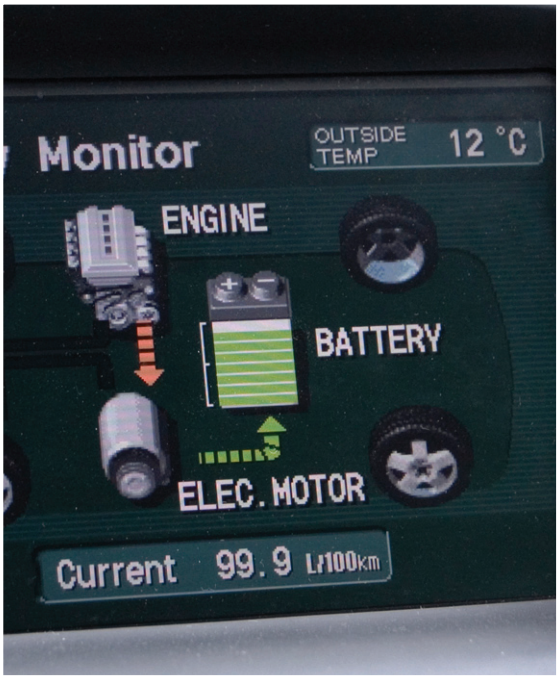
Corporate Climate Change Plan

Energy and Emissions Management

2007



CITY OF NANAIMO
THE HARBOUR CITY

Corporate Climate Change Plan 2007

An Energy and Emissions Management Plan

Prepared for:

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Acronyms

CO_2 – Carbon Dioxide
CO_2e– Carbon Dioxide equivalent
CON – City of Nanaimo
FCM – Federation of Canadian Municipalities
GHG – Greenhouse Gas
GMF – Green Municipal Funds
PCP – Partners for Climate Protection
RDN – Regional District of Nanaimo

Preface

The City of Nanaimo (CON) recognizes climate change as a global issue that can be addressed at the local level if all local governments in Canada begin to effectively manage their emissions through responsible energy management.

The city continues its leadership role in sustainability practices by developing this Corporate Climate Change Plan and making a commitment to embed energy and emissions management into its day-to-day operations.

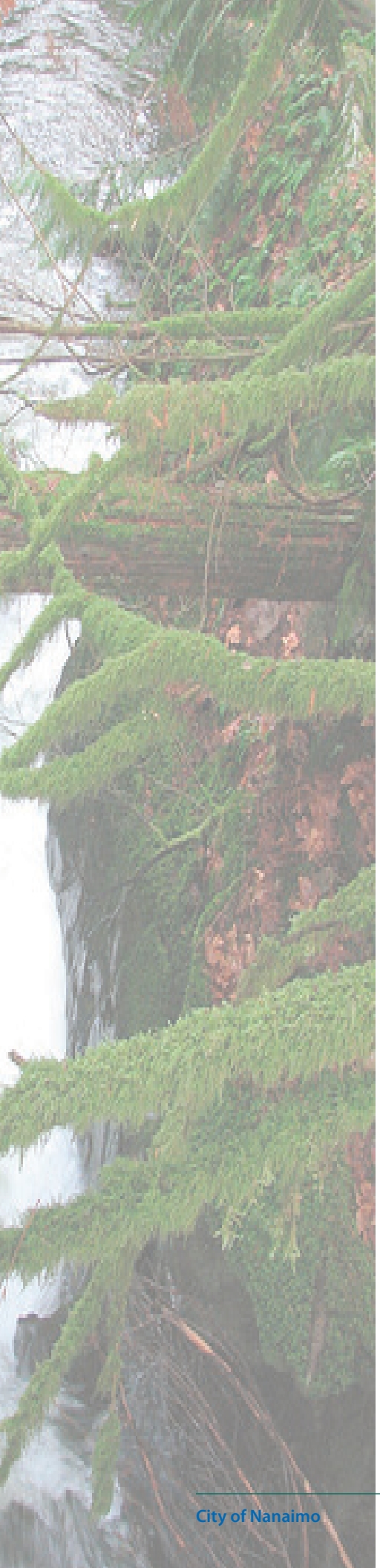
The city's Corporate Climate Change Plan 2007 is the second in a series of plans to be developed as part of the City and Regional District of Nanaimo's commitment to Partners for Climate Protection (PCP). Five corporate plans will be developed, one for each RDN member municipality, and one community plan will be developed that will serve the entire region. Each plan will provide the guidance necessary to implement measures designed to reduce energy consumption, energy costs, and greenhouse gas emissions.

Partners for Climate Protection is led by the Federation of Canadian Municipalities (FCM) and ICLEI-Local Governments for Sustainability. Over 140 local governments across Canada have committed to achieving the five milestones of Partners for Climate Protection and more than 600 communities around the world have committed to ICLEI's Cities for Climate Protection. Once submitted, this Corporate Climate Change Plan will result in the city's recognition from the Federation of Canadian Municipalities for completing the corporate portion of Milestones One, Two and Three of Partners for Climate Protection.

Detailed audits were not undertaken. Instead, estimates of reductions have been provided using staff's knowledge of individual facilities and the results of walkthrough audits. The estimates have been developed to provide staff with a sense of the overall potential for reductions. A successful program will explore all the reduction measures listed as well as new opportunities that arise as new technologies are introduced.

The Federal Government has recognized the important role of local governments in supporting emission reductions and is providing funding for sustainable infrastructure under the New Deal for Cities and Communities. Funding provided in the New Deal presents opportunities for local governments that are committed to climate change action. Due to staff's ability to monitor and report energy consumption and emissions, the city is in a better position to receive funds as it is well positioned to quickly respond to the energy and emissions reporting requirements of successful New Deal Fund projects.

Contents



Executive Summary

In 2002, the City of Nanaimo made a voluntary commitment to participate in the Partners for Climate Protection Program. Council's commitment to this program demonstrates its leadership among local government in British Columbia to improve the quality of life of its residents.

Greenhouse gas emissions, energy, and costs for consumption of energy types were calculated for the city's base year (2001) and forecast year (2012). In the base year, the emissions quantity was 5,048 tonnes CO_2e, the total amount of energy consumed was 126,353 GJ, and the total costs for consumption was $2,242,434. In the forecast year, the forecast of emissions is 6,360 tonnes CO_2e, the forecast of energy consumed is 164,629 GJ, and the forecast of costs for consumption is $5,347,751.

While energy consumption and emissions are projected to increase by 30 percent and 26 percent, respectively, of note is the projection for energy costs — an increase of over 139 percent, further emphasizing the immediate need to establish best management practices for energy use. By doing so, the city will be well positioned to manage the rising costs of fuel, while also addressing the very real concern of climate change.

Forecasted Parameter	Base Year (2001)	Forecast Year (2012)	Percent Change
Energy Consumption	126,353 GJ	164,629 GJ	30%
Energy Costs	$2,242,434	$5,347,751	139%
Emissions	5,048 tonnes CO_2e	6,360 tonnes CO_2e	26%

The City of Nanaimo can reduce its 2001 base year emissions quantity of 5,048 tonnes CO_2e by 1,613 tonnes, or 13 percent, by 2012. Interviews with city staff confirm that the reduction quantity is achievable and should be explored further within reasonable program resources and with a commitment from Council and management to undertake the programs proposed herein.

Sector	2001 Base Year Emissions (tonnes CO_2e)	2012 GHG Projection (tonnes CO_2e)	Reduction of GHG Emissions Completed (2001-2006)	Potential Reduction of GHG Emissions After Projected Growth (2012)	GHG Emissions After Measures (2012)	Percent Reduction of Projected Emissions (2012)
Buildings	2,754	3,800	272	930	2,598	-6%
Lighting[1]	327	360	26	46	288	-12%
Water and Wastewater[2]	81	91	36	11	44	-45%
Vehicle Fleet[3]	1,557	1,680	32	527	1,121	-28%
Corporate Waste	330	429	0	99	330	0%
Total	**5,048**	**6,360**	**366**	**1,613**	**4,381**	**-13%**

[1]LEDs for ornamental and overhead lighting are currently too expensive to be cost effective, although this may change in the near future and should be monitored by staff.

[2]An estimate is provided in the water and wastewater sector, since the volume of potable water and wastewater was not available, and must be used as an indicator for specific measures.

[3]The reductions for the vehicle fleet are aggressive and assume biodiesel will replace conventional diesel fuel by 2012.

Keys to success include creating an interdepartmental work team and assigning a coordinator that would be responsible for implementation of the reduction initiatives identified in Section 4 of this report and presented in detail in the *Technical Compendium of Potential Reduction Initiatives*.

The highest priorities must be afforded to increasing the energy efficiency of existing buildings and ensuring that the energy and atmosphere component of the Leadership in Energy and Environmental Design (LEED™) performance criteria is targeted under the City's Green Building Strategy. Other priorities include lowering automotive fuel consumption.

To be successful, the following is recommended:

1. For the city's corporate operations, assign responsibility for monitoring and reporting energy consumption and emissions to the accounting department. To accomplish this task, it is recommended that the City Sustainability Committee determine the best approach.
2. Create an interdepartmental work team, coordinated by the Deputy City Manager or a designate, and made up of staff from appropriate departments. The work team would review the recommendations in this report and develop a detailed implementation plan that ties specific projects to the capital plan and identifies external funding opportunities.
3. Ensure that energy and emissions management becomes part of the daily activities of city staff so that energy and emissions are considered in policy development, where appropriate, and in any new, city-owned infrastructure in the planning stages. This review would be undertaken before new infrastructure projects are forwarded by Departments for inclusion in budgets.
4. Implement the reduction initiatives as described in the ***Technical Compendium of Potential Reduction Initiatives,*** which describes the potential initiatives for implementation. The priorities for implementation in each sector are as follows:
    - Buildings — Conduct a feasibility study on geothermal heating for pool process water at both indoor pools (Beban Pool and the Nanaimo Aquatic Centre) to offset natural gas consumption and explore and/or enhance existing heat exchange systems on ice plants. Implement the projects if deemed feasible by the sustainability committee. The City Project Manager shall be given special instruction to ensure that performance criteria is met when incorporating the City's Green Building Strategy specifications that target the energy and atmosphere component of the LEED™.
    - Lighting - Significant reductions are possible once LED technology for ornamental and overhead lighting is cost effective. City staff should keep apprised of new technology through ongoing liaisons with BC Hydro (e.g., Ongoing participation in BC Hydro's Street Light Information Management—SLIM program).
    - Water and Wastewater - Review the technical feasibility of higher efficiency mechanical versus electrical adjustable speed drives (ASD) for fans and pumps at the College Park Valve and Pump Station, Rod Glen Potable Water Pump Station, and No. 1 Reservoir. Staff are encouraged to pursue power generation opportunities (e.g., a water turbine project on the gravity feed water mains supplying the majority of potable water to the city; "flow to wire" systems at major pressure reduction valve sites) and use the electricity generated to offset power requirements for new city facilities or to receive a power 'credit' from BC Hydro.
    - Vehicle Fleet - Significant reductions are possible by implementing new technology and alternative fuels as they become available. The fleet manager wishes to build on the successes of the existing electric gasoline-hybrid passenger vehicles by enhancing the existing hybrid fleet of passenger vehicles and extending electric hybrids to the diesel fleet (once the latter technology is available and proven reliable). Biodiesel fuels would result in significant emissions reductions, and implementation is supported by the fleet manager once warranties for all City vehicles allow for up to B20 blends.
    - Corporate Waste - The number of recycling receptacles should be increased at public facilities and staff should be able to recycle the same wastes that are recycled through the existing curbside recycling program.

1 Introduction

The City of Nanaimo (the 'city') made a commitment to address the issues of climate change and clean air planning by endorsing participation in the Federation of Canadian Municipalities' (FCM) Partners for Climate Protection (PCP) initiative in October 2002. The city recognizes that climate change is occurring and will strengthen its overall sustainability program by developing this plan.

Through the process to complete this plan, the city has not only begun the process of identifying energy consumption and the greenhouse gas emissions (GHGs) that result, but it has laid the foundation to continually monitor and manage energy consumption to meet a realistic energy and emissions reduction target. As energy prices continue to increase, energy management will continue to remain a high priority for the city.

This plan can contribute to a city strategy on sustainability that can place the city in a leadership role for local implementation of sustainability initiatives.

1.1 Regional Climate Change Initiative

Although this report is specific to the city's corporate operations, it is part of a larger project that involves each member municipality within the Regional District of Nanaimo. When all the components are completed, the city will have played a major role along with the Regional District in achieving more effective energy and emissions management.

1.2 Plan Development Process

Hyla Environmental Services Ltd. (HES) was hired to take staff through a planning process that culminated in the development of this document. As five corporate climate change plans are to be developed, one for the city, one for the RDN, and one for each of the other three RDN municipalities, key staff from the city were interviewed and provided several critical components of plan development as follows:

- providing the detail required to complete the energy and emissions analysis and confirm the base year emissions quantity
- assisting with the forecast of energy consumption, costs for consumption, and emissions
- selecting the final reduction initiatives to be used to calculate the overall program goal (e.g., the reduction quantity)

1.3 Overall Program Goal: The Reduction Quantity

The overall program goal of the Corporate Climate Change Plan 2007 is to identify the potential for emission reductions, or the reduction quantity. This has been carefully developed through the planning process by combining the reductions that are possible in each sector into an overall reduction quantity for the city's operations. Since emissions are the result of the combustion of fuel and use of electrical energy, the plan incorporates various types of measures, or reduction initiatives, that reduce energy and emissions through:

- conservation through reduced use;
- technological change;
- switching to less carbon-intensive fuel; and,
- offsetting conventional energy with renewable energy.

1.4 Climate Change Plan Structure

This plan presents the results of the planning process in five sections. Section 1 provides the introduction, context, and methodology. Section 2 presents the results of the energy and emissions inventory while section 3 presents the forecasts of energy consumption, costs for consumption, and emissions. Section 4 presents a summary of the reduction initiatives that city staff wish to implement as well as estimates of the potential reductions for each reduction initiative. Section 5 presents an implementation matrix for each sector and provides an estimate of the cost savings, and estimates of the cost for further study and/or implementation.

1.5 The Challenge of Climate Change and Clean Air Planning

All Canadian communities are faced with tough challenges in responding to the need to curb GHG emissions and adapt to the environmental changes that will result from climate change. In British Columbia, the impacts of climate change will manifest themselves in a number of ways that will present both new challenges and opportunities to communities.

It is inevitable that there will be costs associated with taking action on climate change. While investments in new technologies to mitigate climate change will result in job creation, these investments may also have negative implications for growth in other sectors of the economy.

It is important that the city understand the implications of climate change and its impact on these sectors of the economy. Although the scope of this report does not identify economic impacts, the reduction measures that will result provide guidance to city staff on how to identify the economic implications of reducing GHG emissions, if any.

1.6 Global Climate Change and Greenhouse Gas Emissions

The Earth's climate is a dynamic and complex system that is responsible for altering the earth and its inhabitants over the millennia. In modern times, the rate of global climate change has become an increasingly important issue for all levels of government since its effects impact ecological, economic, and social systems in all corners of the world. Internationally, it is accepted that increasing greenhouse gas emissions from human activities is causing the climate to change.

The most significant piece of the climate change puzzle is greenhouse gases. Carbon dioxide is a naturally occurring greenhouse gas that, in conjunction with naturally occurring water vapour, methane and nitrous oxide, traps the sun's heat energy as it reflects from the surface of the earth. This phenomenon, known as the 'greenhouse effect.' allows life to thrive on the majority of the planet by stabilizing global temperature. Conversely, man-made greenhouse gas emissions have been strongly linked to the rapid and continual increase in the earth's atmospheric temperature. If allowed to continue, profound effects on the earth's ecosystem and its inhabitants are predicted.

The key strategy adopted worldwide is to reduce and/or limit greenhouse gas emissions into the earth's atmosphere. A series of conventions and summits have been convened over the last 15 years that have resulted in the development of climate control strategies to reduce greenhouse gas emissions.

The 1992 Earth Summit in Rio de Janeiro, Brazil, was followed by the signing of the United Nations Framework Convention on Climate Change; Canada was among the signatories. In December 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed on targets to reduce GHG emissions. The agreement that set out those targets, including the options available to countries to achieve them, is known as the Kyoto Protocol. Canada's target is to reduce its GHG emissions to six percent below 1990 levels in the period 2008 to 2012. This target is comparable to the targets of our major trading partners. Although the Kyoto Protocol entered into force on February 16, 2005, the Federal Government is currently reconsidering its Kyoto commitments.

On February 2, 2007, the United Nations released the *Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report - Climate Change 2007.* Written by over 2500 top scientists, the report is a comprehensive analysis of the state of climate change that concludes that there is "unequivocal" evidence that climate change is real and happening faster than expected.

At the federal level, Canada's government announced the Canada EcoTrust Fund on February 12, 2007. The Canada EcoTrust for Clean Air and Climate Change will be designed to co-fund with the provinces technology development, energy efficiency, and other projects that will provide funding support for efforts to reduce air pollution and greenhouse gas emissions.

The resources for the Canada EcoTrust initiative will consist of 1.5 billion dollars of new funding on a national basis. This funding will be contained in the government's forthcoming 2007 budget.

In its February 2007 speech from the throne, British Columbia's Lt.-Governor read, "The science is clear. It leaves no room for procrastination. Global warming is real. We will act to stem its growth and minimize the impacts already released. The more timid our response is, the harsher the consequences will be".

Whereas previous provincial plans did not set reduction targets, the forthcoming Provincial Climate Change Plan will set specific targets to reduce greenhouse gas emissions– 33 per cent by 2020. Also, a climate change action team will advise the government on interim targets for 2012 and 2016. There will be a longer-term target for 2050.

The city can play an important role by providing strong leadership to ensure that any federal plan speaks to actions that can be implemented at the local level. This can be accomplished through direct funding to local government to develop educational programs or new infrastructure.

1.7 The Partners for Climate Protection and the Kyoto Protocol

The Federation of Canadian Municipalities (FCM) has been the voice of Canadian municipalities to the Federal government since 1901. In April 2003, the FCM and the city of Regina hosted a Municipal Leaders' Forum on Climate Change in Regina, Saskatchewan. The Forum was initiated in response to Canada's commitment to the Kyoto Protocol.

Milestone One: Complete GHG and energy use inventories and forecasts for both municipal operations and the community as a whole.

Milestone Two: Set Reduction Targets. Suggested PCP targets are a 20 percent reduction in GHG emissions from municipal operations, and a minimum six percent reduction for the community, both within 10 years of making the commitment.

Milestone Three: Develop a Local Action Plan. Develop a plan that sets out how emissions and energy use in municipal operations and the community will be reduced.

Milestone Four: Implement the Plan. Create a strong collaboration between the municipal government and community partners to carry through on commitments, and maximize benefits from greenhouse gas reductions.

Milestone Five: Measure Progress. Maintain support by monitoring, verifying, and reporting greenhouse gas reductions.

At the June 2006 Federation of Canadian Municipalities' Annual General Meeting, 1,400 of Canada's mayors adopted a policy statement supporting Canada's ratification of the Kyoto Protocol.

1.8 Partners for Climate Protection Program

The City of Nanaimo became a member of the FCM's Partners for Climate Protection in October 2002. The PCP is an umbrella initiative that fosters municipal participation in greenhouse gas emission reduction and overall sustainability initiatives. Its goal is to assist municipalities with their greenhouse gas management initiatives by providing tools and logistics support. Local governments that become members of the Partners for Climate Protection make a voluntary commitment to complete five milestones (see http://www.sustainablecommunities.fcm.ca). Once endorsed by Council and approved by the PCP Secretariat, the city will be recognized for completing Milestone One, Two, and Three.

This Climate Change Plan not only focuses on reducing existing greenhouse gas emissions, but also provides the necessary leadership to influence future greenhouse gas emissions through a variety of sustainable mechanisms, such as land use and transportation planning, building codes, permitting, education, and continuous monitoring, that will allow for effective emissions management.

1.9 Local Benefits of Reducing Greenhouse Gas Emissions

Although the co-benefits of reducing energy use and greenhouse gases are varied and dependent upon the manner in which energy is currently used, a managed approach to implementation of reduction measures will have positive effects on air pollution, job creation, and expenditures on energy.

For local government, reducing operating costs, improving public transit and traffic mobility, enhancing open spaces, improving livability and promoting local economic development are additional co-benefits when implementing greenhouse gas emission action plans. Many of the strategies that reduce greenhouse gas emissions affect other cost and livability factors throughout the community at large. For example, less money spent on electricity and fuel costs translates into more disposable income available to the local economy and potentially lower tax increases.

Reducing greenhouse gas emissions has the additional benefit of reducing particulate matter, nitrous oxides, sulphur oxides and volatile organic compounds—all common air contaminants that contribute to the degradation of air quality.

1.10 Regional and Local Context

Nanaimo is located on the east side of Vancouver Island off the southwest coast of British Columbia. Vancouver Island is the largest island in the North American portion of the Pacific Ocean. The Vancouver Island/Coast Region is the second most populous economic region in the province, accounting for 17.6 percent of the provincial population, covering 9.1 percent of the total provincial land mass. With a population base of 750,000, Vancouver Island varies from small rural communities to modern urban centres like Nanaimo.

The City of Nanaimo spans an area of 89.17 square kilometres and is home to approximately 78,000 residents (BC Stats estimate., 2001 - www.bcstats.gov.bc.ca). For more detailed information, go to http://www.city.nanaimo.bc.ca.

1.11 Energy and Emissions Inventory and Forecast

In order to implement an effective strategy to reduce greenhouse gas emissions, it is necessary to develop an inventory of the emissions. In its absence, local government lack a starting point from which progress can be measured. Further, they will not be able to forecast future emissions and predict the benefits of proposed reduction measures.

The emissions inventory for the city's operations provides an analysis for all its activities and operations. This report pertains to the corporate emissions and related reduction initiatives only. The base year emissions quantity is for 2001 and the project period is from 2007 to 2012.

A review of emissions by sector allows an analysis of the activity or operation responsible for various emissions. Corporate emissions by sector include those resulting from buildings, fleet vehicles and other motorized equipment, street lighting, potable water, storm and sanitary sewers, and solid waste generated at city facilities.

A review of emissions by source allows an analysis of the origin of various emissions. The origin of the emission is attributed to the type of fuel burned while carrying out the activity or operation. Major sources of greenhouse gas emissions include electricity, natural gas, diesel fuel, and gasoline. Greenhouse gases are emitted as these fuels are burned. Methane from the decomposition of waste in landfills is also a major source of greenhouse gas emissions, but is a direct emission, as apposed to the emissions from burning fossil fuels.

From the energy consumed by the city's operations, the mass of greenhouse gas emissions is calculated. This information forms the data from which the overall program goal is derived, and upon which evaluation of progress can be measured in the future.

City staff from all sectors of its operations assisted with the collection of energy consumption data.

BC Hydro and Terasen Inc. provided consumption data and costs for consumption of electricity and natural gas for the inventory year of 2001. Vehicle fleet data was compiled from internal city records while solid waste generated from operations was derived from the volume of bins at city facilities and the frequency of pick-up of the bins.

Data was imported into the Energy and Emissions module of Hyla Environmental Services Ltd.'s Energy & Emissions Sustainability Tool. The emissions calculator within this software conforms to the methods described in the International Panel on Climate Change Greenhouse Gas Inventory Reference Manual (IPCC 2006), the principles provided in the International Standards Organization (ISO) Draft International Standard for Greenhouse Gases (ISO 2005), and the general guidance within the FCM's guidance document for the preparation of PCP inventories (FCM 2006). Emissions coefficients are found in the IPCC document while emissions coefficients for electricity are provided by BC Hydro.

Energy and emissions are calculated at the account level (e.g., an asset that consumes energy, such as a building or pumping facility, represents an account in the software). The exception is the vehicle fleet since only the total amount of gasoline and diesel fuel was available. Regardless, data for 2003 and 2005 was entered into the software and reductions were applied to individual vehicles or groups of vehicles for which a reduction initiative would apply. A detailed summary of the energy and emissions inventory is presented in Appendix A.

The Energy & Emissions module of the Energy & Emissions Sustainability Tool will be provided to the city with the intent that staff resources will be committed to updating, monitoring and reporting on energy and emissions on a regular basis.

1.12 Reduction Initiatives and the Reduction Quantity

The Reduction Initiatives module of the Energy & Emissions Sustainability Tool contains over 100 initiatives for local government operations. Of the reduction initiatives presented to city staff, 67 initiatives were selected for inclusion in the final compilation of reduction initiatives. Of the 33 reduction initiatives not selected, 19 were 'not possible' in the city, while the remainder were not selected since they represented well established programs that began prior to the project period. The reduction initiatives selected are presented in the city's *Technical Compendium of Potential Reduction Initiatives* and summarized in Section 4.

The reduction quantity was calculated once staff selected reduction initiatives that could be achieved by the city. The calculation of reductions is based on the energy types that are affected by the measure. The total reductions that could be achieved by the city is the sum of the individual estimates of each reduction measure, including growth for each sector.

The overall reduction quantity is equal to the difference between the sum of the base year inventory plus the reductions, and the forecast year inventory. The overall reduction quantity is expressed as a mass or as a simple percentage of the base year quantity. To achieve a reduction in emissions on emissions inventory calculated in 2012, the total reductions achieved during the project period must be greater than the growth in emissions. When expressed as a percentage, the literal translation is, 'the emissions inventory in 2012 will be X % lower than the 2001 base year quantity'.

2.1 Corporate Inventory Summary

An overview of total energy consumed, costs, and emissions by sector is presented in Table 2.1. For the 2001 inventory year, the city's total energy consumed was 126,353 GJ, total costs were $2,242,434 and total greenhouse gas emissions were 5,048 tonnes CO_2e. A detailed inventory is presented in Sections 2.2 to 2.6.

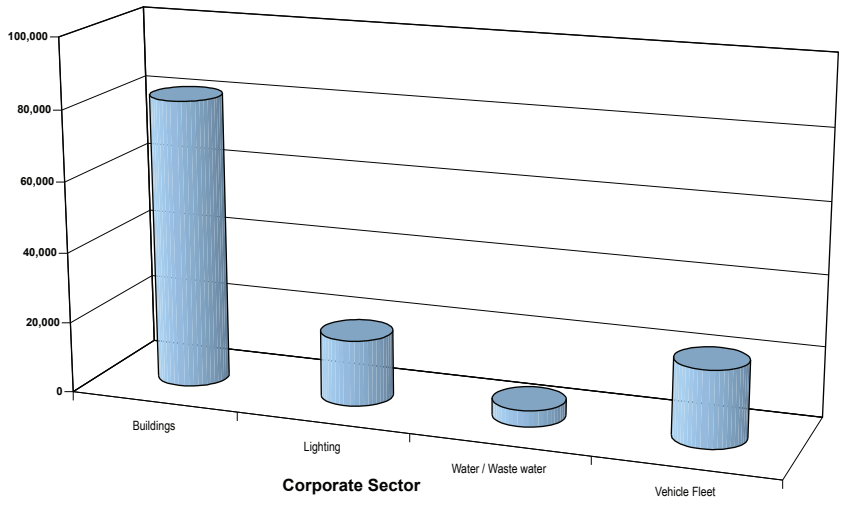
Table 2.1 - Energy, Costs, and Emissions by Sector (2001)

Sector	Total Energy (GJ)	Total Cost	Total Emissions (CO_2e tonnes)	Percent Total Energy by Source	Percent Total Costs by Source	Percent Total Emissions by Source
Buildings	81,441	$995,787	2,754	64%	44%	55%
Lighting	18,681	$861,883	327	15%	38%	6%
Water & Wastewater	4,621	$85,478	81	4%	4%	2%
Vehicle Fleet	21,609	$299,286	1,557	17%	13%	31%
Solid Waste			330	0%	0%	7%
Total	126,353	$2,242,434	5,048	**100%**	**100%**	**100%**

2.1.1 Corporate Energy Consumption

As Figure 2.1.1 illustrates, the majority of energy consumed is in the buildings sector at 81,441 GJ. Lighting consumed 18,681 GJ, the vehicle fleet consumed 21,609 GJ of energy, and water and wastewater infrastructure consumed 4,621 GJ of energy (Table 2.1 and Figure 2.1.1). Since corporate solid waste is a direct GHG emission to the atmosphere, no energy is consumed.

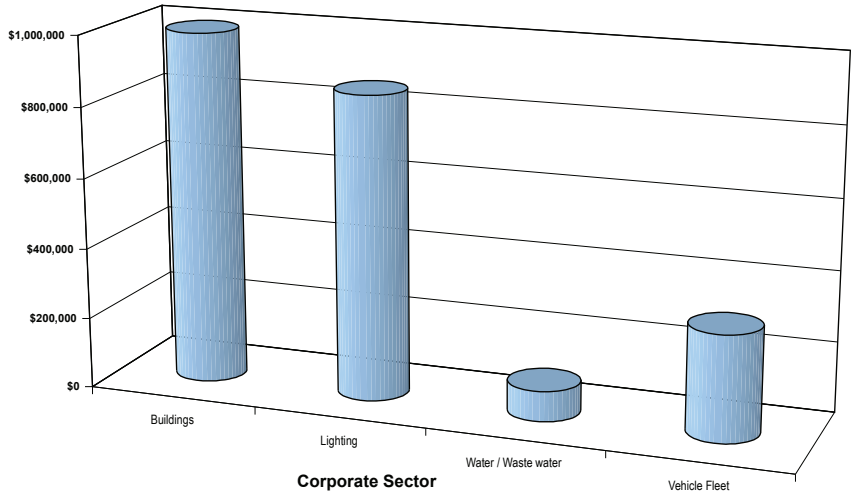
Figure 2.1.1 - 2001 Corporate Energy Consumption (GJ)



2.1.2 Corporate Costs

The majority of the city's total energy costs were incurred by buildings at ~$1 million. Lighting costs were ~$0.85 million, vehicle fleet costs were ~$300 thousand, and water and wastewater costs were ~$85 thousand (Table 2.1 and Figure 2.1.2). Costs to collect corporate solid waste in 2001 were $55,721.49, which includes pickup of bins containing recyclable materials. This figure is not shown in the accompanying table or figure, as it does not represent a cost for energy consumption, nor does it represent an expenditure that could be significantly reduced by reducing corporate waste (e.g., to reduce corporate waste, staff must recycle more aggressively. An expenditure must still be made to pickup recyclable materials).

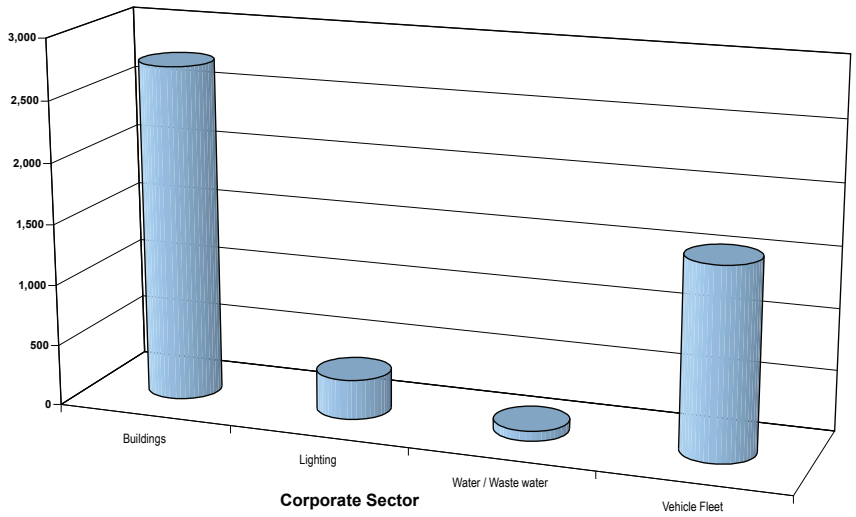
Figure 2.1.2 - 2001 Corporate Energy Costs



2.1.3 Corporate Emissions

The city's buildings produced the majority of emissions at 2,754 tonnes CO_2e or 55 percent of the total. The vehicle fleet followed at 1,557 tonnes or 31 percent, solid waste was 330 tonnes or 7 percent, lighting was 327 tonnes or 6 percent, and, water and wastewater was 81 tonnes or 2 percent of total emissions (Table 2.1 and Figure 2.1.3).

Figure 2.1.3 - 2001 Corporate Emissions (tonnes CO_2e)



2.1.4 Sources of Corporate Energy and Costs

The city consumes five types of energy: electricity, natural gas, gasoline, diesel fuel, and propane for vehicles (a very small amount (10's of litres) of propane is consumed for heaters and off-road equipment, but is not reported for the sake of simplicity). In terms of energy content, electricity accounts for over half (53 percent) of the total energy consumed by the city (Table 2.1.4). Natural gas (29 percent), diesel fuel (10 percent), gasoline (7 percent), and fuel oil (2 percent) follow in rank, respectively. Figure 2.1.4a illustrates the mix of energy by source and Figure 2.1.4b illustrates costs for energy types.

Table 2.1.4 - 2001 Sources of Corporate Energy & Costs

Energy Type	Units	Total Use	Total Energy (GJ)	Total Cost	Percent Total Energy by Source	Percent Total Costs by Source
Electricity	kWh	18,487,306	66,554	$1,525,114	53%	68%
Natural Gas	GJ	36,250	36,250	$398,750	29%	18%
Fuel Oil	litres	50,142	1,939	$19,284	2%	1%
Gasoline	litres	253,103	8,773	$136,676	7%	6%
Diesel Fuel	litres	331,856	12,836	$162,610	10%	7%
Total			**126,353**	**$2,242,434**	**100%**	**100%**

Figure 2.1.4a - 2001 Sources of Corporate Energy (GJ)

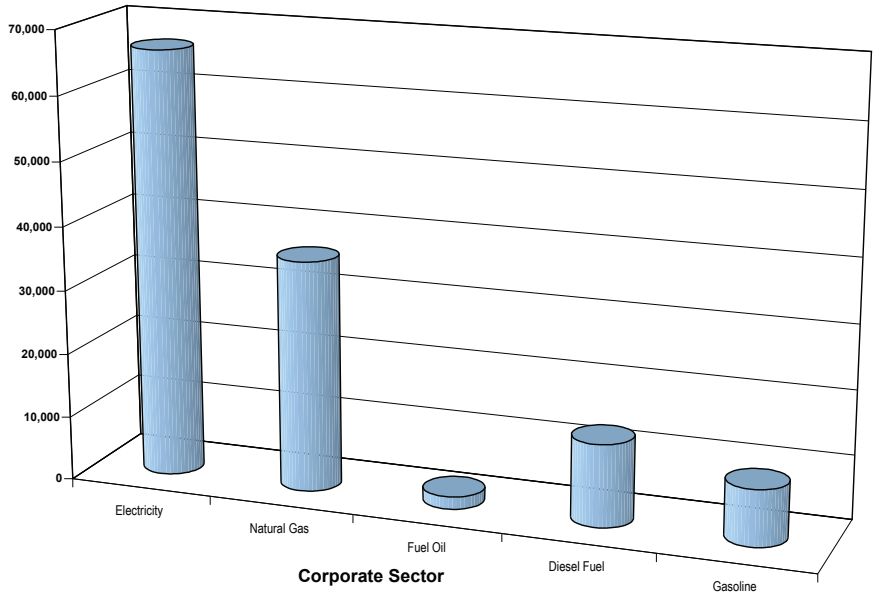
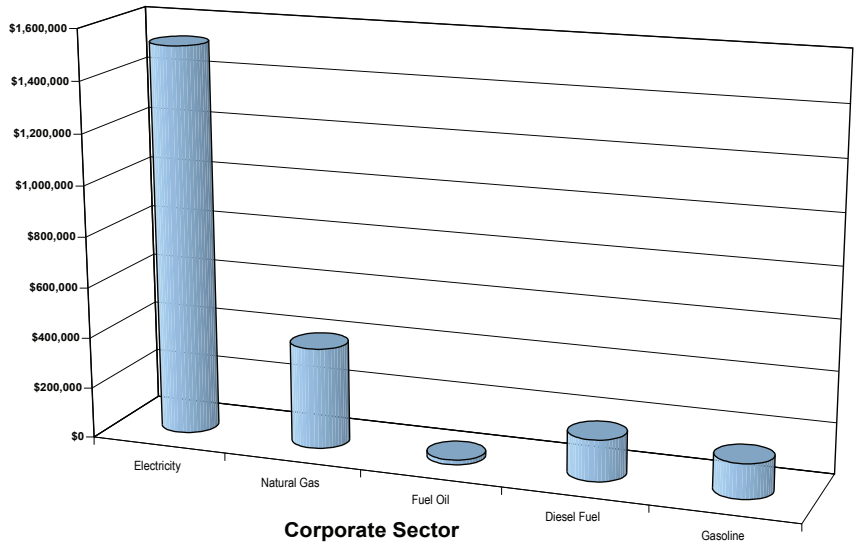


Figure 2.1.4b - 2001 Sources of Energy Costs



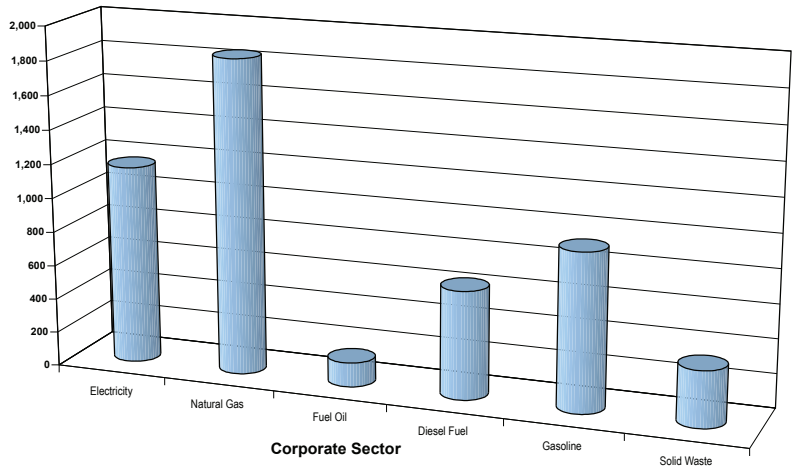
2.1.5 Sources of Corporate Emissions

The greatest source of emissions is from the combustion of natural gas (37 percent of total emissions), followed by electricity (23 percent), diesel fuel (18 percent of total emissions), gasoline (13 percent), direct emissions from solid waste (seven percent), and fuel oil (three percent). Table 2.1.5 and Figure 2.1.5 illustrate the contribution of energy sources to total emissions.

Table 2.1.5 - Sources of Corporate Emissions (2001)

Energy Type	Units	Total Use	Total Emissions (CO_2e tonnes)	Percent by Source
Electricity	kWh	18,487,306	1,165	23%
Natural Gas	GJ	36,250	1,855	37%
Fuel Oil	litres	50,142	142	3%
Gasoline	litres	253,103	633	13%
Diesel Fuel	litres	331,856	923	18%
Solid Waste			330	7%
Total			**5,048**	**100%**

Figure 2.1.5 - 2001 Sources of Corporate Emissions (tonnes CO_2e)



2.2 Buildings

In 2001, the city owned approximately 76 buildings that have electrical connections. The total energy consumed in all buildings in 2001 was 81,441 GJ, which is shared by three energy types: electricity (43,252 GJ), natural gas (36,250 GJ), and fuel oil (1,939 GJ). Total costs for all buildings was $995,787, and their total emissions was 2,754 tonnes CO_2e (Table 2.2.1). Table 2.2.2 ranks the top 15 energy consumers in the buildings sector.

Table 2.2.1 - Summary of Buildings Sector Emissions (2001)

Sector	Energy Type & Units		Total Use	Total Energy (GJ)	Total Costs	Total CO_2e (t)
Buildings	Electricity	kWh	12,014,306	43,252	$577,754	757
	Natural Gas	GJ	36,250	36,250	$398,750	1,855
	Fuel Oil	litres	50,142	1,939	$19,284	142
Totals				**81,441**	**$995,787**	**2,754**

Buildings: Top Energy Consumers	Energy	Costs	CO_2e
Beban Pool/Frank Crane Arena/Social Centre - 2300 Bowen Rd	32,689 GJ	$370,654	1,235.7 t
Nanaimo Aquatic Centre - 741 3rd St	15,534 GJ	$185,057	503.1 t
Cliff Mcnabb Arena - 2300 Bowen Rd	6,296 GJ	$75,286	193.8 t
Public Works Yard - 2020 Labieux Rd Yrd	4,472 GJ	$53,351	138.4 t
Civic Arena - 48 Arena St	4,031 GJ	$48,829	111.1 t
Rcmp Building - 303 Prideaux St	3,409 GJ	$41,388	66.7 t
City Hall Annex - 238 Franklyn St	2,758 GJ	$42,716	86.4 t
Plaza - 51 Gordon St	1,488 GJ	$20,168	26.0 t
Station #1 - 666 Fitzwilliam St	1,407 GJ	$17,879	74.8 t
City Hall - 455 Wallace St	1,238 GJ	$18,303	44.5 t
Centennial Building - 2300 Bowen Rd Vix	1,033 GJ	$15,591	31.0 t
Station #2 - 2499 Dorman Rd	849 GJ	$11,476	33.4 t
Community Services Bldg - 285 Prideaux St	825 GJ	$10,324	37.9 t
Station #3 - 6230 Hammond Bay Rd	582 GJ	$8,152	21.6 t
Bowen Park Complex - 500 Bowen Rd Cplx	565 GJ	$10,754	9.9 t

The Beban Arena and Pool Complex is the top energy consumer since it consumes a large amount of natural gas to heat pool water and electricity to run the ice plant. Since the electricity and natural gas accounts for this complex are combined, a disaggregation of energy consumption is not possible without performing a detailed audit.

The Nanaimo Aquatic Centre (NAC) is ranked number two since it consumes a large amount of natural gas to heat pool water and electricity for motors, fans, and lighting. The Cliff McNabb Arena and city hall are ranked number three and four due to the amount of electricity used to run ice plants and light the ice surface, and the amount of natural gas consumed for space heating, respectively.

The Civic Arena was demolished in 2006, but forms part of the 2001 emissions inventory.

2.3 Lighting

The city's lighting consumed 18,681 GJ of electricity (5,189,287 kWh), resulting in the production of 327 tonnes of CO_2e at a cost of $861,883 (Table 2.3.1). Lighting accounted for six percent of corporate greenhouse gas emissions (Table 2.1). Table 2.3.2 shows the top 15 lighting accounts ranked by energy consumption.

Table 2.3.1 - Summary of Lighting Sector Emissions (2001)

Sector	Energy Type & Units		Total Use	Total Energy (GJ)	Total Costs	Total CO_2e (t)
Lighting	Electricity	kWh	5,189,287	18,681	$861,883	327
Totals				**18,681**	**$861,883**	**327**

Table 2.3.2 - Lighting Ranked by Energy Consumption (2001)

Lighting: Top Energy Consumers	Energy	Costs	CO_2e
Overhead Streetlighting - City-Wide	8,304 GJ	$668,941	145.3 t
Ornamental Lighting - -	6,338 GJ	$119,711	110.9 t
Parcade Lights - Terminal-Skinner St	401 GJ	$7,283	7.0 t
Civic Arena??Foundry Site Lights - 50 Comox Rd	345 GJ	$6,272	6.0 t
Harewood Cent. Pk - Harewood Park-Field Hs	285 GJ	$5,770	5.0 t
Bowen Park Lts 1 - 500 Bowen Rd	260 GJ	$4,770	4.6 t
Bowen Park Lts 2 - 500 Bowen Rd	244 GJ	$4,442	4.3 t
Gordon St Kiosk - Gordon St Kiosk	131 GJ	$2,412	2.3 t
Bowen/Wall - Bowen/Wall	82 GJ	$1,308	1.4 t
Bastion/Wallace - Bastion/Wallace	81 GJ	$1,303	1.4 t
Bowen/Meredith - Bowen/Meredith	79 GJ	$1,268	1.4 t
Brechin Point Rd Boat Ramp - Brechin Pnt Boat Ramp	77 GJ	$1,433	1.3 t
Bowen Kin Pool Lts - 500 Bowen Rd Pool	76 GJ	$1,431	1.3 t
Bowen/Northfield - Bowen/Northfield	74 GJ	$1,185	1.3 t
Rutherford At Wills - Rutherford At Wills	72 GJ	$1,350	1.3 t

Overhead and ornamental streetlights consume the majority of energy in the lighting sector. The city has retrofitted its traffic signals from incandescent to LED technology resulting in considerable savings. Retrofits of ornamental and overhead streetlights are not financially practical at this time, although during the project period (2007-2012), such retrofits will likely be possible.

2.4 Water & Wastewater

The city does not operate any sewage treatment plants or potable water treatment plants, and therefore, energy consumed in the water and wastewater sector is for motors that drive sanitary sewer, potable water, and storm sewer pumps. Overall, 1,283,713 kWh of electricity is consumed, which results in the release of 81 tonnes of emissions at a cost of $85,478 (Table 2.4.1). Table 2.4.2 shows the top 15 water and wastewater accounts ranked by energy consumption.

Table 2.4.1 - Summary of Water and Wastewater Sector Emissions (2001)

Sector	Energy Type & Units		Total Use	Total Energy (GJ)	Total Costs	Total CO_2e (t)
Water & Wastewater	Electricity	kWh	1,283,713	4,621	$85,478	81
Totals				**4,621**	**$85,478**	**81**

Table 2.4.2 - Water and Wastewater Ranked by Energy Consumption (2001)

Water & Wastewater: Top Energy Consumers	Energy	Costs	CO_2e
Rod Glen Pump Station And No. 4 Reservoir - 4217 Early Dr	1,065 GJ	$18,193	18.6 t
Extension Water Process Centre - 2209 Bramley Rd	792 GJ	$12,223	13.9 t
College Park Valve & Pump Station With No. 3 Reservoirs (A&B) - 1071 College Dr Pump	561 GJ	$10,144	9.8 t
No. 1 Reservoir - 1050 Nanaimo Lakes Rd Dam	274 GJ	$5,050	4.8 t
Lost Lake No. 2 Reservoir And Pump Station - 4877 Lost Lake Rd	260 GJ	$7,969	4.6 t
Prince John Pump Station - 267 Prince John Way Pump	254 GJ	$4,632	4.4 t
No. 6 Duke Point Reservoir, Duke Point Valve Stn. & Duke Point Pump Stn. - Duke Point Wtr Stn (1120 Hooker Rd?)	211 GJ	$3,838	3.7 t
Sewer Pump Station - 5668 Brookwood Dr	164 GJ	$3,010	2.9 t
Pryde Avenue Pump Station - 71 Pryde Ave	152 GJ	$2,791	2.7 t
Wiltshire Pump Station - 3507 Wiltshire Drive	143 GJ	$2,629	2.5 t
3674 Lagoon Rd Pump - 3674 Lagoon Rd Pump	127 GJ	$2,343	2.2 t
No. 5 Towers Reservoir & Pump Station - 1311 Langara Dr Pump	104 GJ	$1,917	1.8 t
Long Lake Pump - Long Lake/Ross Rd	104 GJ	$1,925	1.8 t
1065 Cedar Rd Pump - 1065 Cedar Rd Pump	93 GJ	$1,726	1.6 t
Tanya Reservoir No. 7 - 5341 Tanya Dr Resv	57 GJ	$1,079	1.0 t

2.5 Vehicle Fleet

The vehicle fleet includes all motorized vehicles operated by the city, backup generators, and miscellaneous equipment for roads and parks maintenance (photo right), lawns, etc. The amount of fuels consumed by the latter two subcategories is estimated at approximately 3 percent of the diesel fuel consumed (backup generators) and 11 percent of the total gasoline consumed (parks equipment). Due to the limitations of data available for 2001, a disaggregation into subcategories is not available.

The city's gasoline and diesel fuel consumption produced 1,557 tonnes of CO_2e and fuel costs were $299,286. Table 2.5.1 provides a summary of emissions by fuel type.

Table 2.5.1 - Summary of Vehicle Fleet Sector Emissions (2001)

Sector	Energy Type & Units		Total Use	Total Energy (GJ)	Total Costs	Total CO_2e (t)
Vehicle Fleet	Gasoline	litres	253,103	8,773	$136,676	633
	Diesel Fuel	litres	331,856	12,836	$162,610	923
Totals				**21,609**	**$299,286**	**1,557**

Currently, the city operates four gas-electric hybrid vehicles, which were purchased in 2004.

2.6 Corporate Solid Waste

Solid waste generated in municipal facilities accounts for seven percent of total corporate emissions. In 2001, the city's waste from its corporate operations resulted in 330 tonnes of CO_2e.

2.7 Corporate Inventory - Summary

In terms of energy consumed, costs for energy, and total emissions by sector, buildings are ranked number one in all categories. The observed ranking is typical for municipalities that operate one or more indoor pools and/or ice arenas. More specifically, the recreation complexes combined consume 72 percent of total buildings energy, 69 percent of total buildings costs, and generate 75 percent of emissions. Other than buildings, a significant amount of energy is consumed by vehicles (~15 percent) and lighting (15 percent).

3 Forecasting Energy Consumption & Emissions

The energy and emissions inventory presented in Section 2 provides an important base of information that can be used to compare against future inventories. More importantly, it provides a starting point from which to construct a forecast of energy consumption and emissions. The energy consumption and emissions forecast herein provides insights into future energy consumption and emissions that the city may produce. Two types of forecast scenarios have been developed as follows:

1. **Business as Usual (BAU) –** The BAU emissions forecast was developed for the year 2012. This forecast is based on the growth estimates presented in section 3.1 and assumes that no significant GHG reduction measures will be undertaken that would not be considered a common practice (e.g., installing an efficient heating, ventilation, and air conditioning system in a new building would be considered a common practice, whereas the installation of a geothermal heat pump would not);
2. **Typical Implementation –** New initiatives that would not otherwise be considered common practice are implemented according to staff's recommendation to the Council, and the Council's willingness to undertake the initiatives. Mitigation measures will be implemented that reduce energy consumption, costs, and GHG emissions from the business as usual forecast, the effects of which are presented in Section 5– Establishing a Reduction Target.

Forecasts are challenging to develop since they are only as good as one's ability to predict future growth and potential changes in business practices (e.g., public transit expansion). When developing reduction targets (Section 5), it is important that the forecast of emissions is estimated as accurately as possible since it forms part of the calculation of the overall reduction quantity.

The easiest method of developing an emissions forecast is to assume that increases in corporate emissions will be aligned with population growth. In reality, this method is very inaccurate since the addition of one public recreational facility during the forecast period (e.g., indoor pool, ice arena, or new administration hall) would increase corporate emissions by an amount that exceeds the average rate of population growth of 1 percent to 2 percent per year typical in British Columbia (www.bcstats.bc.ca).

The forecast of emissions in the BAU forecast is based on the assumption that the city will provide services with the same level of efficiency as it has in the past, but will also make additions and upgrade core services such as public transit, potable water treatment, and sanitary sewage treatment, thereby adding to energy consumed, costs for consumption, and overall emissions.

3.1 Predicted Growth by Sector

The project team developed the growth forecast based on the 2006-2010 City General Capital Plan and the Waterworks Capital Plan. Normally, forecasts are developed 10 years subsequent to the base year inventory.

Any initiatives completed from 2001 to present year (2006), will be included in the corporate program, although the city has six years inclusive to implement reduction initiatives until the next detailed review is undertaken. The predicted growth in each sector is presented in table 3.1.1.

3.2 Forecast of Energy Consumption and Costs

Energy consumption and associated costs to purchase energy are forecast together although forecasts of each energy type in each sector is weighted according to the mix of energy type in the base year. Although all forecasted parameters are equally important, local governments are paying particular attention to forecasts of energy costs to better prepare for future budgets. Although it is difficult to predict future energy costs, in all certainty, energy costs will increase in the forecast period. Conservative estimates of energy cost increases are provided, but the author makes no claim of expertise in this area and is relying on projections provided by others. Table 3.2.1 and figure 3.2.1 provide a forecast and a chart of projected *energy consumption* to 2012. Table 3.2.2 and figure 3.2.2 provide a forecast and chart of projected *costs for energy* consumption to 2012.

Table 3.1.1 - Predicted Growth by Sector (2001 - 2012)

Sector	Notes	Forecast Percent (2012)
Buildings	includes new buildings and/or renovations to: Twin Ice Rinks (opened 2006); Nanaimo Conference Centre (includes museum); Oliver Road Community Centre; Beban Multi-Purpose Hall; Bowen Park Community Centre; Beban Park Community Centre; and, Beban Aquatic Centre. Includes demolition of Civic Arena. Includes replacing fuel oil furnaces with natural gas appliances	38%
Lighting	nominal increase based on observed trend of electricity consumption from 1994 to 2004 and addition of lighting for conference centre parkade	10%
Water and Wastewater	increase based on observed trend of electricity consumption from 1994 to 2004	12%
Vehicle Fleet	nominal increase based on observed trend of City data from 2001 to 2005	8%
Corporate Waste	addition of 50 tonnes from all growth in corporate buildings	30%

The forecast of energy consumption is aligned with the predicted growth by sector in Table 3.1.1, whereas the forecast of energy costs is highly dependent upon our prediction of costs per unit of energy in the future. The most difficult cost prediction for energy types is gasoline and diesel fuel. The prediction of $2.50/litre of gasoline and $2.25/litre of diesel fuel is considered conservative and based on a reputable source (Nesbitt Burns Oil & Gas Research - Oil & Gas Weekly). However, predictions from Federal US oil and gas analysts (US Energy Agency) are as high as $4.00/litre and $3.50/litre for gasoline and diesel fuel, respectively.

3.3 Forecast of Emissions

The emissions forecast is based on the percentages provided in the initial sectoral forecast (Table 3.1.1). For the sake of simplicity, the emissions forecast does not include any predicted changes to electricity emissions factors, either positive or negative (e.g., the emissions factor increases and decreases according to the mix of power generation by hydroelectricity vs. power generation by burning fossil fuels). Instead, the forecast assumes that electricity factors will remain constant over time. The electricity emissions factor is used to convert the amount of electricity consumed to CO_2e and is important in the calculation. Although it is highly unlikely that emissions coefficients will remain constant over the forecast period, the trend in emissions coefficients in British Columbia is not straightforward since they are based on the origin of electricity provided to BC Hydro customers, which in turn is dependent upon overall demand for electrical energy—parameters that are not easily predicted.

Table 3.2.1 - Forecast of Energy Consumption by Sector (2001 - 2012)

Sector	Energy Type/Unit	Consumption	Energy (GJ)	Total Energy (GJ)	Forecast Percent	Forecasted Energy (GJ)	Forecasted Total Energy (GJ)
		2001				2012	
Buildings	Elect (kWh)	12,014,306	43,252	81,441	138%	59,688	110,813
	Nat Gas (GJ)	36,250	36,250			50,025	
	Fuel Oil (L)	50,142	1,939			1,100[1]	
Lighting	Elect (kWh)	5,189,287	18,681	18,681	110%	20,549	20,549
Water & Wastewater	Elect (kWh)	1,283,713	4,621	4,621	112%	5,176	5,176
Vehicle Fleet	Diesel (L)	253,103	8,773	21,609	130%	11,405	28,092
	Gas (L)	331,856	12,836			16,687	
Total			**126,352**			**164,629**	

[1]Fuel oil is forecast to decrease as older fuel oil furnaces are replaced with natural gas furnaces

Figure 3.2.1 - Forecast of Energy Consumption by Sector (2001 - 2012)

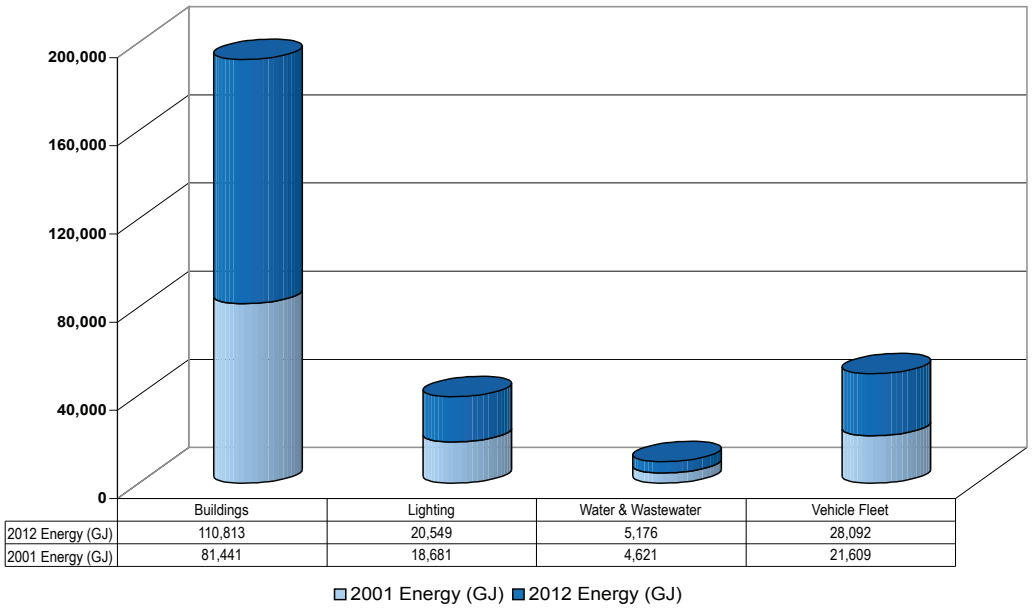


Table 3.2.2 - Forecast of Costs by Sector (2001 - 2012)

Sector	Energy Type/Unit	Consumption	Costs	Total Cost	Forecasted Unit Costs	Forecasted Costs	Forecasted Total Costs
		2001			2012		
Buildings	Elect (kWh)	12,014,306	$577,754	$995,788	$0.08	$1,326,379	$2,215,146
	Nat Gas (GJ)	36,250	$398,750		$15.00	$750,375	
	Fuel Oil (L)	50,142	$19,284		$2.00	$138,392	
Lighting	Elect (kWh)	5,189,287	$861,883	$861,883	$0.21	$1,198,725	$1,198,725
Water & Wastewater	Elect (kWh)	1,283,713	$85,478	$85,478	$0.08	$115,021	$115,021
Vehicle Fleet	Diesel (L)	253,103	$136,676	$299,286	$2.25	$740,326	$1,818,858
	Gas (L)	331,856	$162,610		$2.50	$1,078,532	
Totals		**$2,242,435**			**$5,347,751**		

Figure 3.2.2 - Forecast of Costs by Sector (2001 - 2012)

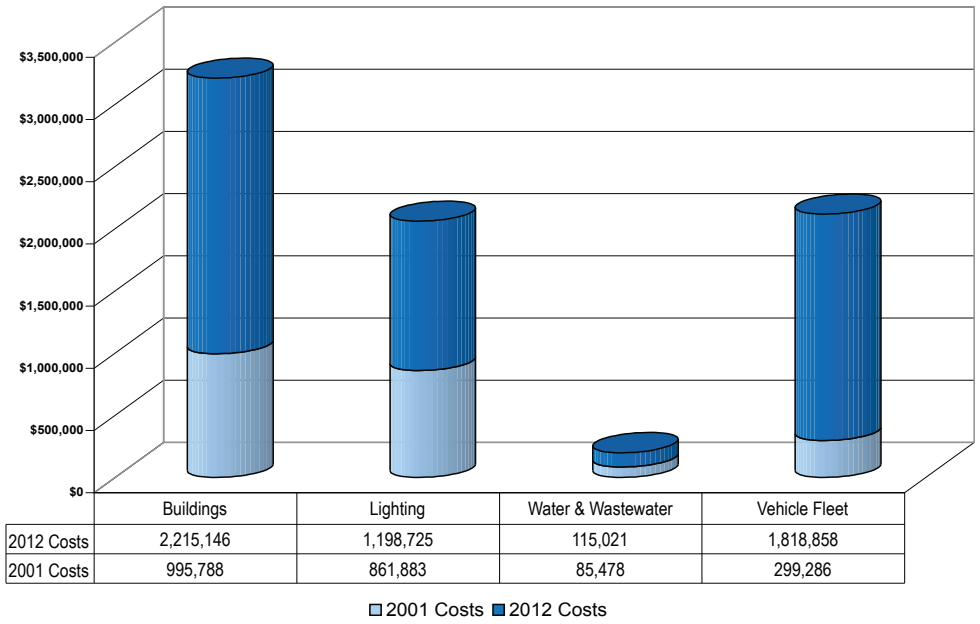
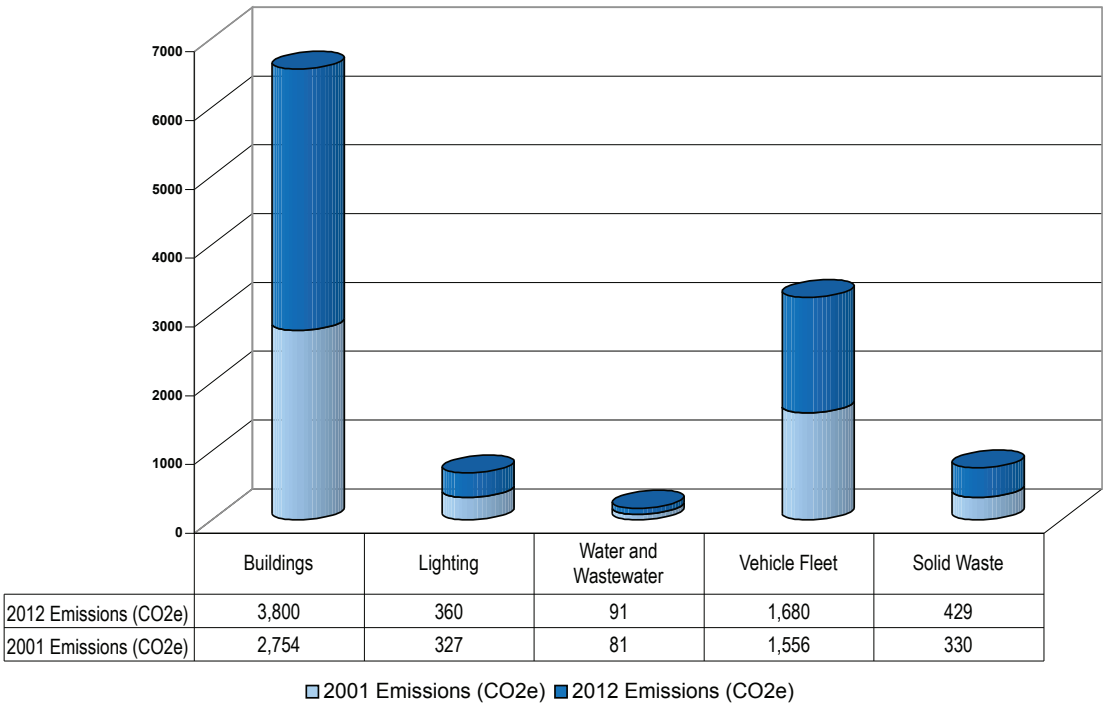


Table 3.3.1 - Forecast of Emissions (CO_2e tonnes) by Sector (2001 - 2012)

Sector	Energy Type/Unit	Emissions CO_2e (t)	Total CO_2e (t)	Forecast Percent	Forecasted Emissions CO_2e (t)
		2001		2012	
Buildings	Elect (kWh)	757	2,745	138%	3,800
	Nat Gas (GJ)	1,855			
	Fuel Oil (L)	142			
Lighting	Elect (kWh)	327	327	110%	360
Water & Wastewater	Elect (kWh)	81	81	112%	91
Vehicle Fleet	Diesel (L)	923	1,556	130%	1,680
	Gas (L)	633			
Corporate Waste	Tonnes	330	330	109%	429
Totals		**5,048**		**6,360**	

Figure 3.3.1 - Forecast of Emissions (CO_2e tonnes) by Sector (2001 - 2012)



3.4 Summary of Forecasts

Overall energy consumption is forecast to increase by 30 percent from 2001 to 2012 largely due to the projected 38 percent increase in the buildings sector. Overall costs for emissions are forecast to increase by 125 percent due to the forecasted increase in the unit cost for automotive fuel. Overall emissions are forecast to increase by 27 percent, lower than the forecast for energy due to the difference in energy types in each of the sectors (electricity and natural gas consumption vary between sectors that are forecast to increase by different amounts). The forecasts for energy consumption, costs, and emissions are summarized in Table 3.4.1.

Table 3.4.1 - Summary of Forecasts

Forecasted Parameter	Base Year (2001)	Forecast Year (2012)	Percent Change
Energy Consumption	126,352 GJ	164,626 GJ	30%
Energy Costs	$2,240,124	$5,347,751	139%
Emissions	5,048 tonnes CO_2e	6,360 tonnes CO_2e	26%

Gasoline and diesel fuel are predicted to rise rapidly in the future. The cost of consumption forecast is largely dependent upon the forecasted unit price for fuel, and although the forecast provided is from a reputable source, it is still subjective. Regardless, there is very little doubt that fuel prices will be higher in 2012 than they are today. The forecast for energy costs for other energy types is based on the same assumptions, although unit costs by energy type, especially automotive fuels, are forecast to rise at an accelerated rate in comparison to growth in consumption.

3.5 Forecasts and Their Contribution to Reduction Targets

The forecast of energy consumption, costs and emissions is essentially the growth in these parameters from the base year through to the forecast period. Forecasts allow us to understand future energy consumption, costs of consumption, and emissions. They should be considered works in progress as new information can change the forecast and therefore the reduction targets.

As stated earlier, the forecast is an essential component of the calculation of the reduction targets. Since all the parameters used to calculate the reduction targets are subject to change, targets are essentially 'moving' as new information is gathered.

The reduction target is equal to the percent difference between the base year inventory and the forecast year inventory. Since reduction targets are absolute and not based on per capita emissions, to achieve an actual reduction, ***the total reductions achieved during the project period must be greater than the growth in emissions.*** Regardless of any overall increase in emissions during the project period, implementing reduction initiatives will, at a minimum, decrease the amount of growth in emissions if the 'Business as Usual' scenario is allowed to continue.

The reduction initiatives that the city selected for implementation over the project period are presented in Section 4. In Section 5, estimates of costs for three payback periods are provided, as well as suggested timeframes for implementation.

4.0 Reduction Initiatives

Reduction initiatives have been selected that will reduce energy consumption and the production of emissions from the existing infrastructure (base year energy and emissions) and infrastructure that will be added in the future (growth in energy and emissions). Reduction initiatives that have been completed subsequent to the start of the project period (2001) to present (2006) have also been included.

Detailed audits of infrastructure were not undertaken, although walkthrough audits were completed on major buildings to confirm that the reduction measures calculated were possible. For each sector (buildings, lighting, water and wastewater, vehicle fleet, waste, etc.) and subsector (ice arenas, overhead lighting, passenger vehicles, potable water pump stations, etc.) tables are provided that summarize estimates of typical reductions for the potential reduction initiatives selected.

We have calculated a preliminary end-use breakdown of energy loads for buildings and infrastructure based on older Power Smart audits (mid 1990s) and our walkthrough audits. Although walkthrough audits were conducted, the estimates do not replace detailed audits of infrastructure, which was beyond the scope of this project.

Although we have described the reduction amounts as *estimates*, the calculations are based on reductions of the energy type that the measure affects. Careful consideration has been given to the effect each measure will have on energy consumption. Measures are applied to end-use breakdowns of the types of energy consumed in all city infrastructure. For example, a measure to reduce the energy consumed for pumping water is applied to that portion of the energy end-use breakdown in a pump station that has been allocated to the motor that drives the pump. Energy end-use breakdowns were developed for all infrastructure, where applicable, and are based on energy audits of city infrastructure that were reviewed by HES. If an example breakdown was not available for a specific type of city infrastructure, a walk-through audit was conducted and/or we used typical energy end-use breakdowns from audits conducted in other communities.

Estimates of reduction quantities are provided for energy consumption, costs for consumption, and GHG emissions. Reduction initiatives have been grouped accordingly and summarized within each subsector. Some examples of reduction initiatives within these groupings are provided in Table 4.0.

Table 4.0 - Measures Subcategories and Example Reduction Measures

Measure Subcategory	Examples	Number of Measures
Bundled Retrofits	lighting retrofits including redesign | auto shutdown software | replace line voltage thermostats	44
Reduced Activity	alternative transportation | telecommuting	7
Reduced Consumption	cross-departmental initiatives to reduce energy use	11
Switch to More Efficient Technology	incandescent to LED | timers and photocells | motors | seals | paperless systems	35
Fuel Switch (less carbon intensive)	fuel oil to natural gas | gasoline to ethanol blend	7
Offset Natural Gas with Renewable Energy	ground source heat pumps | solar walls | heat recovery	6
Offset Electricity with Renewable Energy	turbines | co-generation	5
More Effective Management/Audits	energy consumption tracking | tire audits	10
Enables Other Measures Through Administrative and/or Policy Change	idle-free policy | watering restrictions | energy aware driver training	15
Voluntary initiative, Challenge, or Education	water conservation awareness |	7
Demolish/Dispose/Close Infrastructure	demolition | decommission | sale | replacement due to redundancy	1

A *Technical Compendium of Potential Reduction Initiatives* has been provided to staff that lists all the reduction initiatives that have been applied to each account in the energy inventory. Within this document, accounts are grouped in the same manner in which they appear in the detailed energy and emissions inventory, which is presented in Appendix A. Staff must refer to the technical compendium to review the specific reduction initiatives that have been applied to individual accounts.

Measures Completed and Measures Proposed

The suggested reduction target herein is based on initiatives completed between 2001 and 2006, all reduction initiatives proposed for implementation between 2007 and 2012, and all reduction initiatives proposed for implementation that will reduce growth in energy consumption as new infrastructure is constructed.

Technology

Technology plays an important role in the actual reductions achieved during the project period. The rate of introduction of new technologies that increase energy efficiency and the availability of alternative energy sources and new technologies for energy production are key to achieving significant reductions in the future.

4.1 Buildings Sector

4.1.1 Completed Initiatives

Savings of 7,520 GJ of energy and $90,514 in energy costs have been achieved in the building sector between 2001 and 2006. Energy savings during this period have resulted in emissions reductions totalling 272 tonnes CO_2e.

Lighting retrofits have been completed for the following buildings: RCMP building; Bowen Park Rec Complex; Public Works Yard; City Hall and Annex.

Mechanical retrofits have been completed for the following buildings: RCMP building; Bowen Park Rec Complex; City Hall Annex (includes DDC upgrade).

Table 4.2 lists the reductions achieved to date for lighting and mechanical retrofits in the buildings sector.

4.1.2 Proposed Initiatives Affecting Base Year Energy and Emissions

It is estimated that ~19,000 GJ of energy can be saved by implementing building retrofits. Energy savings would result in approximately ~$210,000, calculated at current day costs for energy consumption. The estimated energy reductions would result in a reduction of 930 tonnes CO_2e.

Table 4.1.1 provides a summary of proposed measures, summarized by measure category, for the buildings sector while Tables 4.1.2 to 4.1.14 provide a summary of proposed measures, also summarized by measure category, for each subsector.

Table 4.1.1 – Summary of Completed Reduction Initiatives for the Buildings Sector (2001-2006)

Buildings		Reductions		
		Consumption	Costs	CO_2e (t)
Bundled Retrofit				
Electricity		148,619 kWh	$9,196	9.4 t
Natural Gas		274 GJ	$3,019	14.0 t
Efficient Technology				
Natural Gas		2,679 GJ	$29,469	137.1 t
Enables Measures Through Administrative/Policy Change				
Electricity		785,040 kWh	$35,573	49.5 t
Natural Gas		1,205 GJ	$13,256	61.7 t
Subtotals	Electricity	933,659 kWh	$44,769	59 t
	Natural Gas	4,159 GJ	$45,744	213 t
Total this Sector:		**7,520 GJ**	**$90,514**	**272 t**

Table 4.1.2 – Summary of Proposed Reduction Initiatives for the Buildings Sector (2007-2012)

Buildings		Reductions		
		Consumption	Costs	CO_2e (t)
Bundled Retrofit				
Electricity		370,780 kWh	$19,017	23.4 t
Fuel Oil		588 L	$218	1.7 t
Natural Gas		94 GJ	$1,037	4.8 t
Efficient Technology				
Electricity		76,678 kWh	$3,620	4.8 t
Fuel Oil		10,929 L	$4,142	31.0 t
Natural Gas		3,022 GJ	$33,237	154.6 t
Fuel Switch				
Fuel Oil		10,286 L	$3,979	29.2 t
Offset with Renewable Energy				
Natural Gas		13,308 GJ	$146,391	680.9 t
Subtotals	Electricity	447,458 kWh	$22,637	28 t
	Natural Gas	16,424 GJ	$180,665	840 t
	Fuel Oil	21,803 L	$8,338	62 t
Total this Sector:		**18,878 GJ**	**$211,640**	**930 t**

Administration Offices

Administration offices in this sector include the City Hall and City Hall Annex. Although lighting has been completed in both buildings, there may be an opportunity to redesign existing lighting in overlit areas of both buildings. A heat recovery project for exhaust air may result in significant natural gas reductions.

Table 4.1.3 – Summary of Reduction Initiatives for Administration Offices

Administration Offices		Reductions		
		Consumption	Costs	CO_2e (t)
Bundled Retrofit				
Electricity		11,249 kWh	$788	0.7 t
Efficient Technology				
Electricity		7,030 kWh	$496	0.4 t
Fuel Oil		7,957 L	$2,975	22.6 t
Natural Gas		851 GJ	$9,356	43.5 t
Subtotals	Electricity	18,278 kWh	$1,284	1 t
	Natural Gas	851 GJ	$9,356	44 t
	Fuel Oil	7,957 L	$2,975	23 t
Total this Subsector:		**1,224 GJ**	**$13,615**	**67 t**

Aquatic Centres and Ice Arenas

This subsector includes both aquatic centres and ice arenas since the Beban Pool, Frank Crane Arena, and social centre share electrical and natural gas connections. Significant savings in this subsector include lighting retrofits, ground source heat pumps, and waste heat recovery from ice plants.

Table 4.1.4 – Summary of Reduction Initiatives for Aquatic Centres and Ice Arenas

Aquatic Centres & Ice Arenas		Reductions		
		Consumption	Costs	CO_2e (t)
Bundled Retrofit				
Electricity		45,045 kWh	$1,922	2.8 t
Efficient Technology				
Electricity		37,197 kWh	$1,587	2.3 t
Offset with Renewable Energy				
Natural Gas		13,308 GJ	$146,391	680.9 t
Subtotals	Electricity	82,242 kWh	$3,510	5 t
	Natural Gas	13,308 GJ	$146,391	681 t
Total this Subsector:		**13,604 GJ**	**$149,900**	**686 t**

Fire Services

This subsector includes all fire halls and the fire training centre. Fuel oil furnaces should be replaced with natural gas at the end of the life of the fuel oil appliance. This is shown as a reduction, whereas the costs for consumption of natural gas are included in the energy forecast in Section 3. Although there are no significant savings in this subsector, bundled retrofits for all fire services buildings combined will result in a significant overall reduction.

Table 4.1.5 – Summary of Reduction Initiatives for Fire Services

Fire Services		Reductions		
		Consumption	Costs	CO_2e (t)
Bundled Retrofit				
Electricity		26,293 kWh	$1,698	1.7 t
Efficient Technology				
Electricity		3,541 kWh	$227	0.2 t
Fuel Oil		2,327 L	$919	6.6 t
Natural Gas		171 GJ	$1,886	8.8 t
Fuel Switch				
Fuel Oil		6,980 L	$2,757	19.8 t
Subtotals	Electricity	29,834 kWh	$1,925	2 t
	Natural Gas	171 GJ	$1,886	9 t
	Fuel Oil	9,307 L	$3,676	26 t
Total this Subsector:		**639 GJ**	**$7,487**	**37 t**

Ice Arenas

This subsector includes the Cliff McNabb Arena (*note: Frank Crane Arena is included in Aquatic Centres and Ice Arenas*). Significant reductions include redesigning existing T8 lighting and retrofitting the remaining T12 lighting. Coin operated timers will reduce natural gas consumption for bleacher heaters.

Table 4.1.6 – Summary of Reduction Initiatives for Ice Arenas

Ice Arenas		Reductions		
		Consumption	Costs	CO_2e (t)
Bundled Retrofit				
Electricity		41,306 kWh	$1,871	2.6 t
Efficient Technology				
Electricity		10,932 kWh	$495	0.7 t
Natural Gas		1,862 GJ	$20,486	95.3 t
Subtotals	Electricity	52,238 kWh	$2,366	3 t
	Natural Gas	1,862 GJ	$20,486	95 t
Total this Subsector:		**2,050 GJ**	**$22,852**	**99 t**

Miscellaneous Buildings

This subsector includes all miscellaneous buildings such as the Centennial Building, the Plaza, the Community Services Building, etc. (see Appendix A). A number of electrical retrofits are possible in these buildings. Since walkthrough audits were not completed for any of the buildings in this subsector, the estimated reductions are likely underestimated.

Table 4.1.7 – Summary of Reduction Initiatives for Miscellaneous Buildings

MISC. BLDGS		Reductions		
		Consumption	Costs	CO_2e (t)
BUNDLED RETROFIT				
Electricity		10,825 kWh	$682	0.7 t
Subtotals	Electricity	10,825 kWh	$682	1 t
Total this Subsector:		**39 GJ**	**$682**	**1 t**

Outdoor Pools

This subsector includes the Bowen Kinsmen Park Pool.

Table 4.1.8 – Summary of Reduction Initiatives for Outdoor Pools

OUTDOOR POOLS		Reductions		
		Consumption	Costs	CO_2e (t)
BUNDLED RETROFIT				
Electricity		19,120 kWh	$1,256	1.2 t
EFFICIENT TECHNOLOGY				
Electricity		637 kWh	$42	0.0 t
Subtotals	Electricity	19,757 kWh	$1,298	1 t
Total this Subsector:		**71 GJ**	**$1,298**	**1 t**

Parks and Sportsfields

This subsector includes 16 parks and sportsfield facilities. Parks and sportsfields with overhead lighting only are included in the lighting sector. Since walkthrough audits were not completed for any of the buildings in this subsector, the estimated reductions are likely underestimated.

Table 4.1.9 – Summary of Reduction Initiatives for Parks and Sportsfields

PARKS & SPORTSFIELDS		Reductions		
		Consumption	Costs	CO_2e (t)
BUNDLED RETROFIT				
Electricity		41,632 kWh	$2,753	2.6 t
FUEL SWITCH				
Fuel Oil		119 L	$44	0.3 t
Subtotals	Electricity	41,632 kWh	$2,753	3 t
	Fuel Oil	119 L	$44	0 t
Total this Subsector:		**154 GJ**	**$2,798**	**3 t**

Police Services

This subsector includes the RCMP Building and RCMP Annex. Retrofits include redesign of existing lighting.

Table 4.1.10– Summary of Reduction Initiatives for Police Services

POLICE SERVICES		Reductions		
		Consumption	Costs	CO_2e (t)
BUNDLED RETROFIT				
Electricity		97,331 kWh	$4,385	6.1 t
Natural Gas		26 GJ	$282	1.3 t
EFFICIENT TECHNOLOGY				
Electricity		9,171 kWh	$403	0.6 t
Subtotals	Electricity	106,502 kWh	$4,788	7 t
	Natural Gas	26 GJ	$282	1 t
Total this Subsector:		**409 GJ**	**$5,070**	**8 t**

Public Works Buildings and Yards

This subsector includes all buildings in the Pubic Works Yard and Parks Maintenance Yard. Retrofits include redesign of existing lighting.

Table 4.1.11 – Summary of Reduction Initiatives for Public Works Buildings and Yards

PUBLIC WORKS BLDGS & YARDS		Reductions		
		Consumption	Costs	CO_2e (t)
BUNDLED RETROFIT				
Electricity		77,980 kWh	$3,661	4.9 t
Fuel Oil		588 L	$218	1.7 t
Natural Gas		69 GJ	$755	3.5 t
EFFICIENT TECHNOLOGY				
Electricity		8,172 kWh	$369	0.5 t
Fuel Oil		645 L	$248	1.8 t
Natural Gas		137 GJ	$1,510	7.0 t
FUEL SWITCH				
Fuel Oil		3,188 L	$1,177	9.0 t
Subtotals	Electricity	86,152 kWh	$4,030	5 t
	Natural Gas	206 GJ	$2,264	11 t
	Fuel Oil	4,421 L	$1,643	13 t
Total this Subsector:		**687 GJ**	**$7,938**	**28 t**

4.1.3 Proposed Initiatives Affecting Growth in Energy and Emissions

Several buildings projects in the city during the project period will significantly increase energy consumption and accompanying emissions. The projects identified by staff include new buildings and/or renovations as follows: Nanaimo Conference Centre and Museum; Twin Ice Rinks (open September 2006); Oliver Road Community Centre; Beban Multi-Purpose Hall; Bowen Park Community Centre; Beban Park Community Centre; and, Beban Aquatic Centre. It is estimated that these additions may increase emissions by 38 percent over the 2001 base year emissions quantity. LEED™ silver should reduce growth energy by 25 percent to 30 percent, depending upon whether or not the LEED™ project achieved a Silver status and included energy conservation.

4.2 Lighting Sector

4.2.1 Completed Initiatives

Savings of 1,512 GJ of energy and $24,956 in energy costs have been achieved in the lighting sector between 2001 and 2006 by converting incandescent traffic signal bulbs to LED technology. Energy savings during this period have resulted in emissions reductions totalling 26 tonnes CO_2e. Table 4.2.1 lists the reductions achieved to date in the lighting sector.

4.2.2 Proposed Initiatives Affecting Base Year Energy and Emissions

Although not yet available as a cost-effective measure, approximately 15,000 GJ of energy could be saved in the future by undertaking streetlighting retrofits. Energy savings would result in approximately $829,008, calculated at current day costs for energy consumption. The estimated energy reductions would result in a reduction of 284 tonnes CO_2e.

Table 4.2.2 provides a summary of proposed measures, summarized for all lighting categories, while Tables 4.2.3 and 4.2.4 provide summaries of proposed measures for the ornamental and overhead streetlight subsectors, respectively.

Table 4.2.1 – Summary of Completed Reduction Initiatives for the Lighting Sector (2001-2006)

LIGHTING		Reductions		
		Consumption	Costs	CO_2e (t)
EFFICIENT TECHNOLOGY				
Electricity		420,094 kWh	$24,956	26.5 t
Subtotals	Electricity	420,094 kWh	$24,956	26 t
Total this Sector:		**1,512 GJ**	**$24,956**	**26 t**

Table 4.2.2 – Summary of Proposed Reduction Initiatives for the Lighting Sector (2007-2012)

LIGHTING		Reductions		
		Consumption	Costs	CO_2e (t)
BUNDLED RETROFIT				
Electricity		34,160 kWh	$2,248	2.2 t
REDUCE CONSUMPTION				
Electricity		95,880 kWh	$6,272	6.0 t
EFFICIENT TECHNOLOGY				
Electricity		606,377 kWh	$102,676	38.2 t
Subtotals	Electricity	736,417 kWh	$111,196	46 t
Total this Sector:		**2,651 GJ**	**$111,196**	**46 t**

Ornamental Streetlighting

This subsector includes all streetlights not owned by BC Hydro (residential and commercial areas with underground wiring). Savings for ornamental lights are estimated at 759 GJ of energy, $14,000 for consumption, and 13 tonnes CO_2e (Table 4.2.3).

Table 4.2.3 – Summary of Reduction Initiatives for Ornamental Lighting

ORNAMENTAL LIGHTING		Reductions		
		Consumption	Costs	CO_2e (t)
EFFICIENT TECHNOLOGY				
Electricity		210,847 kWh	$14,338	13.3 t
Subtotals	Electricity	210,847 kWh	$14,338	13 t
Total this Subsector:		**759 GJ**	**$14,338**	**13 t**

Overhead Streetlighting

This subsector includes all streetlights owned by BC Hydro (streetlights on BC Hydro transmission line poles, although exceptions occur). Savings for overhead lights are estimated at ~1,300 GJ of energy, ~$86,000 for consumption, and 23 tonnes CO_2e.

Table 4.2.4 – Summary of Reduction Initiatives for Overhead Lighting

Overhead Lighting		Reductions		
		Consumption	Costs	CO_2e (t)
Reduce Consumption				
Electricity		95,880 kWh	$6,272	6.0 t
Efficient Technology				
Electricity		276,268 kWh	$80,118	17.4 t
Subtotals	Electricity	372,148 kWh	$86,390	23 t
Total this Subsector:		**1,340 GJ**	**$86,390**	**23 t**

4.2.3 Proposed Initiatives Affecting Growth in Energy and Emissions

The forecast for lighting in Section 3 is based on the trend in lighting accounts over a 10-year period (1994 to 2004), although growth in this sector will depend upon new residential, commercial, and industrial areas in the city. Growth in energy consumption in this subsector, as described in Section 3, is likely overestimated since new lighting technology is emerging rapidly.

4.3 Water and Wastewater Sector

4.3.1 Completed Initiatives

Reductions in the water and wastewater sector are difficult to track since data and indicators in this sector were not kept to confirm the results of reduction measures completed. We estimated that approximately 2,075 GJ of energy and $38,717 in energy costs have been achieved in the water and wastewater sector between 2001 and 2006 by implementing water audits and metres. Energy savings during this period have resulted in emissions reductions of approximately 36 tonnes CO_2e. Table 4.3.1 lists the reductions achieved to date in the water and wastewater sector.

4.3.2 Proposed Initiatives Affecting Base Year Energy and Emissions

Approximately 616 GJ of energy can be saved by undertaking water and wastewater measures in the future. Energy savings would result in approximately $10,713, calculated at current day costs for energy consumption. The estimated energy reductions would result in a reduction of 11 tonnes CO_2e.

Table 4.3.2 provides a summary of the effects of proposed measures, and Tables 4.3.3 and 4.3.4 provide a summary of proposed measures for the liquid waste and potable water subsectors, respectively.

Table 4.3.1 – Summary of Completed Reduction Initiatives for the Water and Wastewater Sector (2001-2006)

Water & Wastewater		Reductions		
		Consumption	Costs	CO_2e (t)
Efficient Technology				
Electricity		5,319 kWh	$585	0.3 t
Effective Management/Audits				
Electricity		191,651 kWh	$12,689	12.1 t
Enables Measures Through Administrative/Policy Change				
Electricity		366,632 kWh	$24,598	23.1 t
Voluntary initiative, Challenge, or Through Education				
Electricity		12,777 kWh	$846	0.8 t
Subtotals	Electricity	576,379 kWh	$38,717	36 t
Total this Sector:		**2,075 GJ**	**$38,717**	**36 t**

Table 4.3.2 – Summary of Proposed Reduction Initiatives for the Water and Wastewater Sector (2007-2012)

Water & Wastewater		Reductions		
		Consumption	Costs	CO_2e (t)
Bundled Retrofit				
Electricity		99,895 kWh	$6,226	6.3 t
Reduce Consumption				
Electricity		8,603 kWh	$586	0.5 t
Efficient Technology				
Electricity		62,609 kWh	$3,901	3.9 t
Subtotals	Electricity	171,106 kWh	$10,713	11 t
Total this Sector:		**616 GJ**	**$10,713**	**11 t**

Liquid Waste Pump Stations

This subsector includes all liquid waste pump stations. Savings are estimated at 255 GJ of energy, $3,901 for consumption, and 4 tonnes CO_2e.

Table 4.3.3 – Summary of Reduction Initiatives for Liquid Waste Pump Stations

LIQUID WASTE PS		Reductions		
		Consumption	Costs	CO_2e (t)
EFFICIENT TECHNOLOGY				
Electricity		62,609 kWh	$3,901	3.9 t
Subtotals	Electricity	62,609 kWh	$3,901	4 t
Total this Subsector:		**225 GJ**	**$3,901**	**4 t**

Potable Water Pump Stations

This subsector includes all potable water pump stations. Savings are estimated at 391 GJ of energy, $6,812 for consumption, and 7 tonnes CO_2e.

Table 4.3.4 – Summary of Reduction Initiatives for Potable Water Pumpstations

POTABLE WATER PS		Reductions		
		Consumption	Costs	CO_2e (t)
BUNDLED RETROFIT				
Electricity		99,895 kWh	$6,226	6.3 t
REDUCE CONSUMPTION				
Electricity		8,603 kWh	$586	0.5 t
Subtotals	Electricity	108,498 kWh	$6,812	7 t
Total this Subsector:		**391 GJ**	**$6,812**	**7 t**

4.4 Vehicle Fleet Sector

4.4.1 Completed Initiatives

Reduction measures in the vehicle fleet sector are difficult to track from the limited data available for the base year 2001. Although significant fuel savings are assumed to have occurred by replacing older gasoline trucks with diesel fuel trucks, fuel consumed and vehicle kilometers traveled for individual fleet vehicles were not tracked by the city until 2003.

We calculated the reductions resulting from the replacement of three passenger vehicles and one van with four gasoline-electric hybrid vehicles. The reduction in gasoline consumption from this measure is estimated to be 110 GJ of energy and $1,532 in gasoline costs per year. Savings during this period have resulted in emissions reductions totalling 7 tonnes CO_2e. Table 4.4.1 lists the total reductions achieved to date in the vehicle fleet sector, but does not include any savings that have occurred by replacing gasoline trucks with diesel fuel trucks.

Table 4.4.1 – Summary of Completed Reduction Initiatives for the Vehicle Fleet Sector (2001-2006)

Vehicle Fleet		Reductions		
		Consumption	Costs	CO_2e (t)
Enables Measures Through Administrative/Policy Change				
Diesel		7,509 L	$5,237	20.9 t
Gasoline		4,515 L	$3,593	11.3 t
Subtotals	Diesel Fuel	7,509 L	$5,237	21 t
	Gasoline	4,515 L	$3,593	11 t
Total this Sector:		**465 GJ**	**$8,830**	**32 t**

4.4.2 Proposed Initiatives Affecting Base Year Energy and Emissions

The most significant reductions proposed in the vehicle fleet sector are through idle-free campaigns, energy aware driver training, and switching at least 90 percent of the total diesel fuel consumed to biodiesel by 2012. Other reductions are possible, such as switching to ethanol-blended gasoline, although we have not included ethanol blends as an option since the availability of a high-blend ethanol gasoline is questionable in the Nanaimo region in the near future. This does not preclude staff from investigating widescale use of ethanol-blended gasoline in the community.

Approximately 7,006 GJ of energy could be saved in the vehicle fleet sector, which would result in an approximate cost savings of $93,239, calculated at current day costs for gasoline and diesel fuel. The estimated energy reductions would result in an emissions reduction of 527 tonnes CO_2e.

Table 4.4.2 provides a summary of proposed measures, summarized for both gasoline and diesel fuel vehicles.

Table 4.4.2 – Summary of Proposed Reduction Initiatives for the Vehicle Fleet Sector (2007-2012)

Vehicle Fleet		Reductions		
		Consumption	Costs	CO_2e (t)
Reduce Activity				
Gasoline		11,289 L	$8,982	28.3 t
Efficient Technology				
Diesel		53,495 L	$38,155	148.8 t
Gasoline		10,234 L	$8,125	25.6 t
Fuel Switch				
Diesel		168,959 L	$117,829	470.0 t
Effective Management/Audits				
Diesel		1,877 L	$1,309	5.2 t
Gasoline		2,258 L	$1,796	5.7 t
Enables Measures Through Administrative/Policy Change				
Diesel		16,896 L	$11,783	47.0 t
Gasoline		31,345 L	$21,978	78.5 t
Voluntary initiative, Challenge, or Through Education				
Gasoline		4,515 L	$3,593	11.3 t
Subtotals	Diesel Fuel	241,227 L	$169,077	671 t
	Gasoline	59,641 L	$44,474	149 t
Total this Sector:		**11,638 GJ**	**$213,551**	**820 t**

4.5 Reduction Initiatives for the Corporate Solid Waste Sector

There are two significant reduction measures that city staff can implement to reduce corporate solid waste in the city's buildings as follows:

1. Expand recycling and composting facilities for staff and the public in city-owned buildings; and
2. Conversion to a paperless system (as much as possible and practical).

By reducing the amount of solid waste produced and landfilled, the city could reduce its corporate emissions in this sector by approximately 99 tonnes CO_2e.

4.6 Summary of Corporate Emission Reductions

There are many opportunities for new GHG reductions within the city's operations. By implementing these initiatives, the city could reduce emissions by 13 percent. Table 4.10.1 provides a summary of the potential reductions in each corporate sector.

Table 4.6.1 – Summary of Estimated Impact of Reduction Measures on Corporate Sectors

Sector	2001 Base Year Emissions (tonnes CO_2e)	2012 GHG Projection (tonnes CO_2e)	Reduction of GHG Emissions Completed (2001-2006)	Potential Reduction of GHG Emissions After Projected Growth (2012)	GHG Emissions After Measures (2012)	Percent Reduction of Projected Emissions (2012)
Buildings	2,754	3,800	272	930	2,598	-6%
Lighting[1]	327	360	26	46	288	-12%
Water and Wastewater[2]	81	91	36	11	44	-45%
Vehicle Fleet[3]	1,557	1,680	32	527	1,121	-28%
Corporate Waste	330	429	0	99	330	0%
Total	**5,048**	**6,360**	**366**	**1,613**	**4,381**	**-13%**

[1]LEDs for ornamental and overhead lighting are currently too expensive to be cost effective, although this may change in the near future and should be monitored by staff.

[2]An estimate is provided in the water and wastewater sector, since the volume of potable water and wastewater was not available, and must be used as an indicator for specific measures.

[3]The reductions for the vehicle fleet are aggressive and assume biodiesel will replace conventional diesel fuel by 2012.

It is important to remember that the 13 percent reduction calculated above represents the potential reductions achievable over the project period (2007-2012) relative to the projected emissions in 2012, which includes the growth of emissions during the project period.

4.7 Corporate Sector Target Statement

The following corporate target statement is suggested:

> ***An emission reduction target of 1,613 tonnes CO_2e, an amount that will reduce emissions by 13 percent below 2001 levels by 2012, is recommended for adoption as the city's corporate operations objective.***

5 Costs and Implementation of Reduction Measures

The reductions in Section 4 are the result of calculations that are based on walkthrough audits, which were undertaken for all major buildings. If a walkthrough audit was not undertaken, we applied measures to infrastructure based on staff's knowledge of the infrastructure in question.

Approximations of reductions have been used to calculate simple payback periods of three, five, and seven years. Although the actual reductions will depend upon a number of factors, it is likely that measures will be selected based on a combination of life-cycle costs (including maintenance costs) and the actual costs to implement, including real staff costs to administer projects. In the absence of detailed audits, these costs are difficult to estimate, although we have carefully considered a typical magnitude of cost for consideration.

Building retrofits and renewable energy projects must be grouped together for study/implementation. This is important when considering how projects are chosen for implementation. Local governments commonly use a simple payback method (e.g., project costs/energy savings) to evaluate whether or not a project or group of projects will be implemented.

Generally, projects with short payback periods (e.g., < five years) are favoured over projects with longer payback periods (e.g., > five years) since it is assumed that shorter paybacks are not as risky. An example is the difference between the payback periods of a typical lighting retrofit that could be paid off within three years versus implementation of a solar wall, which may take as long as 15-20 years.

By choosing projects with *short* payback periods, projects with longer payback periods will usually not be implemented. By blending the projects together, a longer payback period results, where all feasible projects are implemented, which results in long–term savings that are far greater than if only short–term payback projects were implemented (the life of the building is always considered in the evaluation). Although the example is simplistic as it does not consider all financial metrics such as return on investment, internal rate of return, life cycle costs, etc., decisions whether or not to implement projects should not be based solely on the payback period.

The tables that follow provide summaries of payback periods for staff to consider as an estimate of the revenue that may be available to projects. Full audits of buildings and infrastructure would result in refined datasets. Tables are provided for each sector, whereas tables for subcategories are only provided for major reduction initiatives. We have not provided tables for other subcategories since full audits must be undertaken in order to refine the estimated reductions.

Tables are not provided for fleet vehicles and solid waste as there is no payback on measures in these two sectors.

5.1 Simple Payback Periods of Proposed Initiatives in the Buildings Sector

Of the ~19,000 GJ of energy that could be saved by implementing building retrofits and the accompanying ~$210,000 in costs for consumption savings, approximately $530,000 to $1.5 million would be available in project costs with a three-year or seven-year simple payback period, respectively.

Table 5.1.1 provides a summary of the categorized measures for each fuel type along with the estimates for a simple payback period for the buildings sector. Tables 5.1.2 to 5.1.6 provide simple payback periods for administration offices, aquatic centres and ice arenas, police services, and public works buildings and yards. The *Technical Compendium of Potential Reduction Initiatives* provides costs for prefeasibility, feasibility, full audits, and a range of capital costs, where appropriate.

Table 5.1.1 – Summary of Simple Payback Periods for Reduction Initiatives in the Buildings Sector (2001-2006)

Buildings		Reductions			Simple Payback Period		
		Consumption	Costs	CO_2e (t)	Three Years	Five Years	Seven Years
Bundled Retrofit							
Electricity		370,780 kWh	$19,017	23.4 t	*$57,052*	*$95,086*	*$133,121*
Fuel Oil		588 L	$218	1.7 t	*$654*	*$1,091*	*$1,527*
Natural Gas		94 GJ	$1,037	4.8 t	*$3,111*	*$5,186*	*$7,260*
Efficient Technology							
Electricity		76,678 kWh	$3,620	4.8 t	*$10,860*	*$18,100*	*$25,339*
Fuel Oil		10,929 L	$4,142	31.0 t	*$12,425*	*$20,708*	*$28,991*
Natural Gas		3,022 GJ	$33,237	154.6 t	*$99,711*	*$166,185*	*$232,659*
Fuel Switch							
Fuel Oil		10,286 L	$3,979	29.2 t	*$11,936*	*$19,893*	*$27,850*
Offset with Renewable Energy							
Natural Gas		13,308 GJ	$146,391	680.9 t	*$439,172*	*$731,953*	*$1,024,734*
Subtotals	Electricity	447,458 kWh	$22,637	28 t	*$67,911*	*$113,186*	*$158,460*
	Natural Gas	16,424 GJ	$180,665	840 t	*$541,994*	*$903,323*	*$1,264,652*
	Fuel Oil	21,803 L	$8,338	62 t	*$25,015*	*$41,691*	*$58,368*
Total this Sector:		**18,878 GJ**	**$211,640**	**930 t**			

Administration Offices

The City Hall and City Hall Annex have both undergone lighting retrofits but the City Hall building could benefit from a redesign of lighting in overlit areas. The City Hall building could reduce natural gas consumption with heat recovery on exhaust air. The payback for a fuel switch from the existing fuel oil furnace at City Hall to a natural gas furnace does not include the cost of a new natural gas furnace or the costs for consumption of the new natural gas furnace. Table 5.1.2 summarizes the reductions and simple payback for grouped projects.

Table 5.1.2 – Summary of Simple Payback Periods for Administration Offices

Administration Offices		Reductions			Simple Payback		
		Consumption	Costs	CO_2e (t)	Three Year	Five Years	Seven Years
Bundled Retrofit							
Electricity		11,249 kWh	$788	0.7 t	*$2,365*	*$3,942*	*$5,519*
Efficient Technology							
Electricity		7,030 kWh	$496	0.4 t	*$1,487*	*$2,479*	*$3,471*
Fuel Oil		7,957 L	$2,975	22.6 t	*$8,925*	*$14,874*	*$20,824*
Natural Gas		851 GJ	$9,356	43.5 t	*$28,067*	*$46,778*	*$65,489*
Subtotals	Electricity	18,278 kWh	$1,284	1 t	*$3,853*	*$6,421*	*$8,989*
	Natural Gas	851 GJ	$9,356	44 t	*$28,067*	*$46,778*	*$65,489*
	Fuel Oil	7,957 L	$2,975	23 t	*$8,925*	*$14,874*	*$20,824*
Total this Subsector:		**1,224 GJ**	**$13,615**	**67 t**			

Aquatic Centres and Ice Arenas

Since the Beban Pool, Frank Crane Arena, and social complex share the same natural gas metre and we did not undertake a full audit of the complex, we were not able to estimate the disaggregation for electricity and natural gas consumption for these buildings. The highest priority initiative for this complex is to explore geothermal heating for pool process water to offset natural gas consumption. Vending misers on approximately 20 vending machines in this complex would save a considerable amount of electricity. A lighting retrofit should be undertaken on a small number (~40) of T12 lighting fixtures in the social complex. Table 5.1.3 summarizes the reductions and simple payback for grouped projects.

Table 5.1.3 – Summary of Simple Payback Periods for Aquatic Centres and Ice Arenas

Aquatic Centres & Ice Arenas		Reductions			Simple Payback		
		Consumption	Costs	CO_2e (t)	Three Year	Five Years	Seven Years
Bundled Retrofit							
Electricity		45,045 kWh	$1,922	2.8 t	*$5,767*	*$9,611*	*$13,456*
Efficient Technology							
Electricity		37,197 kWh	$1,587	2.3 t	*$4,762*	*$7,937*	*$11,111*
Offset with Renewable Energy							
Natural Gas		13,308 GJ	$146,391	680.9 t	*$439,172*	*$731,953*	*$1,024,734*
Subtotals	Electricity	82,242 kWh	$3,510	5 t	*$10,529*	*$17,548*	*$24,567*
	Natural Gas	13,308 GJ	$146,391	681 t	*$439,172*	*$731,953*	*$1,024,734*
Total this Subsector:		**13,604 GJ**	**$149,900**	**686 t**			

Ice Arenas

Although the Cliff McNabb Arena is part of the Beban Park complex, it is serviced by its own electrical and natural gas connections. Since Twin Rinks opened in 2006, it is not part of the 2001 inventory and is counted in the forecast of emissions. Although this arena is new, it does not employ heat exchange on the ice plants. Heat exchange on all ice plants should be explored at all arenas. Any studies at the Frank Crane Arena must be considered with all potential energy conservation measures of the Beban Park complex in mind (e.g., Beban Pool, Frank Crane Arena, and the social centre). Table 5.1.4 summarizes the reductions and simple payback for grouped projects.

Table 5.1.4 – Summary of Simple Payback Periods for Ice Arenas

Ice Arenas		Reductions			Simple Payback		
		Consumption	Costs	CO_2e (t)	Three Year	Five Years	Seven Years
Bundled Retrofit							
Electricity		41,306 kWh	$1,871	2.6 t	*$5,613*	*$9,354*	*$13,096*
Efficient Technology							
Electricity		10,932 kWh	$495	0.7 t	*$1,485*	*$2,476*	*$3,466*
Natural Gas		1,862 GJ	$20,486	95.3 t	*$61,459*	*$102,432*	*$143,405*
Subtotals	Electricity	52,238 kWh	$2,366	3 t	*$7,098*	*$11,830*	*$16,562*
	Natural Gas	1,862 GJ	$20,486	95 t	*$61,459*	*$102,432*	*$143,405*
Total this Subsector:		**2,050 GJ**	**$22,852**	**99 t**			

Police Services

There is an opportunity to redesign existing T8 lighting at the RCMP Building and the RCMP Annex. Four heat pumps were recently installed at the RCMP building increasing the efficiency of space heating by approximately 12 percent. Table 5.1.5 summarizes the reductions and simple payback for grouped projects.

Table 5.1.5 – Summary of Simple Payback Periods for Police Services

Police Services		Reductions			Simple Payback		
		Consumption	Costs	CO_2e (t)	Three Year	Five Years	Seven Years
Bundled Retrofit							
Electricity		97,331 kWh	$4,385	6.1 t	*$13,154*	*$21,924*	*$30,693*
Natural Gas		26 GJ	$282	1.3 t	*$847*	*$1,412*	*$1,977*
Efficient Technology							
Electricity		9,171 kWh	$403	0.6 t	*$1,210*	*$2,017*	*$2,824*
Subtotals	Electricity	106,502 kWh	$4,788	7 t	*$14,364*	*$23,941*	*$33,517*
	Natural Gas	26 GJ	$282	1 t	*$847*	*$1,412*	*$1,977*
Total this Subsector:		**409 GJ**	**$5,070**	**8 t**			

Public Works Buildings and Yards

There are several buildings in this complex, the age of which make it difficult to assess the practicality of energy efficiency measures. All lighting retrofits are complete in these buildings, although a redesign of existing T8 lighting is possible. A small savings of fuel oil and natural gas is possible by installing interlocking bay doors. Table 5.1.6 summarizes the reductions and simple payback for grouped projects.

Table 5.1.6 – Summary of Simple Payback Periods for Public Works Buildings and Yards

Public Works Bldgs & Yards		Reductions			Simple Payback		
		Consumption	Costs	CO_2e (t)	Three Year	Five Years	Seven Years
Bundled Retrofit							
Electricity		77,980 kWh	$3,661	4.9 t	*$10,983*	*$18,305*	*$25,627*
Fuel Oil		588 L	$218	1.7 t	*$654*	*$1,091*	*$1,527*
Natural Gas		69 GJ	$755	3.5 t	*$2,264*	*$3,774*	*$5,283*
Efficient Technology							
Electricity		8,172 kWh	$369	0.5 t	*$1,108*	*$1,847*	*$2,585*
Fuel Oil		645 L	$248	1.8 t	*$743*	*$1,239*	*$1,734*
Natural Gas		137 GJ	$1,510	7.0 t	*$4,529*	*$7,548*	*$10,567*
Fuel Switch							
Fuel Oil		3,188 L	$1,177	9.0 t	*$3,532*	*$5,887*	*$8,242*
Subtotals	Electricity	86,152 kWh	$4,030	5 t	*$12,091*	*$20,152*	*$28,212*
	Natural Gas	206 GJ	$2,264	11 t	*$6,793*	*$11,321*	*$15,850*
	Fuel Oil	4,421 L	$1,643	13 t	*$4,930*	*$8,216*	*$11,503*
Total this Subsector:		**687 GJ**	**$7,938**	**28 t**			

5.2 Simple Payback Periods of Proposed Initiatives in the Lighting Sector

Of the ~2,600 GJ of energy that could be saved by implementing building retrofits and the accompanying ~$14,000 in costs for consumption savings, approximately $330,000 to $780,000 would be available in project costs with a three-year or seven-year simple payback period, respectively.

Table 5.2.1 provides a summary of the categorized measures for each fuel type along with the estimates for the simple payback period for the lighting sector. Tables 5.2.2 and 5.2.3 provide the simple payback period for ornamental and overhead lighting. The *Technical Compendium of Potential Reduction Initiatives* provides estimates of costs where appropriate. For lighting retrofits, a complete inventory of all lights must be undertaken to estimate costs for implementation.

Traffic signals have been converted to LED technology and the majority of incandescent pedestrian flashers have also been converted to LED.

Significant reductions are possible once LED technology for ornamental and overhead lighting is affordable. Participation in BC Hydro's Street Light Information Management (SLIM) program. Although this is a street light management program, it is assumed that new technology will be introduced to municipalities through this program. City staff should keep apprised of the introduction of new technology.

Table 5.2.1 – Summary of Simple Payback Periods for Reduction Initiatives in the Lighting Sector

Lighting		Reductions			Simple Payback Period		
		Consumption	Costs	CO_2e (t)	Three Years	Five Years	Seven Years
Bundled Retrofit							
Electricity		34,160 kWh	$2,248	2.2 t	*$6,744*	*$11,240*	*$15,736*
Reduce Consumption							
Electricity		95,880 kWh	$6,272	6.0 t	*$18,817*	*$31,362*	*$43,906*
Efficient Technology							
Electricity		606,377 kWh	$102,676	38.2 t	*$308,027*	*$513,378*	*$718,729*
Subtotals	Electricity	736,417 kWh	$111,196	46 t	*$333,588*	*$555,980*	*$778,372*
Total this Sector:		**2,651 GJ**	**$111,196**	**46 t**			

Ornamental and Overhead Lighting

As LED technology for ornamental lighting becomes affordable, significant reductions are possible. Table 5.2.2 and Table 5.2.3 summarize the reductions and simple payback for grouped projects for ornamental and overhead lighting, respectively.

Table 5.2.2 – Summary of Simple Payback Periods for Ornamental Lighting

Ornamental Lighting		Reductions			Simple Payback		
		Consumption	Costs	CO_2e (t)	Three Year	Five Years	Seven Years
Efficient Technology							
Electricity		210,847 kWh	$14,338	13.3 t	*$43,013*	*$71,688*	*$100,363*
Subtotals	Electricity	210,847 kWh	$14,338	13 t	*$43,013*	*$71,688*	*$100,363*
Total this Subsector:		**759 GJ**	**$14,338**	**13 t**			

Table 5.2.3 – Summary of Simple Payback Periods for Overhead Lighting

Overhead Lighting		Reductions			Simple Payback		
		Consumption	Costs	CO_2e (t)	Three Year	Five Years	Seven Years
Reduce Consumption							
Electricity		95,880 kWh	$6,272	6.0 t	*$18,817*	*$31,362*	*$43,906*
Efficient Technology							
Electricity		276,268 kWh	$80,118	17.4 t	*$240,353*	*$400,588*	*$560,824*
Subtotals	Electricity	372,148 kWh	$86,390	23 t	*$259,170*	*$431,950*	*$604,730*
Total this Subsector:		**1,340 GJ**	**$86,390**	**23 t**			

5.3 Simple Payback Periods of Proposed Initiatives in the Water and Wastewater Sector

Of the ~6000 GJ of energy that could be saved by implementing water and wastewater retrofits and the accompanying ~$11,000 in costs for consumption savings, approximately $30,000 to $75,000 would be available in project costs with a three-year or seven-year simple payback period, respectively. Since the payback period for the two major initiatives in this sector (optimize and/or replace liquid waste pumps and the addition of soft start pumps at Rod Glen Potable Water Pump Station and No. 1 Reservoir) extends beyond a seven-year payback, tables for subsectors have not been provided for this sector.

The city has a well developed water and wastewater program and has a water conservation program with a lawn watering restriction in place. A public education program is undertaken in summer months to provide education to residents not adhering to the lawn watering restrictions. Commercial water metres are installed and voluntary metering has been approved with all new homes requiring water metres. Staff wish to investigate the use of water metres on corporate facilities to account for water use and eliminate any water loss.

A water turbine project is possible on the gravity feed water mains supplying the majority of potable water to the city. The electricity from such turbines could generate more than 5 MW of electricity and could be used to power new city buildings or smaller aggregates of community buildings. As this project is conceptual, it has not been included in the energy forecasts.

Table 5.3.1 provides a summary of the categorized measures for electricity along with the estimates for simple payback periods for the water and wastewater sector.

Table 5.3.1 – Summary of Simple Payback Periods for Reduction Initiatives in the Water and Wastewater Sector

Water & Wastewater		Reductions			Simple Payback Period		
		Consumption	Costs	CO_2e (t)	Three Years	Five Years	Seven Years
Bundled Retrofit							
Electricity		99,895 kWh	$6,226	6.3 t	*$18,678*	*$31,129*	*$43,581*
Reduce Consumption							
Electricity		8,603 kWh	$586	0.5 t	*$1,758*	*$2,929*	*$4,101*
Efficient Technology							
Electricity		62,609 kWh	$3,901	3.9 t	*$11,703*	*$19,504*	*$27,306*
Subtotals	Electricity	171,106 kWh	$10,713	11 t	*$32,138*	*$53,563*	*$74,988*
Total this Sector:		**616 GJ**	**$10,713**	**11 t**			

Liquid Waste and Potable Water Pump Stations

Liquid waste and potable water pumps are replaced on an as-needed basis. Staff are encouraged to create an inventory of existing motors and pumps, including their age, and replace older motors with high efficiency motors. Staff should pursue optimization of liquid waste motors as well as investigation of the installation of soft start motors. Soft start motors would need to be tested at Rod Glen and Reservoir No. 1.

5.4 Costs for Proposed Initiatives in the Vehicle Fleet Sector

Estimates of savings for the vehicle fleet are ~57,000 litres of diesel fuel and ~137,974 litres of gasoline. There is no payback associated with vehicle fleet measures and, therefore, simple paybacks are not shown for the vehicle sector as measures will be introduced as vehicles are replaced and as alternative fuels are readily available.

The majority of these initiatives are dependent upon changes in existing technology and the availability of alternate fuels. For example, since electric-diesel hybrid engines will be available for light trucks (Toyota) and heavy duty (Volvo) diesel trucks by 2008-2009, reductions for current diesel fuel use are deferred to the future. As well, the fleet manager would like to fully implement biodiesel fuel for the fleet as soon as it is readily available from local suppliers and does not require an added delivery surcharge. As the experience with the electric-gasoline hybrids has been successful, the fleet manager would like to replace all cavaliers with electric-gasoline hybrids as the cavaliers are scheduled to be taken out of service. The fleet manager will report the costs associated with this measure as required.

An idle-free campaign is recommended, although this measure would be implemented by city administration as a global measure for all staff. The costs to implement this measure would be dependent upon the estimated staff time to design and implement such a campaign (a reasonable estimate is ~0.10 full-time equivalents for a 4-month period).

5.5 Costs for Proposed Initiatives in the Corporate Waste Sector

To estimate costs for measures in the corporate waste sector, a count of the number of recycling receptacles required would need to be undertaken. This could be easily estimated by the number of staff that are stationed at desks for the workday and the number of workstations that are shared by several staff members. Further, an inventory at public facilities and the availability of recycling receptacles available, if any, should be conducted and costs calculated to install appropriate receptacles.

6 Conclusions & Recommendations

The City of Nanaimo has calculated its corporate energy consumption, costs for consumption, and emissions for the base year 2001 as shown below.

Forecasted Parameter	Base Year (2001)	Forecast Year (2012)	Percent Change
Energy Consumption	126,353 GJ	164,629 GJ	30%
Energy Costs	$2,242,434	$5,347,751	139%
Emissions	5,048 tonnes CO_2e	6,360 tonnes CO_2e	26%

The City of Nanaimo can reduce its 2001 base year emissions quantity of 5,048 tonnes CO_2e by 1,613 tonnes, or 13 percent, by 2012. Interviews with city staff confirm that the reduction quantity is achievable and should be explored further within reasonable program resources and a commitment from Council and management to undertake the programs proposed herein.

Sector	2001 Base Year Emissions (tonnes CO_2e)	2012 GHG Projection (tonnes CO_2e)	Reduction of GHG Emissions Completed (2001-2006)	Potential Reduction of GHG Emissions After Projected Growth (2012)	GHG Emissions After Measures (2012)	Percent Reduction of Projected Emissions (2012)
Buildings	2,754	3,800	272	930	2,598	-6%
Lighting[1]	327	360	26	46	288	-12%
Water and Wastewater[2]	81	91	36	11	44	-45%
Vehicle Fleet[3]	1,557	1,680	32	527	1,121	-28%
Corporate Waste	330	429	0	99	330	0%
Total	**5,048**	**6,360**	**366**	**1,613**	**4,381**	**-13%**

[1]LEDs for ornamental and overhead lighting are currently too expensive to be cost effective, although this may change in the near future and should be monitored by staff.

[2]An estimate is provided in the water and wastewater sector, since the volume of potable water and wastewater was not available, and must be used as an indicator for specific measures.

[3]The reductions for the vehicle fleet are aggressive and assume biodiesel will replace conventional diesel fuel by 2012.

In order to achieve this target, it is recommended that Council approve the emissions reduction quantity for the city's operations as follows:

An emission reduction target of 1,613 tonnes CO_2e, an amount that will reduce emissions by 13 percent below 2001 levels by 2012, is recommended for adoption as the city's corporate operations objective.

References

FCM (2006), Developing Greenhouse Gas Emissions and Energy Consumption Inventories: A Standards and Guidance Document for Canadian Municipalities. Federation of Canadian Municipalities: Ottawa. 59pp.

ISO (2006), Draft International Standard ISO/TC 207 WG5 N162. Greenhouse gases - Part 1: Specification With Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals. 28pp.

IPCC (2006), IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

Glossary of Terms (IPCC 2006)

Carbon dioxide (CO_2): A naturally occurring gas; also a by-product of burning fossil fuels and biomass, as well as land use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1.

Climate change: A statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or persistent anthropogenic changes in the composition of the atmosphere or in land use.

Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines "climate change" as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." The UNFCCC thus makes a distinction between "climate change" attributable to human activities altering the atmospheric composition and "climate variability" attributable to natural causes.

Emissions factor: The estimated average emission rate of a given greenhouse gas for a given source.

Equivalent CO_2 (CO_2e): The concentration of CO_2 that would cause the same amount of radiative forcing as a given mixture of CO_2 and other greenhouse gases.

GJ (GigaJoules): A Canadian unit of heating value equivalent to 943,213.3 Btu. The standard gas unit in Canada is the gigajoule, pursuant to GISB under Order 587-A (1997). The Gigajoule is the standard unit of natural gas heating measurement in Canada. A gigajoule (GJ) is a metric term used for measuring energy use. For example, 1 GJ is equal to 277.8 kWh of electricity, 26.9 m^3 of natural gas, 25.9 litres of heating oil. Similar to the energy released when burning a million wooden matches, a gigajoule of gas will cook over 2500 hamburgers, and a gigajoule of electricity will keep a 60-watt bulb continuously lit for six months.

Greenhouse gas: Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. This property of greenhouse gases causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Besides CO_2, N_2O, and CH_4, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC): The Kyoto Protocol was adopted at the Third Session of the Conference of the Parties (COP) to the UNFCCC in 1997 in Kyoto, Japan. It contains legally binding commitments in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (most Organisation for Economic Co-operation and Development countries and countries with economies in transition) agreed to reduce their anthropogenic greenhouse gas emissions (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6) by at least 5 percent below 1990 levels in the commitment period 2008 to 2012. The Kyoto Protocol entered into force on February 16, 2005.

Methane (CH_4): An odorless, colorless, flammable gas, CH_4 is the major constituent of natural gas that is used as a fuel and is an important source of hydrogen and a wide variety of organic compounds.

Nitrous Oxide (N_2O): A powerful greenhouse gas with a global warming potential most recently evaluated at 310. Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

United Nations Framework Convention on Climate Change (UNFCC): The Convention was adopted on May 9, 1992, in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." It contains commitments for all parties. Under the Convention, parties included in Annex I aimed to return greenhouse gas emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The convention entered into force in March 1994. See: Kyoto Protocol.

Appendix A - Detailed Summary of Emissions Inventory

City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

Account & Address	Account Consumption & Costs by Type					Account Subtotal		
	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
2001								
BUILDINGS								
Administration Offices								
CITY HALL ANNEX 238 FRANKLYN ST	Electricity	451,231 kWh	1,624 GJ	$30,242	28 t	**2,758 GJ**	**$42,716**	**86.4 t**
	Natural Gas	1,134 GJ	1,134 GJ	$12,474	58 t			
	Includes 5 separate connections/accounts: 94714000908; 94714000924; 94714000943; 94714000953; 94714000971. Smaller accounts may be outdoor lighting. To be confirmed by City staff.							
CITY HALL 455 WALLACE ST	Electricity	229,788 kWh	827 GJ	$14,337	14 t	**1,238 GJ**	**$18,303**	**44.5 t**
	Fuel Oil	10,609 litres	410 GJ	$3,967	30 t			
Administration Offices Subtotal	Electricity	681,019 kWh	2,452 GJ	$44,579	43 t	**3,996 GJ**	**$61,019**	**131 t**
	Natural Gas	1,134 GJ	1,134 GJ	$12,474	58 t			
	Fuel Oil	10,609 litres	410 GJ	$3,967	30 t			
Aquatic Centres & Ice Arenas								
BEBAN POOL/FRANK CRANE ARENA/SOCIAL CENTRE 2300 BOWEN RD	Electricity	3,603,600 kWh	12,973 GJ	$153,779	227 t	**32,689 GJ**	**$370,654**	**1,235.7 t**
	Natural Gas	19,716 GJ	19,716 GJ	$216,875	1,009 t			
BEBAN POOL/ARENA/SOCIAL CENTRE 2300 BOWEN RD	Natural Gas	351 GJ	351 GJ	$3,865	18 t	**351 GJ**	**$3,865**	**18.0 t**
Aquatic Centres & Ice Arenas Subtotal	Electricity	3,603,600 kWh	12,973 GJ	$153,779	227 t	**33,040 GJ**	**$374,519**	**1,254 t**
	Natural Gas	20,067 GJ	20,067 GJ	$220,740	1,027 t			
Fire Services								
STATION #1 666 FITZWILLIAM ST	Electricity	140,898 kWh	507 GJ	$8,689	9 t	**1,407 GJ**	**$17,879**	**74.8 t**
	Fuel Oil	23,267 litres	900 GJ	$9,190	66 t			

City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

Account & Address	Account Consumption & Costs by Type					Account Subtotal		
	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
Station #2 2499 Dorman Rd	Electricity	82,680 kWh	298 GJ	$5,416	5 t	**849 GJ**	**$11,476**	**33.4 t**
	Natural Gas	551 GJ	551 GJ	$6,060	28 t			
Station #3 6230 Hammond Bay Rd	Electricity	67,323 kWh	242 GJ	$4,419	4 t	**582 GJ**	**$8,152**	**21.6 t**
	Natural Gas	339 GJ	339 GJ	$3,733	17 t			
Station #5 193 4rth Street	Electricity	27,760 kWh	100 GJ	$1,851	2 t	**558 GJ**	**$6,887**	**25.2 t**
	Natural Gas	458 GJ	458 GJ	$5,036	23 t			
Station #4 1400 Cranberry Ave	Electricity	24,366 kWh	88 GJ	$1,631	2 t	**454 GJ**	**$5,657**	**20.3 t**
	Natural Gas	366 GJ	366 GJ	$4,026	19 t			
Fire Training Centre 1900 Labieux Rd Fta	Electricity	18,806 kWh	68 GJ	$1,270	1 t	**68 GJ**	**$1,270**	**1.2 t**
Station #7 26 Pirates Lane	Electricity	16,316 kWh	59 GJ	$1,109	1 t	**59 GJ**	**$1,109**	**1.0 t**
Fire Services Subtotal	Electricity	378,149 kWh	1,361 GJ	$24,385	24 t	**3,975 GJ**	**$52,430**	**177 t**
	Natural Gas	1,714 GJ	1,714 GJ	$18,855	88 t			
	Fuel Oil	23,267 litres	900 GJ	$9,190	66 t			
Ice Arenas								
Cliff Mcnabb Arena 2300 Bowen Rd	Electricity	1,059,120 kWh	3,813 GJ	$47,971	67 t	**6,296 GJ**	**$75,286**	**193.8 t**
	Natural Gas	2,483 GJ	2,483 GJ	$27,315	127 t			
Civic Arena 48 Arena St	Electricity	785,040 kWh	2,826 GJ	$35,573	49 t	**4,031 GJ**	**$48,829**	**111.1 t**
	Natural Gas	1,205 GJ	1,205 GJ	$13,256	62 t			
Ice Arenas Subtotal	Electricity	1,844,160 kWh	6,639 GJ	$83,544	116 t	**10,327 GJ**	**$124,115**	**305 t**
	Natural Gas	3,688 GJ	3,688 GJ	$40,571	189 t			
Indoor Pools								
Nanaimo Aquatic Centre 741 3rd St	Electricity	2,406,960 kWh	8,665 GJ	$109,495	152 t	**15,534 GJ**	**$185,057**	**503.1 t**
	Natural Gas	6,869 GJ	6,869 GJ	$75,562	351 t			
Indoor Pools Subtotal	Electricity	2,406,960 kWh	8,665 GJ	$109,495	152 t	**15,534 GJ**	**$185,057**	**503 t**
	Natural Gas	6,869 GJ	6,869 GJ	$75,562	351 t			
Misc. Bldgs								

Hyla Environmental Services Ltd., 169 Aspenwood Drive, Port Moody, BC V3H 5A5 rhaycock@hyla.ca 604.469.2910

City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

Account & Address	Account Consumption & Costs by Type					Account Subtotal		
	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
Plaza 51 Gordon St	Electricity	413,400 kWh	1,488 GJ	$20,168	26 t	**1,488 GJ**	**$20,168**	**26.0 t**
Centennial Building 2300 Bowen Rd Vix	Electricity	180,410 kWh	649 GJ	$11,369	11 t	**1,033 GJ**	**$15,591**	**31.0 t**
	Natural Gas	384 GJ	384 GJ	$4,223	20 t			
Community Services Bldg 285 Prideaux St	Electricity	51,520 kWh	185 GJ	$3,393	3 t	**825 GJ**	**$10,324**	**37.9 t**
	Natural Gas	554 GJ	554 GJ	$6,095	28 t			
	Fuel Oil	2,212 litres	86 GJ	$836	6 t			
Bastion Bldg 94 Front St	Electricity	37,054 kWh	133 GJ	$2,455	2 t	**133 GJ**	**$2,455**	**2.3 t**
Lubbock Square 580 Fitzwilliam St Down	Electricity	34,624 kWh	125 GJ	$2,297	2 t	**125 GJ**	**$2,297**	**2.2 t**
Harewood Cent. & Lights Howard Ave-Pks Work Yard	Electricity	34,067 kWh	123 GJ	$2,261	2 t	**123 GJ**	**$2,261**	**2.1 t**
Dep Bay Act Cntr/Emergency Cntr 1415 Wingrove St	Electricity	27,121 kWh	98 GJ	$1,810	2 t	**98 GJ**	**$1,810**	**1.7 t**
Kin Hut 2730 Departure Bay Rd	Electricity	6,391 kWh	23 GJ	$456	0 t	**96 GJ**	**$1,239**	**5.8 t**
	Fuel Oil	1,895 litres	73 GJ	$782	5 t			
Swy-A-Lana Lagoon 48 Arena St Mmp	Electricity	19,054 kWh	69 GJ	$1,286	1 t	**69 GJ**	**$1,286**	**1.2 t**
City Cemetary 555 Bowen Rd	Electricity	16,261 kWh	59 GJ	$1,105	1 t	**59 GJ**	**$1,105**	**1.0 t**
Deep Bay Activity Centre 1420 Bay St Lbox	Electricity	15,120 kWh	54 GJ	$1,023	1 t	**54 GJ**	**$1,023**	**1.0 t**
Miners Cottage 1904 Jingle Pot Rd	Electricity	5,411 kWh	19 GJ	$401	0 t	**19 GJ**	**$401**	**0.3 t**
City Cemetary Bowen Rd	Electricity	3,215 kWh	12 GJ		0 t	**12 GJ**		**0.2 t**
500 Bowen Rd Shed 500 Bowen Rd Shed	Electricity	2,790 kWh	10 GJ	$231	0 t	**10 GJ**	**$231**	**0.2 t**
Soccer Field Lights 745 Comox Rd Lght	Electricity	1,105 kWh	4 GJ	$121	0 t	**4 GJ**	**$121**	**0.1 t**
Chinese Cemetary Townsite Rd	Electricity	348 kWh	1 GJ	$73	0 t	**1 GJ**	**$73**	**0.0 t**
Misc. Bldgs Subtotal	Electricity	847,891 kWh	3,052 GJ	$48,448	53 t	**4,149 GJ**	**$60,384**	**113 t**
	Natural Gas	938 GJ	938 GJ	$10,318	48 t			
	Fuel Oil	4,107 litres	159 GJ	$1,618	12 t			

Hyla Environmental Services Ltd., 169 Aspenwood Drive, Port Moody, BC V3H 5A5 rhaycock@hyla.ca 604.469.2910

City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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Outdoor Pools								
Bowen Kin Park Pool 500 Bowen Rd Pool	Electricity	61,678 kWh	222 GJ	$4,053	4 t	**222 GJ**	**$4,053**	**3.9 t**
Outdoor Pools Subtotal	Electricity	61,678 kWh	222 GJ	$4,053	4 t	**222 GJ**	**$4,053**	**4 t**
Parks & Sportsfields								
Bowen Park Complex 500 Bowen Rd Cplx	Electricity	156,840 kWh	565 GJ	$10,754	10 t	**565 GJ**	**$10,754**	**9.9 t**
Trofton Park 1631 Trofton Rd	Electricity	58,200 kWh	210 GJ	$3,827	4 t	**210 GJ**	**$3,827**	**3.7 t**
Caledonia Park 110 Wall St	Electricity Fuel Oil	53,400 kWh 395 litres	192 GJ 15 GJ	$3,515 $147	3 t 1 t	**208 GJ**	**$3,662**	**4.5 t**
Robins Park Washrooms Robins Park Washrooms	Electricity	37,680 kWh	136 GJ	$2,493	2 t	**136 GJ**	**$2,493**	**2.4 t**
Tidewater Park Tidewater Park	Electricity	10,236 kWh	37 GJ	$714	1 t	**37 GJ**	**$714**	**0.6 t**
Wall Street Lacrosse Box 100 Wall St Conc	Electricity	7,566 kWh	27 GJ	$541	0 t	**27 GJ**	**$541**	**0.5 t**
Westwood Lake Field House Westwood Lake Field House	Electricity	7,436 kWh	27 GJ	$532	0 t	**27 GJ**	**$532**	**0.5 t**
Pipers Lagoon Park 3600 Place Rd	Electricity	6,166 kWh	22 GJ	$452	0 t	**22 GJ**	**$452**	**0.4 t**
Mansfield Park 800 St Andrews St Park	Electricity	5,732 kWh	21 GJ	$422	0 t	**21 GJ**	**$422**	**0.4 t**
Comox Park Change Rooms 745 Comox Rd Bldg	Electricity	5,041 kWh	18 GJ	$369	0 t	**18 GJ**	**$369**	**0.3 t**
Bowen Park Tennis Court Lights Bowen Park West	Electricity	2,796 kWh	10 GJ	$231	0 t	**10 GJ**	**$231**	**0.2 t**
Charlaine Boat Ramp Hammond Bay Hammond Bay	Electricity	720 kWh	3 GJ	$96	0 t	**3 GJ**	**$96**	**0.0 t**
Knowles Park Irrigation Rainer/Victoria	Electricity	348 kWh	1 GJ	$73	0 t	**1 GJ**	**$73**	**0.0 t**
Deverill Square Park Haliburton	Electricity	162 kWh	1 GJ	$76	0 t	**1 GJ**	**$76**	**0.0 t**
Parks & Sportsfields Subtotal	Electricity Fuel Oil	352,323 kWh 395 litres	1,268 GJ 15 GJ	$24,097 $147	22 t 1 t	**1,284 GJ**	**$24,243**	**23 t**

Hyla Environmental Services Ltd., 169 Aspenwood Drive, Port Moody, BC V3H 5A5 rhaycock@hyla.ca 604.469.2910

City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
Police Services								
RCMP Building 303 Prideaux St	Electricity	888,480 kWh	3,199 GJ	$39,078	56 t	**3,409 GJ**	**$41,388**	**66.7 t**
	Natural Gas	210 GJ	210 GJ	$2,310	11 t			
	This emission is included since the City owns this building.							
RCMP Annex 580 Fitzwilliam St	Electricity	45,554 kWh	164 GJ	$3,006	3 t	**421 GJ**	**$5,830**	**16.0 t**
	Natural Gas	257 GJ	257 GJ	$2,824	13 t			
Police Services Subtotal	Electricity	934,034 kWh	3,363 GJ	$42,084	59 t	**3,829 GJ**	**$47,218**	**83 t**
	Natural Gas	467 GJ	467 GJ	$5,134	24 t			
Public Works Bldgs & Yards								
Public Works Yard 2020 Labieux Rd Yrd	Electricity	791,680 kWh	2,850 GJ	$35,778	50 t	**4,472 GJ**	**$53,351**	**138.4 t**
	Natural Gas	1,372 GJ	1,372 GJ	$15,095	70 t			
	Fuel Oil	6,451 litres	250 GJ	$2,477	18 t			
Parks Maintenance Yard 89 Prideaux St	Electricity	64,980 kWh	234 GJ	$4,259	4 t	**439 GJ**	**$6,144**	**19.2 t**
	Fuel Oil	5,313 litres	206 GJ	$1,885	15 t			
Prideaux Opp 327 Prideaux St Opp 327	Electricity	1,320 kWh	5 GJ	$135	0 t	**5 GJ**	**$135**	**0.1 t**
Traffic Counter 740 Townsite Rd	Electricity	612 kWh	2 GJ	$89	0 t	**2 GJ**	**$89**	**0.0 t**
Public Works Bldgs & Yards Subtotal	Electricity	858,592 kWh	3,091 GJ	$40,262	54 t	**4,918 GJ**	**$59,719**	**158 t**
	Natural Gas	1,372 GJ	1,372 GJ	$15,095	70 t			
	Fuel Oil	11,764 litres	455 GJ	$4,362	33 t			
Rental House								
Mary Richard Bennet Dover Rd	Electricity	45,900 kWh	165 GJ	$3,029	3 t	**165 GJ**	**$3,029**	**2.9 t**
	6700 Dover Rd?							
Rental House Subtotal	Electricity	45,900 kWh	165 GJ	$3,029	3 t	**165 GJ**	**$3,029**	**3 t**

Hyla Environmental Services Ltd., 169 Aspenwood Drive, Port Moody, BC V3H 5A5 rhaycock@hyla.ca 604.469.2910

City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
Buildings Subtotal		**Consumption**	**Energy**	**Costs**	**CO_2e**	**81,441 GJ**	**$995,787**	**2,754 t**
	Electricity	12,014,306 kWh	43,252 GJ	$577,754	757 t			
	Natural Gas	36,250 GJ	36,250 GJ	$398,750	1,855 t			
	Fuel Oil	50,142 litres	1,939 GJ	$19,284	142 t			
			Volume	Mass	CO_2e			
LIGHTING								
Dock Light								
BRECHIN POINT RD BOAT RAMP BRECHIN PNT BOAT RAMP	Electricity	21,320 kWh	77 GJ	$1,433	1 t	**77 GJ**	**$1,433**	**1.3 t**
Dock Light Subtotal	Electricity	21,320 kWh	77 GJ	$1,433	1 t	**77 GJ**	**$1,433**	**1 t**
Flashing Amber Signal								
MEDIAN FLASHER BOWEN/KENWORTH	Electricity	2,628 kWh	9 GJ	$220	0 t	**9 GJ**	**$220**	**0.2 t**
AMBER TRAFFIC FLASHER 4TH/PINE	Electricity	1,932 kWh	7 GJ	$175	0 t	**7 GJ**	**$175**	**0.1 t**
OVERHEAD PEDESTRIAN LIGHT HWY 19 AT NORTHFIELD RD	Electricity	1,512 kWh	5 GJ	$148	0 t	**5 GJ**	**$148**	**0.1 t**
MEDIAN FLASHER BOWEN/ROSSTOWN	Electricity	1,380 kWh	5 GJ	$139	0 t	**5 GJ**	**$139**	**0.1 t**
MEDIAN FLASHER BOWEN/JAMES	Electricity	788 kWh	3 GJ	$101	0 t	**3 GJ**	**$101**	**0.0 t**
MEDIAN FLASHER HAMMOND BAY/APPLECROS	Electricity	612 kWh	2 GJ	$89	0 t	**2 GJ**	**$89**	**0.0 t**
Flashing Amber Signal Subtotal	Electricity	8,852 kWh	32 GJ	$873	1 t	**32 GJ**	**$873**	**1 t**
Misc. Lighting								
WALL STREET LACROSSE BOX LIGHTS 100 WALL ST CONC	Electricity	16,378 kWh	59 GJ	$1,113	1 t	**59 GJ**	**$1,113**	**1.0 t**
NEWCASTLE AVE PARK 200 NEWCASTLE AVE PARK	Electricity	16,024 kWh	58 GJ	$1,090	1 t	**58 GJ**	**$1,090**	**1.0 t**
DALLAS SQUARE MISC LIGHTS OUTLETS DALLAS SQUARE	Electricity	6,716 kWh	24 GJ	$486	0 t	**24 GJ**	**$486**	**0.4 t**

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City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
Misc. Lighting Subtotal	Electricity	39,118 kWh	141 GJ	$2,688	2 t	**141 GJ**	**$2,688**	**2 t**
Ornamental Lighting								
Ornamental Lighting -	Electricity	1,760,459 kWh	6,338 GJ	$119,711	111 t	**6,338 GJ**	**$119,711**	**110.9 t**
	consumption estimated from costs using $0.068/kWh							
Ornamental Lighting Subtotal	Electricity	1,760,459 kWh	6,338 GJ	$119,711	111 t	**6,338 GJ**	**$119,711**	**111 t**
Overhead Lighting								
Overhead Streetlighting City-Wide	Electricity	2,306,692 kWh	8,304 GJ	$668,941	145 t	**8,304 GJ**	**$668,941**	**145.3 t**
	consumption estimated from costs using $0.29/kWh							
Civic Arena??Foundry Site Lights 50 Comox Rd	Electricity	95,880 kWh	345 GJ	$6,272	6 t	**345 GJ**	**$6,272**	**6.0 t**
Bastion Lights Bastion St	Electricity	5,489 kWh	20 GJ	$406	0 t	**20 GJ**	**$406**	**0.3 t**
Overhead Lighting Subtotal	Electricity	2,408,061 kWh	8,669 GJ	$675,619	152 t	**8,669 GJ**	**$675,619**	**152 t**
Parking Lot Lighting (open)								
Cor Robson-Franklyn Pkglot Robson-Frnkln Prkg Lot	Electricity	3,588 kWh	13 GJ	$283	0 t	**13 GJ**	**$283**	**0.2 t**
Cavan St Pk Lot Cavan St Pk Lot	Electricity	1,524 kWh	5 GJ	$149	0 t	**5 GJ**	**$149**	**0.1 t**
Franklin St Parking Lot Franklin St Parking Lot	Electricity	816 kWh	3 GJ	$103	0 t	**3 GJ**	**$103**	**0.1 t**
Cavan St Parking Lot Cavan St Parking Lot	Electricity	764 kWh	3 GJ	$100	0 t	**3 GJ**	**$100**	**0.0 t**
Briarwood Park Lot Briarwood Park Lot	Electricity	564 kWh	2 GJ	$86	0 t	**2 GJ**	**$86**	**0.0 t**
Parkway Park Lot Parkway Park Lot	Electricity	552 kWh	2 GJ	$86	0 t	**2 GJ**	**$86**	**0.0 t**
Parking Lot Lighting (open) Subtotal	Electricity	7,808 kWh	28 GJ	$806	0 t	**28 GJ**	**$806**	**0 t**
Parking Lot Lighting (u/g)								
Parcade Lights Terminal-Skinner St	Electricity	111,382 kWh	401 GJ	$7,283	7 t	**401 GJ**	**$7,283**	**7.0 t**

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City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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Dunsmuir Park Lot Dunsmuir Park Lot	Electricity	2,484 kWh	9 GJ	$211	0 t	**9 GJ**	**$211**	**0.2 t**
Parking Lot Lighting (u/g) Subtotal	Electricity	113,866 kWh	410 GJ	$7,494	7 t	**410 GJ**	**$7,494**	**7 t**
Pedestrian Signal								
5th/Georgia 5th/Georgia	Electricity	4,188 kWh	15 GJ	$242	0 t	**15 GJ**	**$242**	**0.3 t**
Overhead Pedestrian Light Depart Bay/Argyle	Electricity	3,946 kWh	14 GJ	$310	0 t	**14 GJ**	**$310**	**0.2 t**
Overhead Pedestrian Light Pine/Wentworth	Electricity	3,766 kWh	14 GJ	$296	0 t	**14 GJ**	**$296**	**0.2 t**
Overhead Pedestrian Light Waddington/Strthmore	Electricity	3,636 kWh	13 GJ	$286	0 t	**13 GJ**	**$286**	**0.2 t**
Pedestrian Signal Subtotal	Electricity	15,536 kWh	56 GJ	$1,133	1 t	**56 GJ**	**$1,133**	**1 t**
Playing Field Lighting								
Harewood Cent. Pk Harewood Park-Field Hs	Electricity	79,080 kWh	285 GJ	$5,770	5 t	**285 GJ**	**$5,770**	**5.0 t**
Bowen Park Lts 1 500 Bowen Rd	Electricity	72,360 kWh	260 GJ	$4,770	5 t	**260 GJ**	**$4,770**	**4.6 t**
Bowen Park Lts 2 500 Bowen Rd	Electricity	67,679 kWh	244 GJ	$4,442	4 t	**244 GJ**	**$4,442**	**4.3 t**
Bowen Kin Park Lts 3 500 Bowen Rd	Electricity	18,570 kWh	67 GJ	$1,255	1 t	**67 GJ**	**$1,255**	**1.2 t**
Robins Park Lights Robins Park Lights	Electricity	51 kWh	0 GJ	$73	0 t	**0 GJ**	**$73**	**0.0 t**
Playing Field Lighting Subtotal	Electricity	237,740 kWh	856 GJ	$16,310	15 t	**856 GJ**	**$16,310**	**15 t**
Pole Light								
Parkwood Park 5957 Cathedral Cres	Electricity	984 kWh	4 GJ	$114	0 t	**4 GJ**	**$114**	**0.1 t**
Pole Light 50 Howard Ave Pole	Electricity	176 kWh	1 GJ	$73	0 t	**1 GJ**	**$73**	**0.0 t**
Pole Light Subtotal	Electricity	1,160 kWh	4 GJ	$187	0 t	**4 GJ**	**$187**	**0 t**
Sign Lighting								

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City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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Gordon St Kiosk Gordon St Kiosk	Electricity	36,400 kWh	131 GJ	$2,412	2 t	**131 GJ**	**$2,412**	**2.3 t**
Duke Point Gateway Duke Point Gateway	Electricity	12,810 kWh	46 GJ	$881	1 t	**46 GJ**	**$881**	**0.8 t**
Signage Bowen/Beban Bowen/S Beban Sign	Electricity	2,880 kWh	10 GJ	$237	0 t	**10 GJ**	**$237**	**0.2 t**
Bowen/N Beban Sign Bowen/N Beban Sign	Electricity	2,880 kWh	10 GJ	$237	0 t	**10 GJ**	**$237**	**0.2 t**
Beban/Lawn Sign Beban/Lawn Sign	Electricity	2,004 kWh	7 GJ	$180	0 t	**7 GJ**	**$180**	**0.1 t**
Sign Lighting Subtotal	Electricity	56,974 kWh	205 GJ	$3,946	4 t	**205 GJ**	**$3,946**	**4 t**
Traffic Signal								
Bowen/Wall Bowen/Wall	Electricity	22,677 kWh	82 GJ	$1,308	1 t	**82 GJ**	**$1,308**	**1.4 t**
Bastion/Wallace Bastion/Wallace	Electricity	22,584 kWh	81 GJ	$1,303	1 t	**81 GJ**	**$1,303**	**1.4 t**
Bowen/Meredith Bowen/Meredith	Electricity	21,972 kWh	79 GJ	$1,268	1 t	**79 GJ**	**$1,268**	**1.4 t**
Bowen/Northfield Bowen/Northfield	Electricity	20,544 kWh	74 GJ	$1,185	1 t	**74 GJ**	**$1,185**	**1.3 t**
Rutherford At Wills Rutherford At Wills	Electricity	20,028 kWh	72 GJ	$1,350	1 t	**72 GJ**	**$1,350**	**1.3 t**
3rd And Wakesiah Ave 3rd And Wakesiah Ave	Electricity	19,608 kWh	71 GJ	$1,131	1 t	**71 GJ**	**$1,131**	**1.2 t**
Norwell/Ross Norwell/Ross	Electricity	18,204 kWh	66 GJ	$1,050	1 t	**66 GJ**	**$1,050**	**1.1 t**
Bowen/East Wellington Bowen/East Wellington	Electricity	17,328 kWh	62 GJ	$1,174	1 t	**62 GJ**	**$1,174**	**1.1 t**
Bowen Rd/Labieux Rd Bowen Rd/Labieux Rd	Electricity	16,308 kWh	59 GJ	$941	1 t	**59 GJ**	**$941**	**1.0 t**
Boundary/Meredith Rd Boundary/Meredith Rd	Electricity	16,284 kWh	59 GJ	$940	1 t	**59 GJ**	**$940**	**1.0 t**
Uplands/Rutherford Uplands/Rutherford	Electricity	16,092 kWh	58 GJ	$929	1 t	**58 GJ**	**$929**	**1.0 t**
Hammond Bay/Uplands Hammond Bay/Uplands	Electricity	15,048 kWh	54 GJ	$868	1 t	**54 GJ**	**$868**	**0.9 t**
Bowen/Pryde Bowen/Pryde	Electricity	14,880 kWh	54 GJ	$859	1 t	**54 GJ**	**$859**	**0.9 t**

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City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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2ND/WAKESIAH 2ND/WAKESIAH	Electricity	14,700 kWh	53 GJ	$848	1 t	**53 GJ**	**$848**	**0.9 t**
DEPART BAY/MONTROSE DEPART BAY/MONTROSE	Electricity	14,460 kWh	52 GJ	$834	1 t	**52 GJ**	**$834**	**0.9 t**
DUFFERIN/BOUNDARY DUFFERIN/BOUNDARY	Electricity	14,100 kWh	51 GJ	$965	1 t	**51 GJ**	**$965**	**0.9 t**
TURNER/UPLANDS DR TURNER/UPLANDS DR	Electricity	13,980 kWh	50 GJ	$807	1 t	**50 GJ**	**$807**	**0.9 t**
JORDAN AVE AT MOSTAR JORDAN AVE AT MOSTAR	Electricity	13,980 kWh	50 GJ	$807	1 t	**50 GJ**	**$807**	**0.9 t**
COMOX/WALLACE COMOX/WALLACE	Electricity	13,899 kWh	50 GJ	$953	1 t	**50 GJ**	**$953**	**0.9 t**
BOWEN/WAKESIAH BOWEN/WAKESIAH	Electricity	13,824 kWh	50 GJ	$798	1 t	**50 GJ**	**$798**	**0.9 t**
DEPART BAY/NORWELL DEPART BAY/NORWELL	Electricity	12,864 kWh	46 GJ	$742	1 t	**46 GJ**	**$742**	**0.8 t**
MOSTAR/BOBAN RDS MOSTAR/BOBAN RDS	Electricity	12,564 kWh	45 GJ	$725	1 t	**45 GJ**	**$725**	**0.8 t**
DOVER/DICKINSON DOVER/DICKINSON	Electricity	12,564 kWh	45 GJ	$725	1 t	**45 GJ**	**$725**	**0.8 t**
FITZWILLIAM AT MILTON FITZWILLIAM AT MILTON	Electricity	12,500 kWh	45 GJ	$721	1 t	**45 GJ**	**$721**	**0.8 t**
FRONT/BC FERRIES FRONT/BC FERRIES	Electricity	12,096 kWh	44 GJ	$835	1 t	**44 GJ**	**$835**	**0.8 t**
CHURCH AND FRONT STS CHURCH AND FRONT STS	Electricity	10,728 kWh	39 GJ	$619	1 t	**39 GJ**	**$619**	**0.7 t**
FRONT/BASTION FRONT/BASTION	Electricity	10,500 kWh	38 GJ	$606	1 t	**38 GJ**	**$606**	**0.7 t**
BOWEN AT DUFFERIN CRS BOWEN AT DUFFERIN CRS	Electricity	9,780 kWh	35 GJ	$564	1 t	**35 GJ**	**$564**	**0.6 t**
COMOX/PRIDEAUX COMOX/PRIDEAUX	Electricity	7,269 kWh	26 GJ	$419	0 t	**26 GJ**	**$419**	**0.5 t**
HAMMD BAY/RUTHERFORD HAMMD BAY/RUTHERFORD	Electricity	6,934 kWh	25 GJ	$400	0 t	**25 GJ**	**$400**	**0.4 t**
BASTION-COMMERCIAL BASTION-COMMERCIAL	Electricity	5,520 kWh	20 GJ	$318	0 t	**20 GJ**	**$318**	**0.3 t**
BOWEN/BUTTERTUBS BOWEN/BUTTERTUBS	Electricity	3,636 kWh	13 GJ	$210	0 t	**13 GJ**	**$210**	**0.2 t**
DEPARTURE BAY / BROOKES LAND DEPARTURE BAY BEHIND BROOKES LAND	Electricity	3,552 kWh	13 GJ	$205	0 t	**13 GJ**	**$205**	**0.2 t**

Hyla Environmental Services Ltd., 169 Aspenwood Drive, Port Moody, BC V3H 5A5 rhaycock@hyla.ca 604.469.2910

City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
4TH/HAREWOOD 4TH/HAREWOOD	Electricity	2,736 kWh	10 GJ	$158	0 t	**10 GJ**	**$158**	**0.2 t**
5TH/HAREWOOD 5TH/HAREWOOD	Electricity	2,736 kWh	10 GJ	$158	0 t	**10 GJ**	**$158**	**0.2 t**
MILTON-ALBERT MILTON-ALBERT	Electricity	1,953 kWh	7 GJ	$113	0 t	**7 GJ**	**$113**	**0.1 t**
UPLANDS/OLIVER UPLANDS/OLIVER	Electricity	1,200 kWh	4 GJ	$69	0 t	**4 GJ**	**$69**	**0.1 t**
AULDS/METRAL AULDS/METRAL	Electricity	1,056 kWh	4 GJ	$61	0 t	**4 GJ**	**$61**	**0.1 t**
JINGLE POT / 3RD ISLAND FLASHER JINGLE POT/3RD	Electricity	885 kWh	3 GJ	$51	0 t	**3 GJ**	**$51**	**0.1 t**
5TH ST AT WAKESIAH 5TH ST AT WAKESIAH	Electricity	600 kWh	2 GJ	$35	0 t	**2 GJ**	**$35**	**0.0 t**
5TH AT WAKESIAH AVE 5TH AT WAKESIAH AVE	Electricity	577 kWh	2 GJ	$33	0 t	**2 GJ**	**$33**	**0.0 t**
4TH ST AT WAKESIAH 4TH ST AT WAKESIAH	Electricity	468 kWh	2 GJ	$27	0 t	**2 GJ**	**$27**	**0.0 t**
Traffic Signal Subtotal	Electricity	473,218 kWh	1,704 GJ	$28,112	30 t	**1,704 GJ**	**$28,112**	**30 t**
Unidentified								
- BARSBY/MILL	Electricity	6,612 kWh	24 GJ	$479	0 t	**24 GJ**	**$479**	**0.4 t**
- 4639 HWY 1/BRECHIN RD	Electricity	4,908 kWh	18 GJ	$368	0 t	**18 GJ**	**$368**	**0.3 t**
- 6150 DOUMONT RD	Electricity	4,732 kWh	17 GJ	$360	0 t	**17 GJ**	**$360**	**0.3 t**
- STIRLING AVE 800 BLK	Electricity	2,592 kWh	9 GJ	$218	0 t	**9 GJ**	**$218**	**0.2 t**
- 271 PINE ST	Electricity	2,305 kWh	8 GJ	$199	0 t	**8 GJ**	**$199**	**0.1 t**
- GORDON AND CAMERON ST	Electricity	1,524 kWh	5 GJ	$149	0 t	**5 GJ**	**$149**	**0.1 t**
- CAVAN ST	Electricity	528 kWh	2 GJ	$147	0 t	**2 GJ**	**$147**	**0.0 t**
- KINGFISHER PL	Electricity	348 kWh	1 GJ	$73	0 t	**1 GJ**	**$73**	**0.0 t**
- CAMERON AND GORDON ST	Electricity	264 kWh	1 GJ	$73	0 t	**1 GJ**	**$73**	**0.0 t**

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City Of Nanaimo

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	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
- Wallace/Wentworth	Electricity	264 kWh	1 GJ	$73	0 t	**1 GJ**	**$73**	**0.0 t**
Unidentified Subtotal	Electricity	24,077 kWh	87 GJ	$2,140	2 t	**87 GJ**	**$2,140**	**2 t**
Pool Lighting								
Bowen Kin Pool Lts 500 Bowen Rd Pool	Electricity	21,098 kWh	76 GJ	$1,431	1 t	**76 GJ**	**$1,431**	**1.3 t**
Pool Lighting Subtotal	Electricity	21,098 kWh	76 GJ	$1,431	1 t	**76 GJ**	**$1,431**	**1 t**
Lighting Subtotal		Consumption	Energy	Costs	CO_2e	**18,681 GJ**	**$861,883**	**327 t**
	Electricity	5,189,287 kWh	18,681 GJ	$861,883	327 t			
			Volume	Mass	CO_2e			
Water & Wastewater								
Decomissioned								
Sewer Flow Monitor Bruce / Hewgate	Electricity	2,592 kWh	9 GJ	$218	0 t	**9 GJ**	**$218**	**0.2 t**
Sewer Flow Monitor 1891 Otter Way Cnr Zorkin Rd	Electricity	2,592 kWh	9 GJ	$218	0 t	**9 GJ**	**$218**	**0.2 t**
Sewer Flow Monitor 14th St At Frames Rd	Electricity	123 kWh	0 GJ	$76	0 t	**0 GJ**	**$76**	**0.0 t**
Sewer Flow Monitor 483 Nova St	Electricity	12 kWh	0 GJ	$73	0 t	**0 GJ**	**$73**	**0.0 t**
Decomissioned Subtotal	Electricity	5,319 kWh	19 GJ	$585	0 t	**19 GJ**	**$585**	**0 t**
Flow Station								
Water Meter Chamber Islnd Hwy/Ruthrfrd Rd	Electricity	289 kWh	1 GJ	$79	0 t	**1 GJ**	**$79**	**0.0 t**
Sewer Flow Monitor Esplanade At Milton	Electricity	120 kWh	0 GJ	$73	0 t	**0 GJ**	**$73**	**0.0 t**
Flow Station Subtotal	Electricity	409 kWh	1 GJ	$152	0 t	**1 GJ**	**$152**	**0 t**
Liquid Waste PS								

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City Of Nanaimo

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	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
Extension Water Process Centre 2209 Bramley Rd	Electricity	219,900 kWh	792 GJ	$12,223	14 t	**792 GJ**	**$12,223**	**13.9 t**
Sewer Pump Station 5668 Brookwood Dr	Electricity	45,480 kWh	164 GJ	$3,010	3 t	**164 GJ**	**$3,010**	**2.9 t**
3674 Lagoon Rd Pump 3674 Lagoon Rd Pump	Electricity	35,340 kWh	127 GJ	$2,343	2 t	**127 GJ**	**$2,343**	**2.2 t**
Long Lake Pump Long Lake/Ross Rd	Electricity	28,764 kWh	104 GJ	$1,925	2 t	**104 GJ**	**$1,925**	**1.8 t**
1065 Cedar Rd Pump 1065 Cedar Rd Pump	Electricity	25,800 kWh	93 GJ	$1,726	2 t	**93 GJ**	**$1,726**	**1.6 t**
Pump Wills Rd	Electricity	12,571 kWh	45 GJ	$866	1 t	**45 GJ**	**$866**	**0.8 t**
Dne Ps 84 Commercial St	Electricity	11,419 kWh	41 GJ	$791	1 t	**41 GJ**	**$791**	**0.7 t**
Cameron Isle Pump Stn Front St Cameron Isle Pump Stn Front St	Electricity	10,843 kWh	39 GJ	$753	1 t	**39 GJ**	**$753**	**0.7 t**
Sewer Pump Station 3940 Hammond Bay Rd	Electricity	6,599 kWh	24 GJ	$478	0 t	**24 GJ**	**$478**	**0.4 t**
Island Hwy Sewer Pump Island Hwy Sewer Pump	Electricity	3,892 kWh	14 GJ	$298	0 t	**14 GJ**	**$298**	**0.2 t**
Sewer Flow Monitor 7th / Park	Electricity	2,592 kWh	9 GJ	$218	0 t	**9 GJ**	**$218**	**0.2 t**
Sewer Flow Monitor Buttertubs Dr	Electricity	2,592 kWh	9 GJ	$218	0 t	**9 GJ**	**$218**	**0.2 t**
Sewer Flow Monitor Maki Rd	Electricity	2,592 kWh	9 GJ	$218	0 t	**9 GJ**	**$218**	**0.2 t**
Sewer Flow Monitor 5467 Westdale Rd	Electricity	2,376 kWh	9 GJ	$200	0 t	**9 GJ**	**$200**	**0.1 t**
Queens Pump Lois Ln Pump	Electricity	2,280 kWh	8 GJ	$189	0 t	**8 GJ**	**$189**	**0.1 t**
Park Ave Pump 840 Park Ave Pump	Electricity	2,280 kWh	8 GJ	$234	0 t	**8 GJ**	**$234**	**0.1 t**
106 Wall St Pump 106 Wall St Pump	Electricity	1,852 kWh	7 GJ	$170	0 t	**7 GJ**	**$170**	**0.1 t**
Sewer Flow Monitor In Front 561 Stewart	Electricity	120 kWh	0 GJ	$73	0 t	**0 GJ**	**$73**	**0.0 t**
Sewer Pump Station Fillinger Crs	Electricity	99 kWh	0 GJ	$73	0 t	**0 GJ**	**$73**	**0.0 t**
Liquid Waste PS Subtotal	Electricity	417,391 kWh	1,503 GJ	$26,006	26 t	**1,503 GJ**	**$26,006**	**26 t**

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City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
Potable Water PS								
Rod Glen Pump Station And No. 4 Reservoir 4217 Early Dr	Electricity	295,920 kWh	1,065 GJ	$18,193	19 t	**1,065 GJ**	**$18,193**	**18.6 t**
College Park Valve & Pump Station With No. 3 Reservoirs (A&B) 1071 College Dr Pump	Electricity	155,840 kWh	561 GJ	$10,144	10 t	**561 GJ**	**$10,144**	**9.8 t**
No. 1 Reservoir 1050 Nanaimo Lakes Rd Dam	Electricity	76,020 kWh	274 GJ	$5,050	5 t	**274 GJ**	**$5,050**	**4.8 t**
Lost Lake No. 2 Reservoir And Pump Station 4877 Lost Lake Rd	Electricity	72,240 kWh	260 GJ	$7,969	5 t	**260 GJ**	**$7,969**	**4.6 t**
Prince John Pump Station 267 Prince John Way Pump	Electricity	70,611 kWh	254 GJ	$4,632	4 t	**254 GJ**	**$4,632**	**4.4 t**
No. 6 Duke Point Reservoir, Duke Point Valve Stn. & Duke Point Pump Stn. Duke Point Wtr Stn (1120 Hooker Rd?)	Electricity	58,500 kWh	211 GJ	$3,838	4 t	**211 GJ**	**$3,838**	**3.7 t**
Pryde Avenue Pump Station 71 Pryde Ave	Electricity	42,240 kWh	152 GJ	$2,791	3 t	**152 GJ**	**$2,791**	**2.7 t**
Wiltshire Pump Station 3507 Wiltshire Drive	Electricity	39,738 kWh	143 GJ	$2,629	3 t	**143 GJ**	**$2,629**	**2.5 t**
No. 5 Towers Reservoir & Pump Station 1311 Langara Dr Pump	Electricity	28,769 kWh	104 GJ	$1,917	2 t	**104 GJ**	**$1,917**	**1.8 t**
Tanya Reservoir No. 7 5341 Tanya Dr Resv	Electricity	15,866 kWh	57 GJ	$1,079	1 t	**57 GJ**	**$1,079**	**1.0 t**
Water Pump Station Lost Lake Rd	Electricity	4,538 kWh	16 GJ	$344	0 t	**16 GJ**	**$344**	**0.3 t**
Potable Water PS Subtotal	Electricity	860,282 kWh	3,097 GJ	$58,586	54 t	**3,097 GJ**	**$58,586**	**54 t**
PRV Station								
Prv 900 Harewood Mines Rd	Electricity	41 kWh	0 GJ	$73	0 t	**0 GJ**	**$73**	**0.0 t**
PRV Station Subtotal	Electricity	41 kWh	0 GJ	$73	0 t	**0 GJ**	**$73**	**0 t**
Water Cathodic Test Site								
Water Cathodic Test Site Mcmillan Rd	Electricity	271 kWh	1 GJ	$75	0 t	**1 GJ**	**$75**	**0.0 t**
Water Cathodic Test Site Subtotal	Electricity	271 kWh	1 GJ	$75	0 t	**1 GJ**	**$75**	**0 t**

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City Of Nanaimo

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	Type	Consumption	Energy	Costs	CO_2e	Energy	Costs	CO_2e
Water & Wastewater Subtotal		Consumption	Energy	Costs	CO_2e	**4,621 GJ**	**$85,478**	**81 t**
	Electricity	1,283,713 kWh	4,621 GJ	$85,478	81 t			
			Volume	Mass	CO_2e			
VEHICLE FLEET								
Diesel Fuel Vehicles								
DIESEL FUEL VEHICLES -	Diesel Fuel	331,856 litres	12,836 GJ	$162,610	923 t	**12,836 GJ**	**$162,610**	**923.1 t**
Diesel Fuel Vehicles Subtotal	Diesel Fuel	331,856 litres	12,836 GJ	$162,610	923 t	**12,836 GJ**	**$162,610**	**923 t**
Gasoline Vehicles								
GASOLINE VEHICLES --	Gasoline	253,103 litres	8,773 GJ	$136,676	633 t	**8,773 GJ**	**$136,676**	**633.5 t**
Gasoline Vehicles Subtotal	Gasoline	253,103 litres	8,773 GJ	$136,676	633 t	**8,773 GJ**	**$136,676**	**633 t**
Vehicle Fleet Subtotal		Consumption	Energy	Costs	CO_2e	**21,609 GJ**	**$299,286**	**1,557 t**
	Gasoline	253,103 litres	8,773 GJ	$136,676	633 t			
	Diesel Fuel	331,856 litres	12,836 GJ	$162,610	923 t			
			Volume	Mass	CO_2e			
SOLID WASTE								
Administration Offices								
CITY HALL - 455 WALLACE --	Solid Waste		156 cu. yds	23.40	11 t			**11.0 t**
CITY HALL - 238 FRANKLYN --	Solid Waste		208 cu. yds	31.20	15 t			**14.7 t**
Administration Offices Subtotal	Solid Waste		364 cu. yds	54.60	26 t			**26 t**
Aquatic Centres & Ice Arenas								

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City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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	Type	Mass	Mass	CO_2e	Energy	Costs	CO_2e
Aquatic Centre --	Solid Waste	312 cu. yds	46.80	22 t			**22.0 t**
Beban Complex --	Solid Waste	832 cu. yds	124.80	59 t			**58.7 t**
Civic Arena --	Solid Waste	312 cu. yds	46.80	22 t			**22.0 t**
Aquatic Centres & Ice Arenas Subtotal	Solid Waste	1,456 cu. yds	218.40	103 t			**103 t**
Fire Services							
Dep Bay Firehall --	Solid Waste	156 cu. yds	23.40	11 t			**11.0 t**
Dorman Rd Firehall --	Solid Waste	78 cu. yds	11.70	5 t			**5.5 t**
Fire Training Centre --	Solid Waste	26 cu. yds	3.90	2 t			**1.8 t**
Firehall - 666 Fitzwilliam 30% --	Solid Waste	26 cu. yds	3.90	2 t			**1.8 t**
Chase River Firehall --	Solid Waste	78 cu. yds	11.70	5 t			**5.5 t**
Hammond Bay Firehall --	Solid Waste	78 cu. yds	11.70	5 t			**5.5 t**
Harewood Firehall --	Solid Waste	156 cu. yds	23.40	11 t			**11.0 t**
Fire Services Subtotal	Solid Waste	598 cu. yds	89.70	42 t			**42 t**
Misc. Bldgs							
Community Svc Bldg 70% --	Solid Waste	156 cu. yds	23.40	11 t			**11.0 t**
580 Fitzwilliam - Old Library --	Solid Waste	78 cu. yds	11.70	5 t			**5.5 t**
84 Commercial St-Sub Office --	Solid Waste	156 cu. yds	23.40	11 t			**11.0 t**
Misc. Bldgs Subtotal	Solid Waste	390 cu. yds	58.50	27 t			**27 t**
Parks & Sportsfields							
Beban Park Pitch & Putt --	Solid Waste	78 cu. yds	11.70	5 t			**5.5 t**

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City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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	Type	Mass	Mass	CO_2e	Energy	Costs	CO_2e
Beban Parks Sports Field --	Solid Waste	156 cu. yds	23.40	11 t			**11.0 t**
Bowen Complex --	Solid Waste	156 cu. yds	23.40	11 t			**11.0 t**
Harewood Centennial Park --	Solid Waste	156 cu. yds	23.40	11 t			**11.0 t**
Kin Hut --	Solid Waste	156 cu. yds	23.40	11 t			**11.0 t**
Mary Richard Bennet Park --	Solid Waste	78 cu. yds	11.70	5 t			**5.5 t**
Parks & Sportsfields Subtotal	Solid Waste	780 cu. yds	117.00	55 t			**55 t**
Police Services							
303 Prideaux - Rcmp Bldg --	Solid Waste	156 cu. yds	23.40	11 t			**11.0 t**
Police Services Subtotal	Solid Waste	156 cu. yds	23.40	11 t			**11 t**
Public Works Bldgs & Yards							
Park Maintenace Yard --	Solid Waste	312 cu. yds	46.80	22 t			**22.0 t**
2020 Labieux-Public Works --	Solid Waste	624 cu. yds	93.60	44 t			**44.0 t**
Public Works Bldgs & Yards Subtotal	Solid Waste	936 cu. yds	140.40	66 t			**66 t**

Solid Waste Subtotal	Consumption	Energy	Costs	CO_2e	**330 t**
		Volume	Mass	CO_2e	
	Solid Waste	4,680 cu. yds	702.00 t	330 t	

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City Of Nanaimo

Corporate Energy & Greenhouse Gas Emissions Inventory: 2001

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	Type		Mass Energy	Mass Costs	CO_2e	Energy	Costs	CO_2e
Total		Consumption	Energy	Costs	CO_2e	**126,353 GJ**	**$2,242,434**	**5,048 t**
	Electricity	18,487,306 kWh	66,554 GJ	$1,525,114	1,165 t			
	Natural Gas	36,250 GJ	36,250 GJ	$398,750	1,855 t			
	Fuel Oil	50,142 litres	1,939 GJ	$19,284	142 t			
	Gasoline	253,103 litres	8,773 GJ	$136,676	633 t			
	Diesel Fuel	331,856 litres	12,836 GJ	$162,610	923 t			
			Volume	Mass	CO_2e			
	Solid Waste		4,680 cu. yds	702.00 t	330 t			

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