow Analysis				
Year	Cash Flow (gross)	Annual Debt Service Payments	Net Cash Flow	Outstanding Principal
2012	($23,800)	$0	($23,800)	$0
2013	($8,592)	$0	($8,592)	$363,143
2014	($4,293)	($36,314)	($40,607)	$326,829
2015	$49,647	($36,314)	$13,333	$386,058
2016	$57,871	($45,869)	$12,002	$340,190
2017	$59,918	($45,869)	$14,050	$294,321
2018	$62,038	($45,869)	$16,170	$248,452
2019	$64,233	($45,869)	$18,364	$202,583
2020	$66,506	($45,869)	$20,637	$156,715
2021	$68,858	($45,869)	$22,990	$110,846
2022	$71,294	($45,869)	$25,425	$64,977
2023	$73,816	($45,869)	$27,947	$19,109
2024	$76,427	($9,554)	$66,872	$9,554
2025	$79,130	($9,554)	$69,575	$0

Table 11: Action Plan Cash Flow Analysis

[27] NPV and MIRR are calculated independently of the cash flow displayed. See Methodology Section for details.

The Action Plan includes 11 measures to reduce costs and GHG emissions implemented between 2012 and 2015 according to the schedule in Table 12 below.

Measure Number	Measure Name	Implementation Date
1	Pool Solar	2012
2	Pumps 2 (3 sites)	2013
3	Streetlighting HID to LED (178 Fixtures)	2013
4	Streetlighting HID to LED (178 Fixtures)	2013
5	Streetlighting HID to LED (178 Fixtures)	2013
6	Streetlighting HID to LED (180 Fixtures)	2015
7	New Fleet A	2014
8	Town Green Lighting (100 fixtures)	2013
9	PV 750 kWdc Wastewater Treatment Building (PPA)	2013
10	PV 860 kWdc (PPA)	2014
11	PV 860 kWdc (PPA)	2014

Table 12: Action Plan Measures

The CPUC mandated Renewable Portfolio Standard provides the greatest share of the emissions savings in 2020 per Figure 18 below. The remaining 32% of the savings are spread across the other sectors with Buildings and Other Facilities responsible for the majority of the remainder.

Water Delivery and Wastewater Facilities accounted for 37% of the baseline emissions but are responsible for only 1.4% of the emissions reductions in this plan. This suggests additional energy efficiency projects are available for immediate consideration in these sectors.

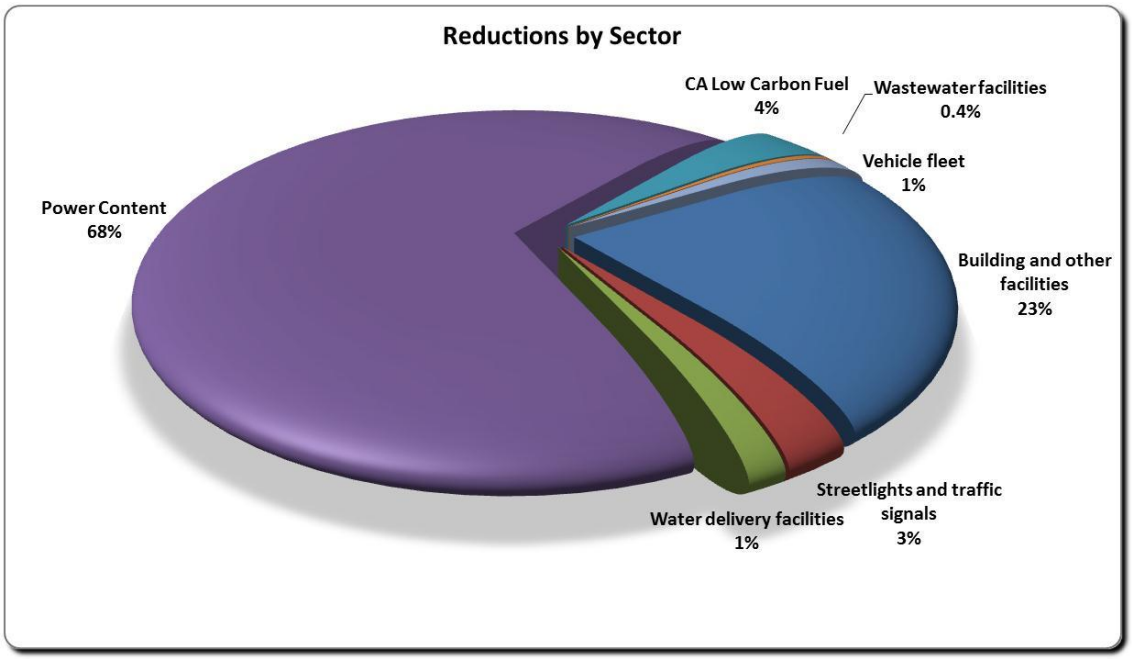

Figure 18: GHG Reduction by Sector as a Percentage of the Total Reduction

Measure Details

Table 13 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.

No.	Measure Name	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value
1	Pool Solar	2012	$23,800	$1,560	$0	8.1	15.2	2.1%	($8,910)
2	Pumps 2 (3 sites)	2013	$98,890	$18,900	$0	21.3	5.2	13.7%	$72,270
3	Streetlighting HID to LED (178 Fixtures)	2013	$88,080	$6,200	$0	9.8	14.2	7.9%	$4,450
4	Streetlighting HID to LED (178 Fixtures)	2013	$88,080	$6,200	$0	9.8	14.2	7.9%	$4,450
5	Streetlighting HID to LED (178 Fixtures)	2013	$88,080	$6,200	$0	9.8	14.2	7.9%	$4,450
6	Streetlighting HID to LED (180 Fixtures)	2015	$95,540	$6,250	$0	9.0	15.3	7.5%	($1,940)
7	New Fleet A	2014	$28,810	$6,220	$0	11.5	4.6	15.1%	$27,350
8	Town Green Lighting (100 fixtures)	2013	$210	$5,120	$0	5.8	0.0	84.7%	$44,920
9	PV 750 kW DC Wastewater Treatment Building (PPA)	2013	$10,710	($1,830)	$0	147.1	N/A	N/A	($32,300)
10	PV 860 kW DC (PPA)	2014	$11,080	($2,090)	$0	160.9	N/A	N/A	($35,590)
11	PV 860 kW DC (PPA)	2014	$11,080	($2,090)	$0	160.9	N/A	N/A	($35,590)

Table 13: Measure Results

Measure Results

The measures in the Action Plan are described below. The description of each measure includes a table listing the cost of implementation, the annual savings, annual CO2e reduction in metric tons, and the financial metrics of simple payback, modified internal rate of return (MIRR) and net present value (NPV).

The measures considered in this analysis are listed in the following pages, with a brief description of each. The inputs and assumptions are provided for each measure in Appendix 7.4.

1- Pool Solar

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Energy Savings (Therms)
1	2012	$23,800	$1,560	$0	8.1	15.2	2.1%	-$8,910	0	1,526

This measure quantifies the energy savings by installing a solar thermal water heating system to displace 1,526 therms of natural gas that is currently being used to heat the Senior Center Pool. This will displace roughly half of the annual therms needed to heat the pool.

2- Pumps 2 (3 Sites)

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Energy Savings (Therms)
2	2013	$98,890	$18,900	$0	21.3	5.2	13.7%	$72,270	108,910	0

The Town operates a number of pumps that consume a considerable amount of energy annually according to the pump test reports for each. The approximate savings available for each pump is based on the findings contained in these reports. The cost for each is a rough estimate based on experiences in other jurisdictions. The rebate numbers are based on a PG&E's calculated rebate of $0.05/annual kWh saved.

Description	Annual kWh Usage	Annual kWh Savings	Pumps	Capital Cost (TEAA estimate)	Rebate (estimate)
Mitchell P2	209,400	54,640	1	$31,502	$2,732
Mitchell P4	132,570	41,543	1	$31,502	$2,077
Shiloh 1 (B2)	27,713	6,474	1	$31,502	$324

3- Street lighting HID to LED (178 Fixtures) PG&E On-Bill Financing

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Energy Savings (Therms)
3	2013	$88,080	$6,200	$0	9.8	14.2	7.9%	$4,450	50,230	0

This measure changes 178 HPS street lighting fixtures to LED fixtures. Fixture costs and cost savings are based on the LED Turn Key proposal from PG&E and reflect the PG&E tariff change per pole. In this measure NPV and MIRR are calculated using a 17 year term to reflect the life of the LED fixture. The details of the lighting retrofit are provided in the following table.

Original Technology	Original Count	Lamp Wattage (nominal)	Rate (per pole)	Replacement Technology	Replacement Wattage	Rate (per pole)	Total Annual Energy Savings (kWh)	Original Annual Energy Cost	Final Annual Energy Cost	Savings: Total Annual Energy Cost Savings
HPS_120v	38	100	$4.99	LED	37	$1.558	12,931	$2,276	$710	$1,565
HPS_120v	9	150	$7.30	LED	51	$2.179	4,598	$789	$235	$554
HPS_120v	131	70	$3.53	LED	24	$0.937	32,698	$5,549	$1,473	$4,076

4- Street and Area Lighting HID to LED (178 Fixtures) PG&E On-Bill Financing

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Energy Savings (Therms)
4	2013	$88,080	$6,200	$0	9.8	14.2	7.9%	$4,450	50,230	0

This measure changes 178 HPS street lighting fixtures to LED fixtures. Fixture costs and cost savings are based on the LED Turn Key proposal from PG&E and reflect the PG&E tariff change per pole. In this measure NPV and MIRR are calculated using a17year term to reflect the life of the LED fixture. The details of the lighting retrofit are provided in the following table.

Original Technology	Original Count	Lamp Wattage (nominal)	Rate (per pole)	Replacement Technology	Replacement Wattage	Rate (per pole)	Total Annual Energy Savings (kWh)	Original Annual Energy Cost	Final Annual Energy Cost	Savings: Total Annual Energy Cost Savings
HPS_120v	38	100	$4.99	LED	37	$1.558	12,931	$2,276	$710	$1,565
HPS_120v	9	150	$7.30	LED	51	$2.179	4,598	$789	$235	$554
HPS_120v	131	70	$3.53	LED	24	$0.937	32,698	$5,549	$1,473	$4,076

5- Street lighting HID to LED (178 Fixtures) PG&E On-bill Financing

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Energy Savings (Therms)
5	2013	$88,080	$6,200	$0	9.8	14.2	7.9%	$4,450	50,230	0

This measure changes 178 HPS street lighting fixtures to LED fixtures. Fixture costs and cost savings are based on the LED Turn Key proposal from PG&E and reflect the PG&E tariff change per pole. In this measure NPV and MIRR are calculated using a17year term to reflect the life of the LED fixture. The details of the lighting retrofit are provided in the following table.

Original Technology	Original Count	Lamp Wattage (nominal)	Rate (per pole)	Replacement Technology	Replacement Wattage	Rate (per pole)	Total Annual Energy Savings (kWh)	Original Annual Energy Cost	Final Annual Energy Cost	Savings: Total Annual Energy Cost Savings
HPS_120v	38	100	$4.99	LED	37	$1.558	12,931	$2,276	$710	$1,565
HPS_120v	9	150	$7.30	LED	51	$2.179	4,598	$789	$235	$554
HPS_120v	131	70	$3.53	LED	24	$0.937	32,698	$5,549	$1,473	$4,076

6- Street lighting HID to LED (180 Fixtures) PG&E On-Bill Financing

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Energy Savings (Therms)
6	2015	$95,540	$6,250	$0	9.0	15.3	7.5%	-$1,940	50,630	0

This measure changes 180 HPS street lighting fixtures to LED fixtures. Fixture costs and cost savings are based on the LED Turn Key proposal from PG&E and reflect the PG&E tariff change per pole. In this measure NPV and MIRR are calculated using a 17 year term to reflect the life of the LED fixture.

Original Technology	Original Count	Lamp Wattage (nominal)	Rate (per pole)	Replacement Technology	Replacement Wattage	Rate (per pole)	Total Annual Energy Savings (kWh)	Original Annual Energy Cost	Final Annual Energy Cost	Savings: Total Annual Energy Cost Savings
HPS_120v	41	100	$4.99	LED	37	$1.558	13,952	$2,456	$767	$1,689
HPS_120v	7	150	$7.30	LED	51	$2.179	3,576	$614	$183	$431
HPS_120v	1	50	$2.56	LED	24	$0.937	154	$31	$11	$19
HPS_120v	130	70	$3.53	LED	24	$0.937	32,448	$5,507	$1,462	$4,045
MH	1	175	$8.77	LED	89	$3.640	499	$105	$44	$62

7- New Fleet A

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Gasoline Savings (gals)
7	2014	$28,810	$6,220	$0	11.5	4.6	15.1%	$27,350	0	1310

The fleet changes specified in the table below are projected to save over 1,300 gallon of fuel annually, resulting in roughly 11.5 metric tons of CO2e avoided annually. A total of 5 units are specified for replacement. The costs are based on the estimated incremental cost of purchasing the more efficient alternative rather than the current model equivalent. The associated vehicle miles per gallon are based on the EPA's combined city/highway fuel economy. The analysis assumes this measure would be fully implemented by 2014. Incremental reductions would accrue prior to the completion date as the more efficient models are employed. A complete list of specific vehicles, associated strategies, and methodology is provided in the appendices.

Count	Current Vehicle	Current Fuel Type	Current Vehicle MPG	Replacement Vehicle	Replacement Fuel Type	Replacement Vehicle MPG	Total Incremental Cost
1	Le Sabre	Gasoline	21	Hybrid Sedan Replacing Midsize	Gasoline	39	$6,000
1	Expedition	Gasoline	14	Large SUV Hybrid	Gasoline	21	$4,000
1	Escape	Gasoline	20	Small SUV Hybrid	Gasoline	30	$4,000
2	Accord	Gasoline	23	Hybrid Sedan Replacing Midsize	Gasoline	39	$12,000

8- Town Green Lighting (100 Fixtures)

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Energy Savings (Therms)
8	2013	$210	$5,120	$0	5.8	0.0	84.7%	$44,920	29,520	0

This measure encompasses a total of 100 Town Green area fixtures. These incandescent and metal halide lamps would be retrofitted to compact fluorescents lamps. This would be a no cost measure as the current PG&E incentives are greater than the capital cost.

Original Fixture	Replacement Fixture	Fixture Count	Annual Energy Savings (kWh)
Metal Halide 100 Watt	CFL 23 Watt	50	7,995
Incandescent 50 Watt	CFL 11 Watt	50	21,525

9- PV-750 kWdc Wastewater Treatment Buildings

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Energy Savings (Therms)
9	2013	$10,710	($1,830)	$0	147.1	NA	NA	-$32,300	752,490	0

This measure specifies a 750 kWdc system producing an average of roughly 750,000 kWh per year. The Net Capital Cost reflects the expended costs to negotiate the PPA contract[28]. The methodology for calculating the solar energy production and cost are provided in the appendices.

This measure assumes a power purchase agreement (PPA) will be utilized to implement the system. A power purchase agreement is a long-term agreement between a power provider (the solar company) and a customer. The customer agrees to purchase energy from the provider at a fixed rate for the term of the agreement. This rate increases every year by an agreed percentage. The life of the agreement may be in the range of 20 years. At the end of the contract period the customer typically has the option to purchase the system at its value at that time. This analysis assumes the cost of energy would be 1% more than the current utility rate, and would escalate at 3.5% per year.

The analysis also assumes the city retains ownership of the Renewable Energy Credits (REC), and the provider pays all maintenance costs including replacement of the inverters which have a life of roughly 10 years. The cost of energy and its escalation over time specified in the contract will have significant influence over the financial metrics of the measure. The assumed term of the contract matches the term of this analysis, 25 years. The general assumptions underlying the PV production calculations are provided in the appendices.

The numbers in the table below are independent of the funding mechanism.

Solar Electric Costs and Benefits Summary		
System Size (DC)	750	kW
System Size (AC)	607	kW
Annual kWh (initial year)	800,600	kWh/yr
Rebate	0	$
Inverter Replacement Cost	$500,500	$
Final Net Cost	$4,257,700	$
System Area	60,740	sq-ft flat
Performance	1,570	AC kWh/yr per CEC AC kW installed

[28]Power Purchase Agreement (PPA).

10- PV 860 kWdc

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Energy Savings (Therms)
10	2014	$11,080	($2,090)	$0	160.9	N/A	N/A	-$35,590	861,100	0

This measure specifies an 860 kWdc system producing an average of roughly 860,000 kWh per year. The Net Capital Cost reflects the expended costs to negotiate the PPA contract[29]. The solar energy production assumptions and calculations are provided in the appendices. The size of this system is based on maintaining a total emissions reduction of 26.2%. The identification and implementation of other more cost effective measures (water/waste water equipment retrofits, aggressive fleet vehicle replacements, and employee commute reductions) would reduce the size of this system required to meet the GHG reduction goal.

The costs reflect the assumption that a power purchase agreement (PPA) described above in Measure 9. The general assumptions underlying the PV production calculations are provided in the appendices.

The numbers in the table below are independent of the funding mechanism.

Solar Electric Costs and Benefits Summary		
System Size (AC)	695.0	kWac
System Size (DC)	860.0	kWdc
Annual KWh (initial year)	916,100	kWh/yr
Final Net Cost	$4,871,000	($)
Rebate	$0	N/A
Inverter Replacement Cos	$347,500	($)
System Area	69,500	sq-ft flat
Performance	1,570	AC kWh/yr per CEC AC kW installed

[29]Power Purchase Agreement (PPA).

11- PV 860 kWdc

No.	Impl. Date	Net Capital Cost	Annual Cost Savings	Annual O&M Cost	Annual CO2e Reduction (metric tons)	Simple Payback (Years)	MIRR	Net Present Value	Annual Energy Savings (kWh)	Annual Energy Savings (Therms)
11	2014	$11,080	($2,090)	$0	160.9	N/A	N/A	-$35,590	861,100	0

This measure also specifies an 860 kWdc system producing an average of roughly 860,000 kWh per year. The Net Capital Cost reflects the expended costs to negotiate the PPA contract[30]. The solar energy production assumptions and calculations are provided in the appendices. The size of this system is also based on maintaining a total emissions reduction of 26.2%. The identification and implementation of other more cost effective measures (water/waste water equipment retrofits, aggressive fleet vehicle replacements, and employee commute reductions) would reduce the required size of this system.

The costs reflect the assumption that a power purchase agreement (PPA) described above in Measure 9. The general assumptions underlying the PV production calculations are provided in the appendices.

The numbers in the table below are independent of the funding mechanism.

Solar Electric Costs and Benefits Summary		
System Size (AC)	695.0	kWac
System Size (DC)	860.0	kWdc
Annual KWh (initial year)	916,100	kWh/yr
Final Net Cost	$4,871,000	($)
Rebate	$0	N/A
Inverter Replacement Cos	$347,500	($)
System Area	69,500	sq-ft flat
Performance	1,570	AC kWh/yr per CEC AC kW installed

[30]Power Purchase Agreement (PPA).

6.0 Summary and Conclusions

The Town has experienced significant growth over the period covered by this analysis. From 2000 to 2010 there has been a 17.8% increase in the Town's population. The associated expansion of Town services has resulted in a 10% increase in GHG emissions from 2000 to 2011 adding to the challenge of meeting the Town's goal of 26% below 2000 levels by 2020 for Town controlled facilities and equipment. Anticipated town growth adds to the challenge.

This aggressive goal can be achieved by the measures outlined in this report. Fortunately, a large portion of the total GHG reduction (68%) will result from the implementation of the CPUC mandated Renewable Portfolio Standard (RPS) and the Low Carbon Fuel Standard. The implementation of the measures will contribute the remaining 32% of the total reduction.

This Action Plan has a very high reliance on photovoltaic (PV) systems which assume power purchase agreements to fund the projects. These will achieve GHG reductions but increase the annual cost of energy for the town. The identification and implementation of other more cost effective measures (water/waste water equipment retrofits, aggressive fleet vehicle replacements and employee commute initiatives) would reduce this reliance on PV and would provide a more balanced approach to emissions reduction as well as lower annual energy costs.

New technologies such as LED lighting, and innovative financing options including PG&E's On-Bill-Financing provide excellent opportunities for the implementation of energy cost and GHG reduction projects. There are also significant new fleet options available now or on the near horizon. These opportunities should be monitored and incorporated when available.

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 Town to meet a number of related goals, including improving the long term financial health of Windsor, reducing the budget vulnerability to future energy cost escalation, addressing the existing maintenance demands of aging equipment, and providing the public a demonstration of commitment and progress in the highly visible challenge of greenhouse gas emissions reduction.

The ultimate achievement of the 26.2% reduction goal will result in energy cost containment, significant relief to the general fund, and will meet the Town's obligation in the global effort to reduce greenhouse gas emissions. The leadership exhibited by the Town of Windsor will be a valuable example for other cities considering a similar path into the future.

7.0 Appendices

7.1 Basis for 2000 GHG Inventory and Trends
7.2 2011 GHG Inventory
7.3 Photovoltaic System Production Assumptions and Example Calculations
7.4 Measure Inputs
7.5 Vehicle Lists

7.1 Basis for 2000 GHG Inventory and Trends

Town of Windsor Baseline Year 2000 Greenhouse Gas Inventory
GHG Inventory Report, Town of Windsor, Amy Boncszewski, Intern for the Town of Windsor, September 2003
(Modified with additional data from Town Staff and updated per LGOP)

	kWh	Therms	Gasoline (gals/yr)	Diesel (gals/yr)	CO2e (Metric Tons)
Buildings and other facilities					
Senior Center	42,624	4,506			34.78
Corp Yard		414			2.19
Community Center	55,110	1,673			23.00
Police Dept. Bldg.	289,111	10,937			132.09
Total	**386,845**	**17,530**	**0**	**0**	**192**
Streetlights					
Streetlights	651,005				167.14
Traffic Signals	312,934				80.34
Total	**963,939**	**0**	**0**	**0**	**247**
Water delivery facilities					
Emergency Pump	445				0.11
Blue Bird Well	2				0.00
Vine Country Estates					0.00
111 Shiloh Rd					0.00
8425 Stomper Drive					0.00
Mark West Booster Pump					0.00
Wilson Park					0.00
Trenton-Healdsburg Rd					0.00
1300 Golf Course Dr.					0.00
197 Windsor River Rd					0.00
Vinecrest Booster Pump	4,174				1.07
Water Pumps Shiloh 1,2,3	80,243				20.60
155 HP PUMP/GOLF	827,266				212.39
Irrigation	94,009				24.14
WN - Water Pumps Eastside Rd.	***Removed per LGOP: Structural Change in Organization (Outsourcing)***				
Water Supply					0.00
Water Pumps Shiloh 1,2,3b					0.00
Comm Wtr Pump 75hp, #7, #8					0.00
Total	**1,006,139**	**0**	**0**	**0**	**258**
Vehicle Fleet					
Gasoline			36,583		321.20
Diesel				9,653	98.55
Total	**0**	**0**	**36,583**	**9,653**	**420**
Solid Waste Facilities					
Paper Products	***Removed per LGOP: Solid Waste Facilities Guideline***				
Food Waste	***Removed per LGOP: Solid Waste Facilities Guideline***				
Plant Debris	***Removed per LGOP: Solid Waste Facilities Guideline***				
Wood/Textiles	***Removed per LGOP: Solid Waste Facilities Guideline***				
Total	**0**	**0**	**0**	**0**	**0**
Wastewater Facilities					
Sewer Lift Station	15,269				3.92
Waste Water	2,587,333				664.26
Pasture Irrig/Reclaimed					0.00
Sewage Treatment-150HP #10					0.00
Total	**2,602,602**	**0**	**0**	**0**	**668**
Commute					
Fuel			7,993	56	70.74
Total	**0**	**0**	**7,993**	**56**	**71**
2000 Total	**4,959,525**	**17,530**	**44,576**	**9,708**	**1,857**

Note: Due to a structural change in the Town's water supply system Water Pumps Eastside Rd. is now removed from the baseline to be able to accurately compare this baseline to future years. This structural change is due to the outsourcing of water supply pressure to the Sonoma County Water Agency in 2007. Also due to the LGOP solid waste facility guidelines the portion of solid waste previously allocated to this baseline has been removed, this is because Windsor does not have operational control of the solid waste facilities.

Energy Savings from 2000 to 2020 (Trend Measures)									
End Use	Trend Measure Year	kWh	Therms	Gasoline (gals/yr)	Diesel (gals/yr)	CNG Fleet (Therms)	Electric Fleet (kWh)	Propane (gals/yr)	LNG (gals/yr)
Past	2000	0	0	0	0	0	0	0	0
Past	2001	-811,110	-107	-2,392	-11	0	-1,151	0	0
Past	2002	-811,110	-107	-2,392	-11	0	-1,151	0	0
Past	2003	-811,110	-107	-2,392	-11	0	-1,150	0	0
Past	2004	-811,110	-107	-2,392	-11	0	-1,151	0	0
Past	2005	131,293	-719	-2,392	-11	0	-1,151	0	0
Past	2006	131,293	-719	-2,392	-11	0	-1,151	0	0
Past	2007	131,293	-719	-2,392	-11	0	-1,151	0	0
Past	2008	131,293	-719	1,633	17	0	-1,151	0	0
Past	2009	131,293	-719	1,633	17	0	-1,150	0	0
Past	2010	131,293	-719	3,431	-24	0	-1,151	0	0
Current	2011	0	0	0	0	0	0	0	0
Future	2012	-74,277	-223	-558	-87	0	0	0	0
Future	2013	-74,277	-223	-558	-87	0	0	0	0
Future	2014	-74,277	-223	-558	-87	0	0	0	0
Future	2015	-74,277	-223	-558	-87	0	0	0	0
Future	2016	-74,277	-223	-558	-87	0	0	0	0
Future	2017	-74,277	-223	-558	-87	0	0	0	0
Future	2018	-74,277	-223	-558	-87	0	0	0	0
Future	2019	-74,277	-223	-558	-87	0	0	0	0
Future	2020	-74,277	-223	-558	-87	0	0	0	0

Table 14: Calculation of GHG Emissions Trends

7.2 2011 GHG Inventory

Town of Windsor Year 2011 Greenhouse Gas Inventory

	kWh	Therms	Gasoline (gals/yr)	Diesel (gals/yr)	CO2e (Metric Tons)
Buildings and other facilities					
CIA USE IN COMMON	3	0			0.00
COMMERCIAL OR INDUSTRIAL	46,203	4,780			34.70
CITY LANDSCAPING-IRR	4	0			0.00
GREENS SUB PHASE 1 & 2	14	0			0.00
IRRIGATION METER	19	0			0.00
IRRIGATION PWR PED	518	0			0.11
LANDSCAPE CNTRL/SPRKLR	97	0			0.02
LAND & LIGHT FOR VENTANA 6	205	0			0.04
LANDSCAPING IRRIG	15	0			0.00
MAINT SHOP	0	601			3.18
NON RES SOLAR ELEC GEN	217,920	0			44.38
PARK IRRIG	10	0			0.00
PARK IRRIG/LIGHTING	408	0			0.08
PARK LTS & SPRKLR CTRL	2,614	0			0.53
PARK SPRINKLER CONTR	80,820	0			16.46
PARKING LOT LIGHTS	8,801	0			1.79
PASTURE IRRIG/RECLAMED	147,405	0			30.02
POLICE DEPT BLDG	0	7,708			40.78
SENIOR CENTER	35,787	0			7.29
SENIOR CENTER	0	7,835			41.45
SPRINKLER CONTROLLER	614	0			0.13
SPRINKLER CONTROLLER	41	0			0.01
SPRNKLR CONTRLR-ZONE 1	21	0			0.00
TOWN SQUARE LIGHTS	54,320	0			11.06
ULTIMO-VINTAGE GREENS IV	454	0			0.09
WI CMNS LANDSCAPE PUMP	2	0			0.00
WINDSOR COMM CTR	0	1,348			7.13
WINDSOR COMMUNITY CTR	43,840	0			8.93
ZONE 3 LANDSCAPING	196	0			0.04
UNKNOWN ZONE	184,560	0			37.59
Total	**824,891**	**22,272**	**0**	**0**	**286**
Streetlights					
STREETLIGHT SITE	1,035,922				210.98
TRAFFIC SIGNALS	68,405				13.93
Total	**1,104,327**	**0**	**0**	**0**	**225**

	kWh	Therms	Gasoline (gals/yr)	Diesel (gals/yr)	CO2e (Metric Tons)
Water delivery facilities					
2 HP BOOSTER STA PUMP	12,596				2.57
BLUE BIRD WELL	6,017				1.23
COMM WTR PMP 75HP	131,400				26.76
COMM WTR PMP STA #7	157,160				32.01
COMM WTR STA #8	70,960				14.45
EMERGENCY PUMP	174				0.04
INTERTIE PUMP STA PWR	11,754				2.39
PARK WELL	11,321				2.31
SHILOH B/PUMP #1	81,517				16.60
SHILOH B/PUMP #2	57,361				11.68
SHILOH B/PUMP #3	26,896				5.48
155 HP PUMP/GOLF	119,031				24.24
Total	**686,187**	**0**	**0**	**0**	**140**
Vehicle Fleet					
Nat Gas Vehicles					0.00
Electric	11,508				2.34
Propane					0.00
LNG					0.00
Biodiesel					0.00
Gasoline			41,046		359.49
Diesel				8,559	87.17
Total	**11,508**	**0**	**41,046**	**8,559**	**449**
Solid Waste facilities					
Total	**0**	**0**	**0**	**0**	**0**
Wastewater Facilities					
COMM. INDUSTRIAL SOLAR	276,320	0			56.28
LIFT STATION	17,902	0			3.65
SEWAGE TRTMNT-150HP #10	777,864	0			158.42
SEWER LIFT STATION	9,771	0			1.99
SEWER LIFT STATION	14,164	0			2.88
SEWER TREATMENT	3,704,781	0			754.53
Total	**4,800,802**	**0**	**0**	**0**	**978**
Commute					
Fuel		0	14,720	102	129.96
Total	**0**	**0**	**14,720**	**102**	**130**
2011 Total	**7,427,715**	**22,272**	**55,766**	**8,661**	**2,207**

The Town of Windsor's 2011 GHG inventory above has been compiled from utility billing data and Staff supplied data (vehicle and commute).[31]

[31]Additonal PG&E billing data detail is available in the Town of Windsor Energy Cost and GHG Summary (ECGSR), TEAA, July 2, 2012.

7.3 Photovoltaic System Production Assumptions andExample Calculations

Example: Uses 91.0 kWac fixed axis system

Solar Electric System Performance		Inputs in Blue	Calculations in Black
Module Temp. (PTC) Rating (%)	89%		
Inverter Efficiency (%)	91%		
CEC AC Rating (%)	81%	(CEC Rating net AC watts/gross DC watts)	
Dust & Dirt (%)	7%		
Manufacturer Fudge (%)	3%		
Module Mismatch (%)	1%		
Wiring (%)	3%		
Real AC Performance / DC Rating	68%		
Inverter replacement cost	824	($/kWac)	
Output Degradation	0.5%	(per year)	
Size (DC)	112.4	kW DC	
Size (AC)	91.0	(Net CEC AC Kilowatts)	
CEC Performance	1,570	(CEC AC Rating kWh/yr per CEC AC kW installed)	
Real Performance	1,318	(Real AC kWh/yr per CEC AC kW installed)	
Annual kWh (initial year)	119,937	(kWh/yr)	
Module Degradation	0.5%	(% / yr)	
System Maintenance	0.25%	(% Gross system cost / yr)	
Permit	$1,200	($)	
TOU Meter	$443	($)	
Cost	$7.0	($/netACwatt)	
Rebate	$0.00	(PBI = $/netAC kWh, EBPB = $/watt)	
Time of Use Factor	1.0	Ave. ($/kwhr) generation / ($/kwhr) use	
Total Installed Costs	$639,843	($)	
Rebate	$0	($)	
Final Net Cost	$639,843	($)	

7.4 Measure Inputs

Measure Number	1	2	3	4	5
Measure Name	Pool Solar	Pumps 2 (3 sites)	Streetlighting HID to LED (178 Fixtures)	Streetlighting HID to LED (178 Fixtures)	Streetlighting HID to LED (178 Fixtures)
Implementation Date	2012	2013	2013	2013	2013
Status	Future	Future	future	future	future
Financed	no	yes	yes	yes	yes
Term of Analysis (yrs)	25	25	25	25	25
Term of Financing (yrs)	10	10	10	10	10
Discount Rate	5.0%	5.0%	5.0%	5.0%	5.0%
MIRR Reinvestment Interest Rate (%)	10.0%	10.0%	10.0%	10.0%	10.0%
Inflation Rate	3.5%	3.5%	3.5%	3.5%	3.5%
Interest Rate	0.0%	0.0%	0.0%	0.0%	0.0%
Term of MIRR and NPV	10	10	17	17	17
kWh Energy Cost Escalation Rate	3.5%	3.5%	3.5%	3.5%	3.5%
Nat Gas Energy Cost Escalation Rate	2.3%	2.3%	2.3%	2.3%	2.3%
Vehicle Fuel Cost Escalation Rate	8.0%	8.0%	8.0%	8.0%	8.0%
Energy Cost ($/kWh)	$0.16	$0.16	$0.16	$0.16	$0.16
Energy Cost ($/Therm)	$1.00	$1.00	$1.00	$1.00	$1.00
Gasoline Energy Cost ($/Gal)	$3.78	$3.78	$3.78	$3.78	$3.78
Diesel Energy Cost ($/Gal)	$3.78	$3.78	$3.78	$3.78	$3.78
BioDiesel Energy Cost ($/Gal)	$4.16	$4.16	$4.16	$4.16	$4.16
Ethanol Energy Cost ($/equiv Gal)	$4.72	$4.72	$4.72	$4.72	$4.72
CNG Vehicle Energy Cost ($/Therm)	$1.00	$1.00	$1.00	$1.00	$1.00
Electric Vehicle Energy Cost ($/kWh)	$0.16	$0.16	$0.16	$0.16	$0.16
Utilizing PPA Financing (no cap or O&M cost)	no	no	no	no	no
PPA Initial % Increase over Utility kWh	1.0%	1.0%	1.0%	1.0%	1.0%
PPA Initial Cost of Energy	$0.16	$0.16	$0.16	$0.16	$0.16
PPA Energy Cost Escalation Rate	3.5%	3.5%	3.5%	3.5%	3.5%
Natural Gas (# CO2/Therm)	11.66	11.66	11.66	11.66	11.66
Gasoline (#CO2/gal)	19.36	19.36	19.36	19.36	19.36
Diesel (#CO2/gal)	22.51	22.51	22.51	22.51	22.51
BioDiesel (#CO2/gal)	1.03	1.03	1.03	1.03	1.03
Ethanol (#CO2/gal)	12.23	12.23	12.23	12.23	12.23
CNG (#/Therm)	11.66	11.66	11.66	11.66	11.66
Propane (#/gal)	12.32	12.32	12.32	12.32	12.32

Measure Number	6	7	8	9	10	11
Measure Name	Streetlighting HID to LED (180 Fixtures)	New Fleet A	Town Green Lighting (100 fixtures)	PV 750 kW DC Wastewater Treatment Building	PV 515 kW DC	PV 515 kW DC
Implementation Date	2015	2014	2013	2013	2014	2014
Status	future	Future	Future	future	future	future
Financed	yes	no	no	no	no	no
Term of Analysis (yrs)	25	25	25	25	25	25
Term of Financing (yrs)	10	10	10	10	10	10
Discount Rate	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
MIRR Reinvestment Interest Rate (%)	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Inflation Rate	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Interest Rate	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Term of MIRR and NPV	17	10	10	25	25	25
kWh Energy Cost Escalation Rate	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Nat Gas Energy Cost Escalation Rate	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%
Vehicle Fuel Cost Escalation Rate	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Energy Cost ($/kWh)	$0.16	$0.16	$0.16	$0.16	$0.16	$0.16
Energy Cost ($/Therm)	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00
Gasoline Energy Cost ($/Gal)	$3.78	$3.78	$3.78	$3.78	$3.78	$3.78
Diesel Energy Cost ($/Gal)	$3.78	$3.78	$3.78	$3.78	$3.78	$3.78
BioDiesel Energy Cost ($/Gal)	$4.16	$4.16	$4.16	$4.16	$4.16	$4.16
Ethanol Energy Cost ($/equiv Gal)	$4.72	$4.72	$4.72	$4.72	$4.72	$4.72
CNG Vehicle Energy Cost ($/Therm)	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00
Electric Vehicle Energy Cost ($/kWh)	$0.16	$0.16	$0.16	$0.16	$0.16	$0.16
Utilizing PPA Financing (no cap or O&M cost)	no	no	no	yes	yes	yes
PPA Initial % Increase over Utility kWh	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
PPA Initial Cost of Energy	$0.16	$0.16	$0.16	$0.16	$0.16	$0.16
PPA Energy Cost Escalation Rate	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Natural Gas (# CO2/Therm)	11.66	11.66	11.66	11.66	11.66	11.66
Gasoline (#CO2/gal)	19.36	19.36	19.36	19.36	19.36	19.36
Diesel (#CO2/gal)	22.51	22.51	22.51	22.51	22.51	22.51
BioDiesel (#CO2/gal)	1.03	1.03	1.03	1.03	1.03	1.03
Ethanol (#CO2/gal)	12.23	12.23	12.23	12.23	12.23	12.23
CNG (#/Therm)	11.66	11.66	11.66	11.66	11.66	11.66
Propane (#/gal)	12.32	12.32	12.32	12.32	12.32	12.32

7.5 Vehicle Lists

Vehicle replacement methodology:

- Model years 2008 and newer are excluded for replacement in this analysis.
- PD/Sheriff vehicles are excluded as they are controlled by the County and not the Town of Windsor.
- Miles per year allocated to departments to reflect total annual fuel consumption from 2011 annual fuel log (actual annual miles traveled unavailable for this analysis).

VEHICLE LIST FOLLOW ON NEXT PAGE

Analysis ##	Dept.	Make	Year	Model	Fuel Type	MPG or MPkWh	Annual Miles	Replace	Replacement Vehicle	Incr. Cost	Fuel	MPG or MPkWh
1	PW	buick	2002	le sabre	gasoline	21	9704	YES	Hybrid Sedan Replacing Midsize	$6,000	Gasoline	39.0
2	PW	ford	2003	explorer	gasoline	14	9704	NO				
3	PW	jeep	1996	cherokee 4x4	gasoline	19	9704	NO				
5	PW	ford	1990	455	diesel	7	9704	NO				
6	PW	dodge	1996	ram 2500	gasoline	14	9704	NO				
9	PW	dodge	2001	ram 3500	gasoline	18	9704	NO				
10	PW	ford	2001	f350	gasoline	17	9704	NO				
13	PW	gmc	1987	c50	gasoline	7	9704	NO				
14	PW	dodge	1999	ram 2500	gasoline	14	9704	NO				
17	PW	dodge	1996	ram 2500	gasoline	14	9704	NO				
18	PW	ford	2000	expedition	gasoline	14	9704	YES	Large SUV Hybrid	$4,000	Gasoline	21.0
20	PW	dodge	1999	ram 2500	gasoline	14	9704	NO				
21	PW	international	2000	4900	diesel	7	9704	NO				
22	PW	international	2003	4300	diesel	7	9704	NO				
23	PW	ford	2001	f550	gasoline	7	9704	NO				
24	PW	dodge	1999	ram 3500	gasoline	18	9704	NO				
30	PW	chevy	2003	3500	gasoline	15	9704	NO				
31	PW	ford	1994	f350	gasoline	17	9704	NO				
33	PW	chevy	2003	c2500	gasoline	16	9704	NO				
36	PW	ford	2003	f250	gasoline	13	9704	NO				
37	PW	ford	2003	f250	gasoline	13	9704	NO				
44	Administration	honda	2001	accord	gasoline	23	19408	YES	Hybrid Sedan Replacing Midsize	$6,000	Gasoline	39.0
45	Administration	honda	2001	accord	gasoline	23	19408	YES	Hybrid Sedan Replacing Midsize	$6,000	Gasoline	39.0
46	Administration	dodge	1992	caravan	gasoline	16	19408	NO				
47	Administration	dodge	2000	dakota	gasoline	21	19408	NO				
49	BLDG	Toyota	2005	Prius	gasoline	48	14556	NO				
50	Parks & Fac	ford	2003	f250	gasoline	13	21834	NO				
51	Parks & Fac	ford	2003	f250	gasoline	13	21834	NO				
52	Parks & Fac	ford	2003	f250	gasoline	13	21834	NO				
53	Parks & Fac	ford	2003	f250	gasoline	13	21834	NO				
54	Parks & Fac	ford	2003	f350	gasoline	17	21834	NO				
57	EDCS	ford	2006	f450	gasoline	7	8491	NO				
59	Parks & Fac	ford	2006	f-150	gasoline	18	21834	NO				
60	Parks & Fac	ford	2006	ranger	gasoline	15	21834	NO				
62	EDCS	ford	2003	ranger	gasoline	15	8491	NO				
63	EDCS	ford	2003	ranger	gasoline	15	8491	NO				
64	EDCS	ford	2001	e350	gasoline	16	8491	NO				
65	EDCS	chevy	2005	c1500	gasoline	18	8491	NO				
66	Streets	Ford	2004	F350	gasoline	17	18195	NO				
67	Streets	Ford	2005	F250	gasoline	13	18195	NO				
93	PW	Ford	2007	Escape	gasoline	20	9704	YES	Small SUV Hybrid	$4,000	Gasoline	30.0
97	Water	Ford	2007	Ranger	gasoline	15	19408	NO				
98	PW Inspector	Ford	2008	Escape Hybrid	gasoline	27	9704	NO				
99	Water	Ford	2008	F250	gasoline	13	19408	NO				
102	UM	Ford	2008	Escape Hybrid	gasoline	27	10432	NO				
105	Water	Ford	2008	Escape Hybrid	gasoline	27	19408	NO				
110	Adm meter reade	Ford	2008	Escape Hybrid	gasoline	27	29112	NO				
116	PW	Ford	2008	Escape Hybrid	gasoline	27	9704	NO				
117	Waste Water	Ford	2008	Escape Hybrid	gasoline	27	17467	NO				