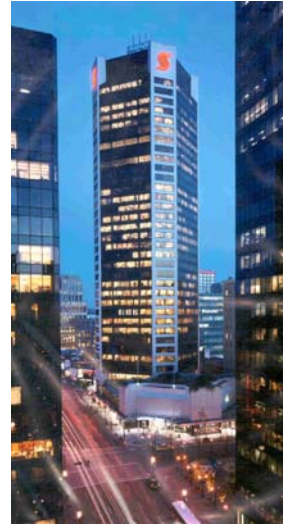


# Making Dollars and Cents Out of Green Buildings



## A Review of the Financial Impacts of the BOMA Go Green Program

August 2007



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- BC Ministry of Energy, Mines and Petroleum Resources
- Green Building Foundation
- Metro Vancouver (formerly the Greater Vancouver Regional District)

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# Scope of the Work

Buildings of any size can participate in the BOMA Go Green program which is about much more than just certification: the application process will help assess how well a building performs and includes practical suggestions for tangible ways to improve environmental practices. The purpose of this report is to present the financial impacts of the strategies outlined in Go Green in a manner that is meaningful to building owners and managers.

Aligning with the structure of BOMA Go Green and using publicly available data from recently completed projects, the report presents an overview of the objective of each of the 10 areas of compliance, the strategies that have been successfully employed by projects to address the objectives and, where data exists, the resulting financial impacts such as:

- Return on investment through operational savings
- Personnel and productivity impacts
- Operational process enhancements
- Market impacts such as asset value, tenant turnover rates, etc

For each of the 10 Go Green categories the report provides a brief summary of strategies and an illustrative case study and useful resources for next steps or further information. While the report has been written in response to the needs of BOMA BC and BC's Accommodation and Real Estate Services (ARES) to present useful information to British Columbian building owners and managers, it is anticipated that much of the content is of national interest and significance. Specifically, the report is intended to illustrate the benefits of pursuing Go Green environmental and performance improvement strategies from the perspective of:

- an owner and/or landlord considering undertaking a Go Green assessment and certification
- an owner and/or landlord of a Go Green building, and
- a tenant of a Go Green building

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## 1 Introduction

Incorporated in 1911, the Building Owners and Managers Association of British Columbia (BOMA BC) is the largest commercial real estate industry association in British Columbia with over 300 member firms and represents more than \$7 billion in commercial real estate in the province. BOMA BC's vision is to be recognized as the principal voice, through leadership and advocacy, for the commercial real estate industry.

Recognizing the need to assist property owners in planning for energy efficiency, occupant health and other environmental improvements, BOMA launched its national Go Green program in February 2005. Go Green has been widely and rapidly accepted by the commercial real estate industry as an emblem of environmental compliance and good stewardship.

Companies that have "greened" their buildings are now enjoying immense benefits. For example the Bank of America has found that green projects<sup>1</sup>:

- Have higher lease-up (20%) and occupancy (8%) rates than average
- Have commanded rents up to 10% higher than market rate
- Conform to environmental and insurance standards for occupational health and safety
- Every dollar saved in operating expenses from green building yields ten dollars in increased property value per square foot

Energy efficiency and environmental considerations are at the forefront of business considerations. Ninety four percent of corporate real estate executives surveyed in 2007<sup>2</sup> rated energy efficiency as either the most important issues or an important issue on the list of issues they will face over the next decade. More than two thirds say they will increase their budgets and efficiency over the next five years. The U.S. Environmental Protection Agency estimates that the building industry can reduce energy usage by up to 30 per cent simply by improving operating standards. If a one million square foot portfolio can reduce its energy consumption by just 10 percent it would mean a potential \$2.5 million in asset value increase<sup>3</sup>. Moreover, commercial property owners in the US spend nearly \$93 billion on energy annually; studies show that in a portfolio of 100 million square feet inefficiency represents almost \$40 million in excess energy spending<sup>4</sup>.

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<sup>1</sup> Albert Sumody, Senior Vice-President, Commercial Real Estate Group, Bank of America, May 2007

<sup>2</sup> "CoreNet Global Urges Corporate Sector to Cut Energy Use" – Paul Rosta, April 30, 2007.

<sup>3</sup> BOMA BC Go Green Checklist [www.boma.bc.ca/gogreen](http://www.boma.bc.ca/gogreen)

<sup>4</sup> Jones Lang LaSalle, "Energy Strategies for the 21st Century," 2007

The 2006 Greater Vancouver market for green building renovations and retrofits is growing quickly. By December 2006, less than two years since the Go Green program was launched, there were 70 Go Green buildings in BC (40% of the Canadian total). BOMA is keen to expand this very successful program. To do so necessitates the ability to compellingly communicate the economic bottom line benefits of Go Green to prospective participants.

Responding to the growing demand for environmentally responsible real estate practices from both clients and employees, many property owners, companies and investors are now evaluating triple bottom line results as part of their consideration. For example, CB Richard Ellis Group Inc. has pledged to become carbon neutral as a company by 2010 and has begun to promote a variety of energy efficiency programs to owners and tenants of the 1.7 billion square feet of building space it manages worldwide<sup>5</sup>.

This report highlights the elements of BOMA's Go Green program and gives real world examples of companies and organizations that have implemented each of the elements. Particular attention is given to the nature of the upgrades made and the benefits and return on investment achieved. The report is divided into the following four major sections:

- 1. Introduction** – An overview of the Go Green program and buildings in the regional context of British Columbia.
- 2. Trends and Findings** – Gives a summary of each of the ten Go Green requirements with a particular focus on the financial implications, payback, performance improvements and special environmental considerations.
- 3. Next Steps** - Describes the energy audit, water audit, and indoor air quality profile as the crucial next steps for going green,
- 4. Appendices** – The appendices contain the detailed research and case studies for each of the ten Go Green criteria.

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<sup>5</sup> "CB Richard Ellis Launches 3-Year Plan to Go "Carbon Neutral" – CoStar Green Report. May 31, 2007.

## 1.1 Go Green And Go Green Plus

The Go Green program is a “best practices” model designed for existing or occupied buildings of any size and includes the following components:

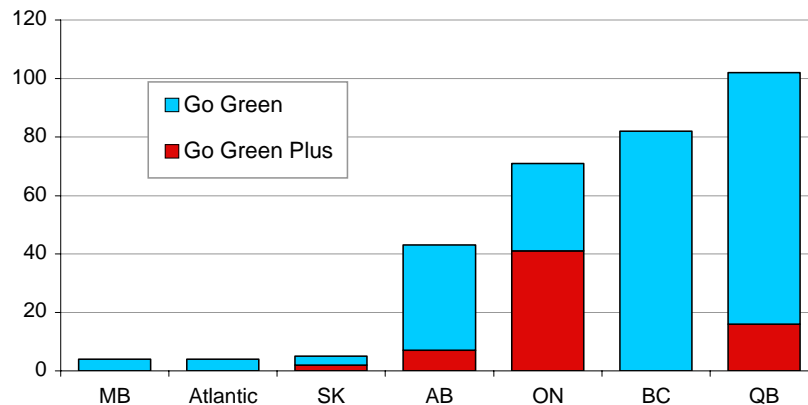
- Identifies a ‘best practices’ benchmark for professionally managed buildings.
- Recognizes buildings that meet or exceed the requirements inherent in the benchmark with a ‘Go Green designation.
- Assists buildings that cannot meet the requirements.
- Fosters environmental consciousness in the commercial building industry

### 1.1.1 Go Green Requirements

Section 1 – Resource Consumption	Requirement 1: Energy Use Requirement 2: Water Use
Section 2 – Waste Reduction & Recycling	Requirement 3: Construction Waste Requirement 4: Recycling
Section 3 – Building Materials	Requirement 5: Hazardous Materials Requirement 6: Material Selection Requirement 7: Ozone Depleting Substances
Section 4 – Interior Environment	Requirement 8: Indoor Air Quality Requirement 9: HVAC Maintenance
Section 5 – Tenant Awareness	Requirement 10: Communication Program

To register a building under Go Green, a building owner/manager applies directly (with application fee) to the local BOMA association, for certification. A qualified verifier reviews and validates the application and the building. If the building is recommended for certification, the local Board or designated governing body reviews and approves (or rejects) the application. If approved, the building is awarded certification and receives a building decal from BOMA Canada along with recognition on the BOMA website and in various promotional materials. After three years the building must apply and pay for re-certification.

## BOMA Go Green Buildings in Canada<sup>6</sup>



Go Green Plus provides an additional in-depth benchmarking tool with the potential for third party certification. Go Green Plus is intended to enable participants to:

- Rate and benchmark the building's performance;
- Develop comprehensive action plans to improve environmental performance;
- Evaluate an entire portfolio of buildings and identify the strengths and weaknesses of each building;
- Foster increased environmental consciousness in building design and operations; and
- Recognize that environmental objectives are a key part of strategic asset planning for commercial buildings.

Go Green Plus is an online building and management environmental audit. The program measures the building's environmental factors such as energy use, indoor health and environmental performance against the best industry operation and management practices. Go Green Plus is designed to both monitor the ongoing performance and improvements of a building's operations, and provide a tool to address tenant expectations for healthier workplaces, in a recognized and cost-effective way.

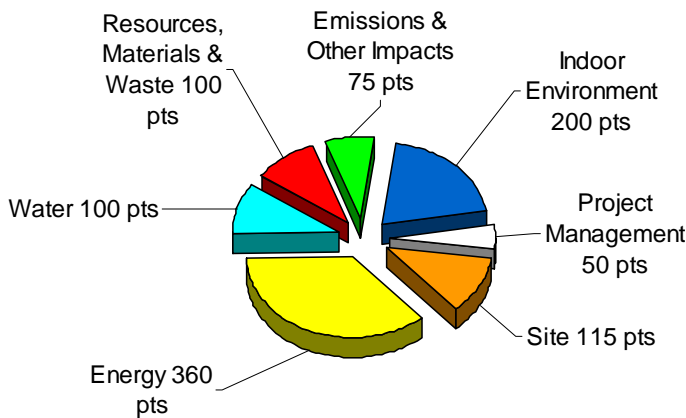
Go Green Plus can also identify areas for potential savings in resource consumption, from both capital improvements and enhanced building management processes. In addition, Go Green Plus offers an important educational tool, designed to encourage sustainable best practices throughout the commercial real estate industry. Go Green Plus uses the online environmental assessment tool, Green Globes, administered by the Green

<sup>6</sup> BOMA June 2007 data: <http://www.bomagogreen.com/buildings.html>

Buildings Initiative<sup>7</sup> based in Portland, Oregon. Green Globes is a checklist but with no prerequisites and a total of 1,000 available points. A minimum number of credits must be either attempted or achieved.

The two-step process of Go Green followed Go Green Plus enables managers to first establish sound planning protocols and then easily measure the impacts of building improvements as they occur. The uptake of Go Green Plus has been particularly successful in Ontario on account of the large number of government-owned buildings whose clients have already signed on to a range of environmental commitments. Information about Go Green and Go Green Plus is available from [www.bomagogreen.com](http://www.bomagogreen.com).

**1.1.2 BOMA Go Green Plus Categories**



	% Points
1 Globe	35 - 54%
2 Globes	55 - 69%
3 Globes	70 - 84%
4 Globes	85% plus

<sup>7</sup> [www.thegbi.org](http://www.thegbi.org)

## 1.2 Regional Context

There are approximately 110 billion square feet of gross floor area presently existing in Canada<sup>8</sup>. Sixty-five million square feet of space are added every year and 110 million square feet of space are renovated every year.<sup>9</sup> In British Columbia construction, building design and real estate are the single largest contributors to provincial GDP goods and services at \$19.5m<sup>10</sup>. In Vancouver,<sup>11</sup> the impacts of construction, operation and disposal of the region's buildings are significant:

- 309 million m<sup>3</sup> of water
- 64 million GJ natural gas
- 51 million GJ of electricity
- 3.6 million tonnes of GHG emissions (28% region's total)
- 1.7 million tonnes of construction waste of which 67% is recycled

The BC commercial market has experienced a marked upswing in recent years. Lower vacancy rates imply higher occupancy levels with corresponding increases in plug loads and air conditioning needs. Generally, buildings have experienced year-to-year increases in both occupancy levels and plug loads since 2002.

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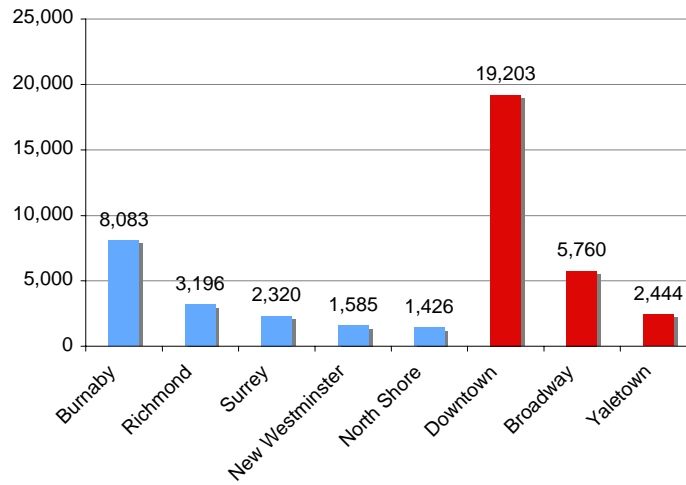
<sup>8</sup> Comprising institutional, commercial, industrial and high-rise residential according to Peter Busby, "Building Kyoto." Canadian Architect, July 2002.

<sup>9</sup> Ibid.

<sup>10</sup> BC Stats 2006

<sup>11</sup> GVRD [www.gvrd.bc.ca/buildsmart](http://www.gvrd.bc.ca/buildsmart)

**BC lower mainland inventory of office space<sup>12</sup>**



Total office inventory as of Dec 2006 44 million sf. City of Vancouver areas in red and comprises 63 per cent of the total (000's sf)

<sup>12</sup> Courtesy Avison Young

## 2 Trends and Findings

The following table summarizes the findings presented in this report. The number of projects reviewed was limited. The intention was to select projects which could supply data to demonstrate proven market-ready solutions to each of the 10 BOMA Go Green requirements. The table is therefore presented for illustrative purposes only in order to demonstrate the range of savings that have been successfully achieved. The extent to which savings have been realised depend on a host of factors which are each discussed under 10 separate Go Green requirements in the body of this report and summarized on the following pages.

### Summary of Building Performance Improvements Based on Projects Reviewed in this Report

BOMA Go Green Sections	BOMA Go Green Requirements	\$/sf savings	Payback (years)
Section 1 – Resource Consumption	Requirement 1: Energy Use	\$0 - \$0.51	0 - 8.5
	Requirement 2: Water Use	\$0.01	0 - 2
Section 2 – Waste Reduction & Recycling	Requirement 3: Construction Waste	\$0.10 to \$0.48	0 - 2
	Requirement 4: Recycling	\$0.02	<5
Section 3 – Building Materials	Requirement 5: Hazardous Materials	varies	<2
	Requirement 6: Material Selection	-	no cost premium
	Requirement 7: Ozone Depleting Substances	-	no cost premium
Section 4 – Interior Environment	Requirement 8: Indoor Air Quality	varies	0 - 5
	Requirement 9: HVAC Maintenance	varies	0 - 10
Section 5 – Tenant Awareness	Requirement 10: Communication Program	\$0.30	<2

**Overall** - There is clear evidence that value exists in undertaking green building improvements. Cumulative savings are possible from undertaking all of the measures described in Go Green and summarized above. Moreover, the study found that the most successful savings were generated from a holistic approach, leveraging synergies across systems.

However, readers are cautioned against cumulating the results in this study and applying them as a total (i.e. a cumulative savings per ft<sup>2</sup>). The findings presented in this report are taken from specific projects for illustrative purposes only; the sample size of completed projects in this study is still too small for statistical analysis. Actual savings from Go Green strategies vary based on building size, age, location, use etc. For example, older buildings with low-efficiency systems will have more to gain from a comprehensive upgrade than their more modern counterparts.

The objective of this study was to demonstrate that savings were possible and quantifiable for a wide range of building type. Success in delivering savings such as those quoted depend on the experience of the team, the motivation and early buy-in of the owner and the scope for systems integration. It is hoped that this study will encourage more building owners to produce case studies of their projects and to share lessons learned.

While buildings that have completed Go Green have entrenched sound planning practices, it is important to point out that adherence to Go Green will not, in and of itself, generate savings. It is the implementation of managed building improvements identified via the Go Green program and subsequently measured using Go Green Plus that has been shown to deliver meaningful returns on investment.

A constraint to this project is the fact that there is no centralized agency collecting building performance data. Moreover, Go Green has not been in existence long enough for comprehensive information to have been collected for all 10 environmental requirements.

Despite the caveats cited above, early feedback reveals that on average, buildings that have completed Go Green Plus are performing better than their conventional counterparts in the areas of energy, water efficiency and waste diversion.

A 2007 study<sup>13</sup> undertaken by BOMA BC in collaboration with BC's Ministry of Energy, Mines and Petroleum Resources demonstrates the scale of environmental improvements in 45 BOMA Go Green certified buildings across Canada. Building size ranged from 35,000sf to 3.2 million sf.

The study revealed a total annual energy savings 217,000 GJ which computes to approximately \$2.4 million per year or \$0.06/sf<sup>14</sup>. Energy savings attributable to natural gas and steam (i.e. thermal savings) is approximately 158,000 GJ or 73% of the total savings for the 45 buildings in the sample. It is anticipated that the total program savings, when the study sample size is extrapolated to all certified buildings, is close to 400,000 GJ or \$0.11/sf.

The Go Green program has seen an average reduction in building energy consumption of 11 per cent<sup>15</sup> to date providing evidence that investment in the BOMA Go Green assessment and certification process has the potential to deliver financial returns in energy, water and waste management strategies.

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<sup>13</sup> "Go Green Energy Savings" report to BOMA BC prepared by Douglas Spratt and Associates, February 2007

<sup>14</sup> Assuming marginal cost rates of electricity: 6.79 cents / kWh and Natural Gas: \$8.189 / GJ

<sup>15</sup> Go Green Plus certified buildings only

## Energy Conservation

Reducing energy use begins with an energy audit of the building. Conservation measures often include improvements in HVAC systems and controls, upgrading lighting and electrical systems, and building commissioning and retro-commissioning.

<b>Go Green Requirements</b>	<p>An energy audit of the applicant's building must have been performed within the past three years.</p> <p>Building management must have a written plan to address energy issues raised in the audit.</p>
<b>Financial impacts</b>	<p>The level of investment and the resulting savings varies widely depending on the exact nature of the upgrades. For example, comprehensive HVAC and electrical improvements in office buildings in Vancouver costing between \$4 and \$5 per sf net leasable have successfully delivered as much as 20 percent energy savings bringing their annual energy costs to below 30 kWh/sf per year and recouping annual savings of up to \$0.51/sf.</p>
<b>Payback</b>	<p>Payback depends on specific upgrades, but is generally 0 – 8.5 years. The following highlights some of the different paybacks for various investments:</p> <ul style="list-style-type: none"> <li>• Replacing fans and pump drive motors with high efficiency models can produce paybacks between six months to 1.25 years.</li> <li>• While costs vary widely, replacing existing boiler(s) with higher efficiency models can be cost effective with paybacks between three and seven years.</li> <li>• While payback periods for even the largest HVAC, electricity and controls upgrades can be kept below 10 years many low cost strategies provide rapid returns of fewer than two years.</li> <li>• Lighting is the primary consumer of electricity in office buildings. Upgrades comprising improved lamps, controls and tenant communication plan can return between 10 and 25 percent improvement in electricity consumption and pay back periods of less than five years.</li> <li>• Building commissioning can return a payback of around two years</li> </ul>
<b>CO<sub>2</sub> emissions savings</b>	<p>CO<sub>2</sub> emission reductions of as much as 0.79tons/1,000sf have been realised through HVAC, controls and lighting improvements</p>
<b>Performance improvements</b>	<p>Go Green Plus buildings on average consume 31 kWh/sf per year which is 11 percent less than the Canadian average.</p> <p>Upgrades comprising improved lamps and controls can return between 10 and 25 per cent improvement in electricity consumption</p>
<b>Environmental considerations</b>	<p>When employee productivity improvements are factored into the cost-benefit analysis of a lighting upgrade, payback periods are reduced from about three years to a matter of days: a compelling proposition for owner-occupier businesses. However, realization of these benefits can be a challenge for the conventional lease structure where the investor is not the direct beneficiary</p>
<b>Other observations</b>	<p>An integrated design and management process that includes a holistic approach to building performance and includes tenants is key to success.</p>

## 2.1 Water Conservation

Reducing water use begins with a water audit of the building. Conservation measures typically focus on reducing the amount of potable water used for landscaping and irrigation, the installation of water efficient fixtures and appliances to reduce domestic uses, and retrofitting once-through cooling systems (for chillers, compressors, condensers, etc) with re-circulating systems.

<b>Go Green Requirements</b>	<p>A water audit of the applicant's building must have been performed within the past three years.</p> <p>Building management must have a written policy that is intended to minimize water use and encourage water conservation.</p>
<b>Financial impacts</b>	<p>Go Green Plus buildings have recouped average annual savings in the region of \$0.01/sf from water conservation strategies.</p>
<b>Payback</b>	<p>Water saving measures can deliver rapid project paybacks (less than two years) when the cost benefit analysis takes into consideration associated energy use reductions for hot water and reduced costs of treatment (e.g. swimming pools, etc). For most water efficiency upgrades, payback is less than two years:</p> <ul style="list-style-type: none"> <li>• Improved blowdown controls on boilers have been shown to can deliver rapid payback (less than two years).</li> <li>• Switching to non-potable water sources for irrigation and building cooling where applicable can deliver rapid payback (less than two years).</li> <li>• The costs of replacing water-efficient fixtures such as dual flush toilets, waterless urinals can be recouped in less than two years.</li> </ul>
<b>CO<sub>2</sub> emissions savings</b>	<p>CO<sub>2</sub> emission reductions may occur if water efficiency strategies result in reduced energy use for heating hot water.</p>
<b>Performance improvements</b>	<p>On average, Go Green Plus buildings use 93 litres of water per square foot per year (data ranges from 56 litres in Quebec to 100 litres in Toronto).</p> <p>Go Green Plus buildings consume 18 per cent less water than average Canadian office buildings.</p>
<b>Environmental considerations</b>	<p>Water efficiency strategies associated with heating hot water will impact energy consumption savings</p>
<b>Other observations</b>	<p>Landscape irrigation is the largest consumer of water in Greater Vancouver office buildings.</p>

## 2.2 Construction Waste

It has been shown that effective DLC (demolition, landclearing, and construction) waste management for both new construction and retrofits not only help protect the environment, but can also generate significant economic savings. Cost-effective reduction of DLC waste requires careful planning for separation and material recovery, with recovery requirements often included in project specification and contracts. Sub-contractors are often held accountable through proper documentation processes.

<b>Go Green Requirements</b>	Building management must have a written policy that is intended to minimize construction waste being sent to landfill.
<b>Financial impacts</b>	Savings can be realized from reduced tipping fees and increased revenue from the sale of salvaged materials. In one case this resulted in savings worth \$0.48/sq. ft. Coordinated waste management programs have been shown to deliver savings of as much as 30 per cent of waste disposal costs.
<b>Payback</b>	Can be immediate
<b>CO<sub>2</sub> emissions savings</b>	CO <sub>2</sub> emission reductions may occur as a result of less reduced haulage
<b>Performance improvements</b>	Construction waste diversion rates in recent tenant improvement projects in Vancouver have exceeded 70 per cent with negligible impact on project cost and schedule.
<b>Environmental considerations</b>	Construction waste comprises between 30 and 40 per cent of Greater Vancouver's landfills
<b>Other observations</b>	Savings from waste diversion are maximized through early planning, clear communication with the contractor and ongoing communication with trades. In Greater Vancouver disposal bans are in effect for cardboard and gypsum. There are plans to implement a ban on electronics disposal in the near future

## 2.3 Recycling

Office buildings generate large volumes of recyclable wastepaper, typically representing 75 to 80 per cent of all waste generated. At this time, paper is the only significant material recycled from office buildings that has the potential to generate revenues, which can then subsidize the costs recycling other materials. Therefore it is important to consider recycling program costs as a "basket of goods" when assessing costs and benefits. Employee buy-in and participation is also crucial for the success of any recycling program.

<b>Go Green Requirements</b>	Building management must have implemented a program that incorporates the recycling of all fibre and consumable products such as office paper, newspaper, cardboard, plastic, cans and bottles, for both tenants and operations at the site.
<b>Financial impacts</b>	Disposal costs are now higher than recycling costs for some materials helping to support the business case for recycling programs. In one case approximately 17 trucks avoided per building resulting in an average annual savings of about \$0.02/sf from reduced haulage trips and tipping fees.
<b>Payback</b>	Payback from setting up and managing a recycling program can be immediate.
<b>CO<sub>2</sub> emissions savings</b>	CO <sub>2</sub> emission reductions may occur as a result of less reduced haulage
<b>Performance improvements</b>	Go Green Plus buildings divert approximately 17 per cent more waste than an average building. An estimated 583 tonnes of waste is diverted annually from one average Go Green Plus building which equates to 0.6Kg (1.32lbs) per square foot.
<b>Environmental considerations</b>	The average office worker uses approximately 0.68Kg (1.5lbs) of paper each day. 85 per cent of waste diverted from a typical Go Green Plus building is paper.
<b>Other observations</b>	A tenant communication program is critical to the success of any recycling program. Recycling programs for plastics require additional investment given low weight to volume ratio, low value of waste material and subsequent high recycling costs. While the collection of organic waste is still in its infancy, a few businesses are investigating feasibility and undertaking pilot projects.

## 2.4 Hazardous Materials

The average multi-tenant office facility has a myriad of hazardous products, including oils, glycol, fluorescent lamps, batteries, asbestos, lead, silica, man-made fibre, mould, and cleaning solvents.

An effective hazardous materials management plan begins with an inventory of current materials and the development of work practices and procedures for proper handling. Training is often required, especially for those supervisors and/or workers directly involved with the materials.

<b>Go Green Requirements</b>	Building management must have completed a hazardous materials survey and maintained an inventory of these materials. Where hazardous materials are present in the building, a hazardous materials management plan must be in place.
<b>Financial impacts</b>	The costs of implementing a comprehensive HAZMAT communication and education program are more than offset by improved occupant well-being and reduced insurance claims.
<b>Payback</b>	No data available.
<b>CO<sub>2</sub> emissions savings</b>	No data available
<b>Performance improvements</b>	While quantitative data is not available, case studies show that occupant well-being is improved through reduced exposure to HAZMAT. Insurance claims may also be reduced on account of safer working environments and improved storage, handling and disposal practices.
<b>Environmental considerations</b>	Managing hazardous materials (HAZMAT) is increasingly important as health risks related to building materials become better understood. Disposal of HAZMAT is also becoming easier and cheaper with recycling facilities available for fluorescent lighting, electronics etc
<b>Other observations</b>	Tenant education programs, particularly with respect to newer recycling programs (batteries, fluorescent lamps, electronics, etc) are critical for success. As new products enter the market, management of HAZMAT components is sometimes challenged by lack of recyclers and disposal facilities: a disposal policy can be valuable for tenant communication.

## 2.5 Materials Selection

Material selection can impact occupant health, operation and maintenance contracts and building durability. A materials selection policy should, as much as possible, consider the environmental impacts throughout a material's entire lifecycle. Many manufacturers have made this task easier by creating industry-specific certification and labelling programs.

<b>Go Green Requirements</b>	Building management must have a written policy for the selection of building materials that attempts to reduce any potential negative impact on the environment.
<b>Financial impacts</b>	<p>The costs and benefits of material selection need to factor in life-cycle considerations: sometimes an additional up-front cost for a higher-performance product can be paid back quickly or may eliminate another cost down the line.</p> <p>Manufacturers are rapidly rolling out competitively priced greener healthier options to their product lines.</p>
<b>Payback</b>	Varies
<b>CO<sub>2</sub> emissions savings</b>	Buying local products and products with recycled content may reduce CO <sub>2</sub> emissions at the manufacturing stage.
<b>Performance improvements</b>	<p>The performance of green products varies</p> <p>While many green products such as paint, carpet, furniture and so on perform as well as conventional alternatives, care is necessary to clearly describe performance standards expected of products and assemblies.</p>
<b>Environmental considerations</b>	<p>Material selection can impact occupant health, operation and maintenance contracts and building durability.</p> <p>Suppliers are going green, enacting zero-waste policies for their products and offering servicing and take-back programs (e.g. carpet, furniture, etc).</p>
<b>Other observations</b>	<p>The health impacts of building products is becoming better understood and increasingly valued by tenants.</p> <p>The growing number of different green product labels can cause confusion.</p> <p>Installation of greener products require education and communication programs for tenants and janitorial staff to ensure they are utilized and cared for correctly.</p> <p>The development of a consistent policy will enable clear communication of expected product standards and performance with designers, tenants and suppliers.</p>

## 2.6 Ozone Depleting Substances

Ozone depleting substances (ODS) commonly occur as man-made gases in chillers, air conditioning and refrigeration systems. ODSs largely comprise chlorofluorocarbons (CFCs), hydrofluorocarbons (HCFCs), hydrochlorofluorocarbons (HCFCs), and halons. Halons are typically used in fire protection systems in fixed installations for computer equipment, electricity board switch gear, and in hand-held fire extinguishers.

Ensuring that a building is not contributing to ozone-depletion begins by taking an inventory of materials and equipment containing CFC's and HCFC's, and then planning for their replacement. Refrigerant leak detection and proper maintenance techniques are also critical for minimizing the release of ODSs.

<b>Go Green Requirements</b>	Building management must have a documented plan for identifying and ultimately eliminating the use or storage of ozone depleting substances.
<b>Financial impacts</b>	Non-ozone depleting alternative HFC refrigerants are cost competitive with traditional products
<b>Payback</b>	No data available
<b>CO<sub>2</sub> emissions savings</b>	Like CO <sub>2</sub> , ozone-depleting substances (ODSs) significantly contribute to global greenhouse effect.
<b>Performance improvements</b>	The performance of non-ozone depleting alternative HFC refrigerants has been shown to perform to the same standards as traditional products.
<b>Environmental considerations</b>	ODSs are extremely hazardous to human health and are a primary driver of atmospheric pollution and global warming Disposal ODSs is proving increasingly challenging and expensive.
<b>Other observations</b>	There is increasing awareness of the ozone depleting potential of CFC and HCFC refrigerants. The development of a management plan has proven valuable to identify, coordinate and budget for the storage and phase-out of ODSs.

## 2.7 Indoor Air Quality

Increased indoor air quality (IAQ) improves occupant health, resulting in increased productivity and less absenteeism. Managing a building for good indoor air quality involves properly operating and maintaining HVAC equipment, implementing staff and tenant IAQ management plans, ensuring adequate ventilation and careful selection of indoor materials.

<b>Go Green Requirements</b>	Building management must have in place a documented means for addressing tenant/occupant concerns regarding indoor air quality.
<b>Financial impacts</b>	<p>The costs of improved indoor air quality have been shown to be recouped through faster lease-up rates, higher rents and lower tenant turn-over. Most importantly, improvements in indoor air quality can result in increased employee productivity of up to 30% in some cases.</p> <p>Buildings renovated to high standards of IAQ and environmental performance have leased up 20% faster and avoided as much as \$25psf in tenant improvements.</p>
<b>Payback</b>	While data for BC buildings is sparse, it has been shown elsewhere that ventilation and daylighting improvements can return paybacks of less than 5 years for energy savings and less three years in productivity improvements.
<b>CO<sub>2</sub> emissions savings</b>	CO <sub>2</sub> emissions savings may occur where IAQ strategies incorporate energy saving measures
<b>Performance improvements</b>	<p>Although difficult to quantify, the largest benefit offered by a healthy building is employee productivity.</p> <p>Studies have shown that worker productivity in green and healthy offices can improve between two and 16 per cent.</p> <p>Green commercial offices report lower vacancies. In some cases all the tenants were retained.</p> <p>Doubling outdoor air supply rate at constant pollution load, or a two-fold decrease of pollution load at constant ventilation rate, can increase human performance by 1.9%.</p> <p>Green health care facilities with high IAQ standards have enjoyed a patient recovery rate of as much as 21 per cent faster than average.</p> <p>Educational establishments have shown that test scores can improve by as much as 20 per cent in healthy, day lit classrooms.</p> <p>Increases in retail sales in the region of 40 per cent due to green renovations have been reported by companies such as Wal-Mart</p>
<b>Environmental considerations</b>	A healthy building invariably offers other benefits as well such as energy savings. A holistic approach to budgeting and planning is necessary to optimize gains.
<b>Other observations</b>	The creation and regular update of an IAQ profile will provide prompt feedback of potential issues.

## 2.8 HVAC Maintenance

Maintenance on HVAC systems is often deferred until breakdowns occur. A HVAC preventative maintenance program will save money in the long run and will help ensure that indoor air quality objectives are being met.

<b>Go Green Requirements</b>	Building management must have in place a heating, ventilation and air conditioning (HVAC) preventative maintenance program.
<b>Financial impacts</b>	<p>Costs and savings vary widely and depend on (1) size of the heating plant, (2) number of boilers, (3) severity of existing problems, and (4) condition and operation of the boiler prior to adjustments.</p> <p>The average cost for air sealing contractor and consultant - \$30,000 for medium sized building</p> <p>Cost of installing thermostat for electric heaters with 120 or 240 volt thermostats - \$140 to \$170</p> <p>Cost for air balancing - \$30 to \$40 per zone</p> <p>Overall cost to install timeclocks to control exhaust fans - \$200 per fan. Results in savings will be influenced by the number and size of local exhaust fans controlled.</p> <p>Cost to have pipework insulated - \$5 to \$20 per linear metre (\$1.50 to \$6 per foot) depending on pipe diameter. Results in savings from pipework insulation can be influenced by (1) surrounding air temperatures, (2) value and condition of existing insulation, and (3) contribution of pipe heat loss to space heating.</p> <p>Cost of installing duct insulation based on a 20 inch x 20 inch duct \$5 to \$14 per linear foot.</p> <p>Cost savings for air sealing and repairs will be influenced by: (1) existing condition of the duct and duct insulation, if any, (2) volume and temperature of air being moved, (3) temperature of area surrounding the ducts.</p>
<b>Payback</b>	<p>Payback on regular diagnostics and maintenance is five to seven years for atmospherically vented gas boiler (based on typical improvements) and four to six years for gas boilers with power venting systems or oil-fired boilers.</p> <p>Prompt upgrades of controls, replacement of filtration media and fine-tuning offer rapid paybacks (less than three years for controls; immediate payback on filters and cleaning when occupant well-being is factored in).</p>
<b>CO<sub>2</sub> emissions savings</b>	CO <sub>2</sub> emissions savings may occur where energy saving measures are implemented.
<b>Performance improvements</b>	Testing and performing regular adjustments to boiler combustion efficiency to ensure peak operating performance will result in maintaining optimum efficiencies range between 75 to 80 per cent. Boiler efficiency can fall to 50 per cent or less without proper maintenance and adjustment.
<b>Environmental considerations</b>	Poor HVAC maintenance can impact indoor air quality and the health of occupants leading to insurance claims.
<b>Other observations</b>	Tenants are asking about building systems maintenance schedules and are becoming aware of the link between optimal maintenance of systems and occupant health.

## 2.9 Communication Program

Tenant and employee engagement and participation are critical to the success of any Go Green program. Tenants can help identify indoor air quality problems, impact daily energy and water use and determine the success of a recycling program. An effective communication program depends on frequency, accuracy, comprehensiveness, and inclusiveness.

<b>Go Green Requirements</b>	Building management must have in place a well-understood system for communicating with tenants/occupants on environmental issues specific to the building
<b>Financial impacts</b>	<p>Given current levels of energy wastage in lighting and office equipment operations and low recycling levels, there are significant savings to be gained from tenant communication programs.</p> <p>Case studies have revealed \$44 in savings per year per computer station by shutting off computers and monitors during evenings and on weekends which extrapolates to a saving in the region of \$0.30/sf for an office building at an occupancy of one worker per 150 sf.</p>
<b>Payback</b>	Sophisticated programs, appropriately structured, have been shown to pay for themselves out of the savings they generate.
<b>CO<sub>2</sub> emissions savings</b>	CO <sub>2</sub> emissions savings may occur where energy saving measures are implemented
<b>Performance improvements</b>	Tenant communication programs are critical to the long-term success of a building improvement project. Neglecting to engage tenants in a building improvement project can not only jeopardize project success but may even result in unhappier tenants and a poorer performing building than before the project started.
<b>Environmental considerations</b>	Tenant engagement, education and ongoing communication is critical to the success of any building performance improvement program.
<b>Other observations</b>	<p>Tenant communication programs need to be adequately planned, budgeted and then maintained and monitored.</p> <p>Feedback opportunities for tenants are important as are a go-to-person to address complaints and provide prompt responses to questions.</p>

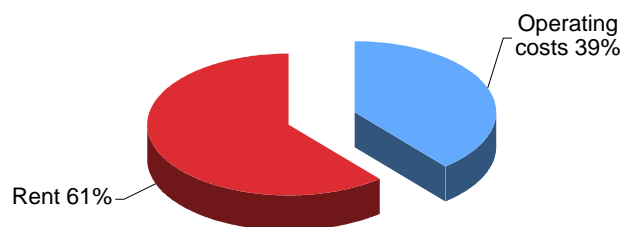
## 2.10 Considerations of Both Cost and Value

When contemplating green improvements to a building it is important to review not merely cost and payback but also the impacts of the improvements on asset value. While it is beneficial to prioritize bottom line financial savings in order to engage with the capital planning process, these savings ultimately only comprise a modest part of the total costs of operating a building and make up even less of the total cost of operating a business.

For example: Pennsylvania Power and Light noted a conversion's electricity savings amounted to a payback in 4.1 years with a 24 percent return on investment. However, benefits from lower absenteeism and higher productivity meant a simple payback of just 69 days, a 540 percent return on investment<sup>16</sup>.

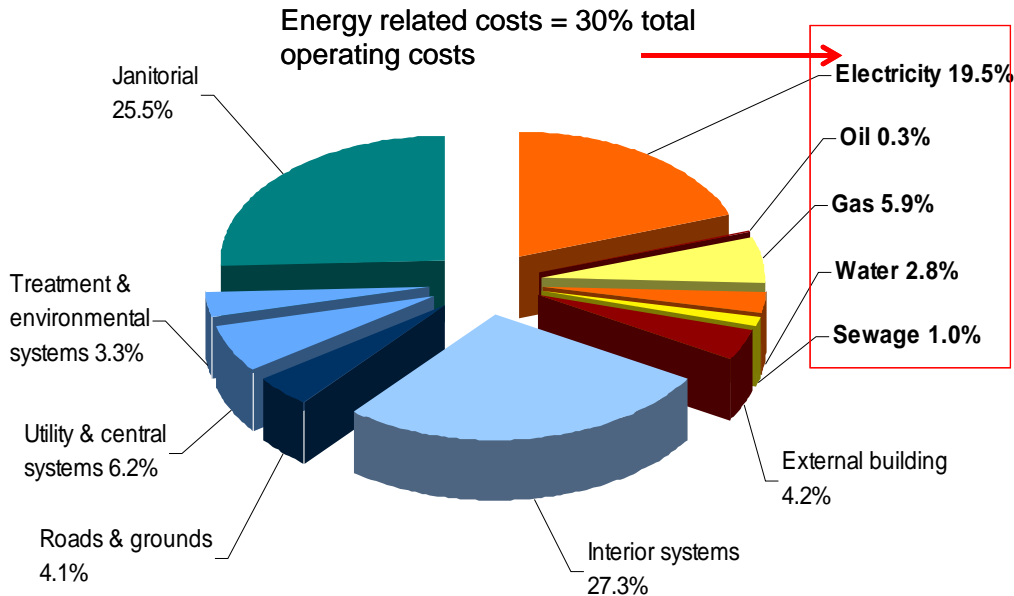
Because they are easy to measure, a lot of attention has been focused on energy savings. However, these are small when compared to overall business costs. According to CB Richard Ellis and the International Facilities Management Institute, rent comprises on average 61 percent of total building costs in Greater Vancouver with operating costs making up only 39 percent. When operating costs are broken down, energy related expenses comprise approximately 30 percent of operating costs which in turn make up less than 12 percent of total building costs.

### Average building costs in Greater Vancouver 2006<sup>17</sup>



<sup>16</sup> Green Value Report, [www.rics.org](http://www.rics.org)

<sup>17</sup> Data courtesy CB Richard Ellis, International Facilities Management Institute, Asset Strategics 2006

**Breakdown of commercial building operations costs<sup>18</sup>**

Both cost and value are therefore critical factors in the business case for performance improvements in buildings. According to a 2005 report completed by the Royal Institute of Chartered Surveyors<sup>19</sup>, there is the potential for a range of additional and sizeable benefits to be factored into the overall value proposition of a particular green strategy. When compared to the total costs of operating a business, energy costs are less than one per cent. By comparison, total annual real estate expenses are usually around 10 percent of such costs, while staff costs can be as high as 85 percent. This means that the biggest return on investment should arise when green buildings improve business productivity.

The study uncovered instances of green features improving productivity and some examples are cited in this report in the Indoor Air Quality section. The study concludes that green buildings can achieve greater value than their conventional equivalents. However, in all cases neither owners, developers, appraisers nor the green building sector, fully value or communicate this advantage.

<sup>18</sup> Data courtesy CB Richard Ellis, International Facilities Management Institute, Asset Strategics 2006

<sup>19</sup> Green Value, [www.rics.org](http://www.rics.org)

**Property value benefits of green improvements**

The Royal Institute of Chartered Surveyors researched and analysed a wide range of building types to verify the extent to which property value was impacted by the adoption of green features. It was demonstrated that significant benefits were available in the following areas:

- Increased productivity
- Improved risk, marketability
- Lower operation/maintenance costs
- Energy & resource savings
- Grants, subsidies, inducements etc.
- Attract tenants faster (i.e. absorption)
- Higher rents, investment/sale value
- Lower turnover/vacancy
- Reduced fitting-out costs (i.e. TI's)
- Lower internal move costs (i.e. churn)
- Faster, better public process

**Green Value Study [www.rics.org](http://www.rics.org)**

Improving efficiencies within serviceable building stock have also been shown to offer significant savings both to the building's direct beneficiaries and the region as a whole. The following table developed by Sheltair for the GVRD shows that by greening only 20 per cent of Greater Vancouver's building stock, the region would net over \$2.8 billion in energy and infrastructure savings.

**Value of resource conservation attributable to green building in the Greater Vancouver region 2000 to 2005<sup>20</sup> (\$ millions)**

Proportion of green building	Energy savings	Water & wastewater savings	Solid waste savings	Air quality savings	Net savings
20%	2,170	480	30	130	2,810
40%	4,340	960	60	260	5,620
60%	6,510	1,440	90	390	8,430
80%	8,680	1,920	120	520	11,240

**2.10.1 An Integrated Approach is Key to Success**

Review of successful retrofit projects demonstrates that a holistic approach to building improvements, when applied, consistently generate more reliable and substantial returns than a piecemeal method. As shown in the case studies cited in this report, investments in capital upgrades have reaped greater returns when combined with:

- Creation of (or improvements to) building management frameworks
- Tenant awareness programs
- Energy use benchmarking
- Operator training

For example, while the investment in a single strategy to improve building performance (such as an upgrade in building controls) might recoup savings in the region of \$0.05 - \$0.10/sf<sup>21</sup>, one project which embraced a holistic approach to the entire building systems and undertook a comprehensive overhaul of HVAC and electrical systems returned annual savings of up \$0.51/sf<sup>22</sup>.

Research into case studies for this report has shown that it is the most significant environmental and operational improvements that tend to be documented and these projects have invariably adopted an integrated approach. It has proven difficult in some cases to separate the individual impacts and benefits of specific strategies. Moreover, if

<sup>20</sup> Strategic Assessment of Resource and Economic Impacts of Green Buildings in Greater Vancouver (2004)

<sup>21</sup> interview with building controls specialist EMCO

<sup>22</sup> The Vancouver Centre – refer to case study under 1. Energy Use

individual strategies are undertaken in isolation then the operational and environmental improvements are likely to be less.

The optimization of environmental performance is best achieved through an Integrated Design Process (IDP) which consists of a series of charrettes in which all parties in the building process contribute to the development of the building design. While the IDP process is gaining acceptance within the new construction realm, it is equally applicable and beneficial to renovations and retrofits. IDP enables all aspects of the building and the building process to strive to minimize their impact on the natural environment.

Traditional building processes are linear with the architect and/or engineer determining the project design and the contractors building (and troubleshooting) the specifications that they are given. In contrast, in an IDP, the project would be designed with the engineering systems and construction practicalities in mind, so that all systems and processes are optimized.

While integrated design is rapidly being taken up within the new construction sector, IDP has also been successfully applied to building retrofits and tenant improvements. As a result, deeper green solutions tend to be undertaken as a bundle of measures rather than in isolation.

#### **Benefits of IDP**

**Collaboration:** Cultivating collaboration among all players in the building process to create a context in which a design team can better achieve goals, maximize benefits, alleviate both real and perceived risks and to introduce specialized and local knowledge in a timely manner.

**Communication:** Creating a context that permits a rigorous and intentional communication process will reconcile multiple points of view and enhance the synergies between systems and strategies.

**Cost savings:** Exposing potential cost savings through synergistic strategies and systems and permitting more effective solutions to be discovered through direct exchange of ideas and feedback. The additional time and money for meetings and communication may be offset through savings from more efficient design and the avoidance of costly mistakes.

**Improved performance:** Bringing operations staff into the process early may ensure that a building performs as intended. Contractors experienced in green buildings will have more knowledge of alternative design strategies and can include them early in the process. They can offer practical experience to the team and give more accurate estimates of construction consequences and costs.

**Prof. Ray Cole "Building Green: Adding Value through Process" 2005**

### 3 Next Steps

This report presents potential economic benefits and impacts of incorporating green and healthy strategies into building retrofits and the value of the Go Green program as a framework within which to manage these improvements. Without a doubt, Go Green's primary value is as a tool to guide the investigation, assessment and prioritization of the options available to owners as they contemplate building improvements.

Careful planning is critical to success and the first step to improve building performance commences with an audit of existing operations, resource flows and patterns of use. BOMA Go Green provides a practical framework to the initial audit and assessment processes. While audits of all aspects of building operation are key to success, the two primary considerations, given their direct impacts on capital investment and operational costs, are energy and water use. With the significance of health and occupant well-being in reducing lease-up time, improving tenant retention and reducing vacancy rates, the optimization of indoor air quality is the third area which demands scrutiny.

#### 3.1 The Energy Audit

The upgrade of base-building services is expensive and normally only undertaken in conformance with long-range capital investment plans. An energy audit is a valuable first step for building managers interested in identifying and prioritizing potential improvements in performance and operational efficiency.

Frequently, audits reveal that less costly investments in improved controls, monitoring and benchmarking systems in parallel with operator training and tenant education programs, will deliver sizeable energy efficiencies within shorter payback periods. Detailed audit protocols are available such as BC Hydro's Detailed Energy Audit Requirements<sup>23</sup> or via a range of proprietary computer modelling systems.

An energy assessment examines the ways energy is currently used in a building or facility and identifies alternatives for reducing energy costs. The goals of the assessment are:

- to clearly identify the types and costs of energy use,
- to understand how that energy is being used and possible wasted.
- to identify and analyze alternatives such as improved operational techniques and equipment upgrades that will reduce energy costs, and

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<sup>23</sup> more information at [www.bchydro.com/business](http://www.bchydro.com/business)

- to perform an economic analysis on the alternatives to determine which ones are most cost effective.

Before the energy assessment is performed, as much of the following information is gathered and analyzed as possible:

- The facility layout including floor area(s), floor plan(s), construction features (wall and roof materials and insulation levels) and door and window sizes and construction.
- Operating hours.
- Equipment lists including boilers, space heaters, air conditioners, chillers, water heaters and process equipment.
- Heating degree days (HDD) and cooling degree days (CDD) for the location.
- Utility bills for the past three years.

There are three levels of energy assessment

- **Level 1: Walk-through assessment:** This includes a tour of the building to visually inspect each system. Energy consumption data is analyzed in terms of quantities and patterns. Comparisons are made with industry averages or benchmarks. Clients are provided with preliminary estimates of saving potentials and a list of low-cost savings opportunities through improvements in operational and maintenance practices and minor equipment upgrades. Simply paybacks are usually provided. Recommendations are made for more detailed future assessments.
- **Level 2: Standard assessment:** The standard assessment quantifies energy use and losses through a detailed review and analysis of systems, equipment, operational characteristics and on-site measurements and testing. Standard engineering calculations are used to analyze efficiencies and calculate energy and cost savings based upon upgrades to each system. The assessment will include an economic analysis of recommended energy saving measures.
- **Level 3: Computer simulation:** This assessment is usually only warranted for complex facilities or systems. It includes a detailed analysis of energy use by function and a comprehensive evaluation of energy use patterns. Computer simulation software is used to predict building system performance and accounts for changes in weather and other conditions. The goal is to build a base for comparison that is consistent with the actual energy use of the facility. The assessor then analyzes upgrades to the various systems to improve efficiency and

measure their effects compared to the baseline. This method also accounts for interactions between systems to prevent an overestimate of savings.

#### **Sub-metering the key to drilling down to individual tenants energy consumption**

Taking the measurement and monitoring of energy use beyond a one-time audit requires more substantial commitment and specific budget allocation. However, for those buildings in which tenant energy use is widely disparate (such as multi-tenant laboratories, technical facilities, etc), the investment in a sub-metering system at the time of a comprehensive building systems retrofit may make sense.

Easily accessible feedback on resource use increases both awareness and motivation to act in ways that change attitudes, minimize resource use and save money. Companies that have implemented a process to measure and record their energy consumption, monitor their consumption against targets, and take action to address variances from the targets can reduce their energy costs by 5–25% through implementing low-cost or no-cost operational changes.

**“The costs and benefits of sub-metering” Light House Sustainable Building Centre 2007.**

## **3.2 The Water Audit**

A water audit is a systematic approach to collecting information about water flows coming into the building, the water uses and processes within the building, and the wastewater outputs. An audit is the first step to a better understanding of water consumption levels and patterns.

Water audits are classified into level 1, 2, or 3 depending on the degree of detail. The classification system comes from energy auditing industry norms and the work of Natural Resources Canada.<sup>24</sup> Water audit costs vary depending on the level of the audit and the type of building. There are three levels of water audit

- **Level 1 Scoping:** a walk-through audit comprising a systems analysis of the facility water consumption and develops a rough baseline of water uses and requirements in terms of quality, quantity, and seasonal variation. The process is designed to be an efficient tool for identifying and prioritizing water conservation opportunities. The report provides sufficient documentation to proceed with an in-

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<sup>24</sup> GVRD Standardized ICI Water Audit Process

house water conservation program and/or identify areas where more detailed investigation is required.

- **Level 2 Scoping with In-depth assessment in some areas:** consists of a level 1 audit for the whole facility and a level 3 depth audit only for specified items such as a cooling system for example.
- **Level 3 In-depth assessments in all areas:** provides a detailed summary of all water consumption with engineering calculations documenting feasible water conservation opportunities.

### 3.3 The IAQ Profile

Addressing tenant/occupant concerns regarding indoor air quality requires developing a system for identifying and diagnosing indoor air quality problems. It is important to initially gain an understanding how indoor air quality is impacted by air movement within the building and possible source contaminants. Other environmental stressors such as improper lighting, noise, vibration, overcrowding, ergonomic stressors, and job-related psychosocial problems (such as jobs stress) can produce symptoms that are similar to those associated with poor air quality and so having a basic understanding a building's current air quality will help owners and managers properly diagnose potential problems.

An IAQ profile, describes the features of the building structure, function, and occupancy that impact indoor air quality. The IAQ profile can be divided into three major stages and can be done in conjunction with the energy assessment or as part of the development of the HVAC's preventive maintenance program.

- Collect and review existing records.
- Conduct a walkthrough inspection of the building.
- Collect detailed information on the HVAC system, pollutant pathways, pollutant sources, and building occupancy.

## **Appendix A - Energy Conservation**

## A. Energy Conservation

### GO GREEN REQUIREMENTS

**An energy audit of the applicant's building must have been performed within the past three years.**

**Building management must have a written plan to address energy issues raised in the audit.**

### KEY FINDINGS

The level of investment and the resulting savings varies widely depending on the exact nature of the upgrades, as does the payback, but is generally 5 – 8.5 years. Findings include:

- Go Green Plus buildings on average consume 31 kWh/sf per year which is 11 percent less than the Canadian average.
- Comprehensive HVAC and electrical improvements on office buildings in Vancouver have successfully delivered as much as 20 percent energy savings at capital costs of between \$4 and \$5 per sf net leasable, bringing their annual energy costs to below 30 kWh/sf per year and recouping annual savings of up to \$0.50/sf.
- Payback periods for HVAC, electricity and controls upgrades can be kept below 10 years. Many low cost strategies provide rapid returns.
- Lighting is the primary consumer of electricity in office buildings. Upgrades comprising improved lamps, controls and tenant communication plan can return between 10 and 25 percent improvement in electricity consumption and pay back periods of less than 5 years.
- Substantial gains in productivity and occupant well-being should be factored into the cost-benefit analysis of a lighting upgrade.
- An integrated design and management process that includes a holistic approach to building performance and includes tenants is key to success.

## A.1. Energy Conservation Overview

The average energy consumption in Canadian office buildings is 36 kWh/SF/year<sup>25</sup>. Across North America, building owners spend an annual average of \$1.34 per square foot on electricity and 18 cents per square foot on natural gas. Energy represents about 19 percent of total expenditures for the typical office building<sup>26</sup> of which lighting, heating, and cooling represent between 54 and 71 percent of total energy use depending on climate<sup>27</sup>.

In the GVRD in 2004, 61 million GJ of natural gas and 51 million GJ of electricity were consumed in buildings<sup>28</sup> which, when taken together, totals approximately \$1.4 billion in annual energy costs<sup>29</sup>. Energy use within buildings is impacted by:

- Building size, age
- Type of owner (government, non-profit, private organization, individual, etc)
- Orientation, location and use
- Heating, cooling, ventilation systems and controls
- Lighting systems and controls

In 2006, British Columbia imported approximately 10 percent of electricity supply. Demand for electricity is anticipated to grow by up to 45 percent over the next 20 years<sup>30</sup>. Every year since 2001, BC has been a net importer of electricity. In 20 years, as demand grows, the province is expected to need significantly more electricity.

The growing gap between electricity supply and demand will increasingly expose businesses to uncertain market rates. Conservation will become increasingly important as BC aims to recoup 50% of incremental electricity demand through efficiency measures. Building owners will be increasingly targeted for energy efficiency measures.

The financial impact of energy savings is significantly greater than those savings associated with water, wastewater, solid waste or air quality. The business case for the

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<sup>25</sup> Energy Savings report for BOMA BC by Douglas Spratt and Associates, February 2007

<sup>26</sup> [www.bchydro.com/business/investigate/investigate6009](http://www.bchydro.com/business/investigate/investigate6009)

<sup>27</sup> [www.bchydro.com/business/investigate/investigate6009.html](http://www.bchydro.com/business/investigate/investigate6009.html)

<sup>28</sup> [www.gvrd.bc.ca/buildsmart](http://www.gvrd.bc.ca/buildsmart)

<sup>29</sup> Assuming marginal cost rates of electricity: 6.79 cents / kWh  
and Natural Gas: \$8.189 / GJ

<sup>30</sup> [www.energyplan.gov.bc.ca](http://www.energyplan.gov.bc.ca)

benefits of resource savings is also supported by the decision of some of the world's largest companies, such as IBM, Southern California Gas Company, Ford Motor Company, Lockheed, Toyota, and Wal-Mart to build green.

## A.2. Improving Energy Use 1: HVAC Systems and Controls

HVAC equipment can account for nearly 50% of building energy costs. Investing in the most efficient equipment and controls can deliver substantial savings while optimizing building comfort as possible for occupants. Strategies can include both short-term and often simple, low-cost measures as well as long term solutions which need to be planned and factored into maintenance and capital investment plans. The most successful solutions are derived from a holistic approach to energy management. Projects that include improvements to management frameworks, operator training, tenant awareness and control systems tend to return better ROI on capital investments.

### Summary of financial impacts of HVAC improvements<sup>31</sup>

Strategy	Financial considerations	Simple payback period
Replace large electric fan and pump drive motors (1 hp and greater) with high efficiency models	Incremental cost for large high efficiency motors - \$30 to \$90/hp  Annual energy cost savings for continuously operating large motor - \$60 to \$80/hp	6 months to 1.25 years
Replace existing heating and ventilation system in an indoor pool area with a swimming pool dehumidification system.	Installation costs - \$20,000 to \$70,000  (Cost depends on surface area of the pool, ease of connecting to existing air and pool water circulation systems, and availability of electrical and other services)	4 to 8 years for cases where pools were previously ventilated by 100% fresh air, 100% exhaust air systems.
Replace existing boiler(s) with higher efficiency models.	When replacing a boiler, the payback evaluation of the higher efficiency boiler over a standard efficiency model should be based on the incremental cost of the new unit over the standard model.	3 to 7 years

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<sup>31</sup> Ontario Ministry of Municipal Affairs and Housing

### **A.1.1. HVAC Systems Upgrade Case Study**

Project	Vancouver Centre, 650 West Georgia Street, also known as the Scotia Tower	
Location	Vancouver, BC	
Age at time of retrofit	27 years (completed 1977)	
Size	462,500sf net, 34 storeys	
Client	GWL Realty Advisors Inc.	
Consultant	Prism Engineering	
Project completion	2004	
Project cost	\$2.5 million	\$4.32/sf
Savings (electricity)	2,800,000 kWh	6.05 kWh/sf
Savings (fuel)	8,400 GJ	18.16 MJ/sf
Savings (\$)	\$235,000 per year	\$0.51//sf
Carbon emissions reduction	366 tons CO <sub>2</sub> e avoided per year	
Payback period	8.5 years	
Certification	BOMA Go Green	

The Vancouver Centre complex largely comprises office space with ground floor retail and a lower level food court and mall. The primary office tenant is Scotiabank. The building underwent a comprehensive mechanical system upgrade and energy optimization improvement in a series of project stages between January 2003 and May 2004.

The total scope of work comprised the installation of new variable speed chiller plant in tandem with condensate heat recovery “scavenger” systems to recapture heat from the building before sending it to drain, control system overhaul, a lighting retrofit, variable speed drives for all floor fans, heat recovery from steam condensate, and a new integrated HVAC. A new lighting control system was also installed. A key driver for the project was the elimination of the ozone depleting CFC refrigerant R11 in the chilled water system. The annual GHG savings from electricity is 73 tonnes based on the BC average emission increasing to 2,513 tonnes based on the emissions from thermal sources (marginal).

### **Vancouver Centre annual energy savings breakdown 2005**

<b>Utility</b>	<b>Baseline</b>	<b>Savings</b>	<b>% savings</b>
Electrical consumption	\$518,360	\$94,620	18%
Electrical Demand	\$237,565	\$33,535	14%
Steam	\$451,380	\$107,758	24%
<b>Total</b>	<b>\$1,207,305</b>	<b>\$235,913</b>	<b>20%</b>
Total per sf net leasable	\$2.61	\$0.51	

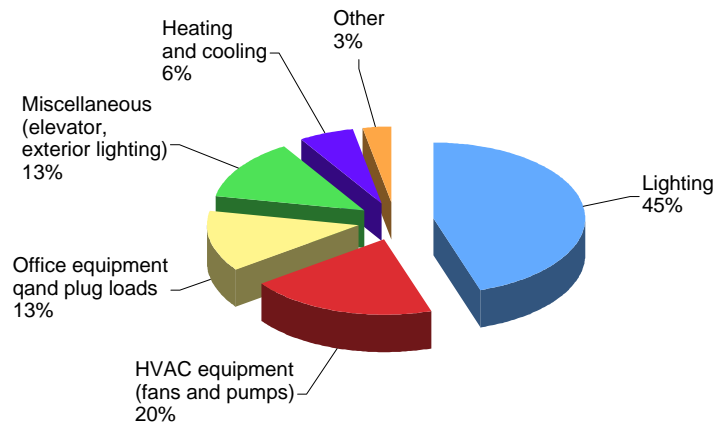
### **A.3. Improving Energy Use 2: Lighting and Electrical Systems**

An audit of electrical consumption patterns can reveal operational inefficiencies and point to investment priorities. In most cases, lighting tends to be the largest user comprising 48 per cent of total electricity costs for the average office building<sup>32</sup>.

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<sup>32</sup> GVRD research

**Electrical use in offices in the GVRD<sup>33</sup>**



Lighting and lighting control upgrades are frequently completed in tandem with programs to reduce plug loads which, on average, comprise 13 percent of office electrical consumption and which largely comprise office equipment and computers. A holistic approach to lighting and electrical retrofits is important as tenant awareness, signage and operator training are all critical to project success. The costs and structure of coordinated marketing campaigns can vary widely. Institutions such as UBC have proven so successful at generating energy savings from social marketing programs that they have been able to fund the entire program through savings.

**Costs and benefits to upgrading lamps**

Strategy	Financial considerations	Simple payback period
Replace interior incandescent light fixtures with fluorescent or LEDs used for 8 hours/day of operation	Approx. \$200 in annual savings in eliminating 1,000 Watts (1 kW) of lighting (based on \$0.08/kWh)	Less than 1 year
Replace T12 fluorescents with T8 lamps with electronic ballasts to reduce electricity consumption by 35% and to achieve better quality lighting	No additional incremental cost for conventional T8s.  Premium T8s can add an additional 15% - 20% savings over conventional T8s.  Add dimmable ballasts and daylight sensors for 25% - 50% cost premium	Less than 1 year

<sup>33</sup> [www.gvrd.bc.ca/smartsteps](http://www.gvrd.bc.ca/smartsteps) Sector Guide for Offices

<b>Strategy</b>	<b>Financial considerations</b>	<b>Simple payback period</b>
Replace incandescent lamps exit signs with LED	Small cost premium determined by volume purchase and lamp type. Some incentive programs available from BC hydro.	Payback 3.7 years for 15 watt Exit sign Payback 2.5 years for 25 watt Exit sign
Replace existing exterior incandescent lighting fixtures and post-top luminaries with high pressure sodium fixtures	Small cost premium determined by volume purchase and lamp type. Some incentive programs available from BC hydro.	Payback less than 3 years for HP sodium lamps which last 10 times longer and use 75 per cent less energy
Timeclock or photocell control to turn outdoor lights off during daylight hours	Small cost premium determined by volume purchase and lamp type.	Payback is 4 years if high quality replacement timeclock controls a circuit with 10 lamps Payback is two years if one lamp is controlled by one individual photocell

### **Costs and benefits to improving energy efficiency in office equipment and computers**

<b>Strategy</b>	<b>Financial considerations</b>	<b>Simple payback period</b>
New equipment to be EnergyStar certified	Cost competitive with conventional	Less than one year
Tenant communication to set all equipment to go into sleep mode and to be shut off at weekends and evenings.	\$44 in savings per year per computer station by shutting off computers and monitors during evenings and on weekends	Less than one year

### A.1.2. Case Study: Lighting and Lighting Control Upgrade



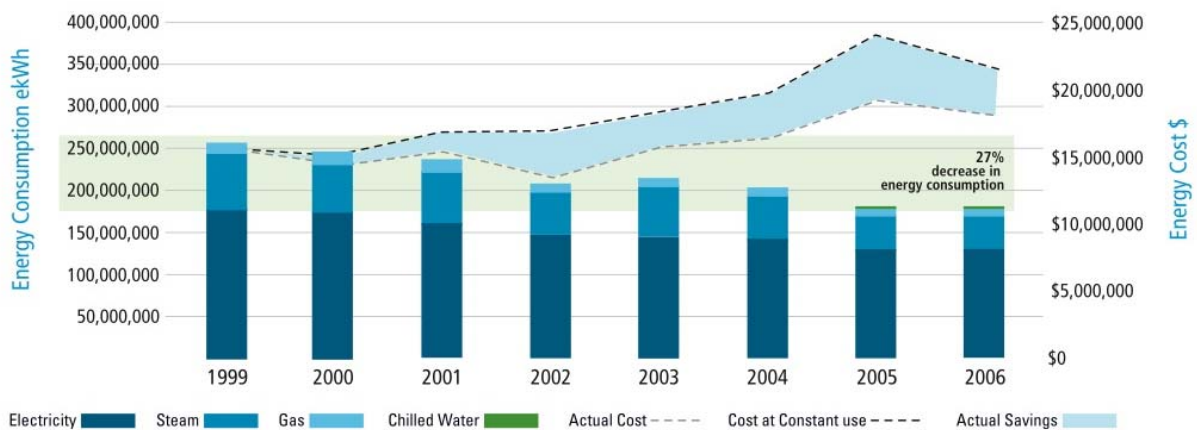
Project	Toronto Dominion Centre Leaseholds Ltd comprising: <ol style="list-style-type: none"> <li>1. TD Centre # 1 - Toronto Dominion Tower, 66 Wellington Street West (completed 1967)</li> <li>2. TD Centre # 2 - Royal Trust Tower, 77 King Street West (completed 1969)</li> <li>3. TD Centre # 3 - Canadian Pacific Tower, 100 Wellington Street West (completed 1974)</li> <li>4. TD Centre # 4 - TD Waterhouse Tower, 79 Wellington Street West (completed 1985)</li> <li>5. TD Centre # 5 - Ernst &amp; Young Tower, 222 Bay Street (completed 1991)</li> <li>6. TD Centre # 6 - 95 Wellington Street West, 95 Wellington Street West (completed 1995)</li> </ol>
Location	Toronto, ON
Age at time of retrofit	Between 5 and 33 years
Size	TD Centre # 1, 56 storeys TD Centre # 2, 46 storeys TD Centre # 3, 32 storeys TD Centre # 4, 39 storeys TD Centre # 5, 31 storeys TD Centre # 6, 15 storeys Total net leasable: 400,000m <sup>2</sup> (4,284,000sf) office and 16,700 m <sup>2</sup> (179,000sf) retail

Client	Cadillac Fairview Corporation Ltd	
Consultant	Ameresco	
Project completion	Lighting retrofit and HVAC controls 2000	
Energy Savings	162 636 GJ (45.18 million ekWh)	
Project cost	\$26,775,000	\$6.00/sf
Savings (\$)	\$4,250,000 per year	\$0.99/sf
Carbon emissions reduction	35,000 tons CO <sub>2</sub> e avoided per year	
Payback period	< 5 years	
Certification	BOMA Go Green Plus (All 6 buildings)	

The Toronto-Dominion Centre houses more than 100 office tenants and some 70 retail concourse tenants: over 21,000 workers in total. A lighting retrofit completed in 2000 comprised lamp replacement with T8 technology or better with electronic ballasts, the installation of occupancy sensors and automated lighting controls.

Financial assistance from the federal government through the Energy Innovators Initiative (EII) helped to pay for a communication program to improve employee and tenant awareness and to train staff on the improved facility systems.

**Toronto-Dominion Centre energy implementation plan<sup>34</sup>**



<sup>34</sup> Chart courtesy Energy Efficiency at Work [www.energy-efficiency.com](http://www.energy-efficiency.com)

## TD Centre total annual energy savings breakdown 2002

	Baseline	Savings	% savings
Total	\$16.75 m	\$4.25 m	25%
Total per sf	\$3.75	\$0.99	

### A.1.3. Other Examples

#### **UBC's Ecotrek project: a case study in Energy Performance Contracting**

Through a cost recoverable method known as Energy Performance Contracting (EPC), UBC was able to undertake an enormous energy and water savings initiative that took place over a period of three years.

At a cost of \$35m, Ecotrek is the largest project of its kind Canada and involved rebuilding and retrofitting the infrastructure of nearly 300 academic buildings totalling approximately 6.8 million square feet of building space. The EPC enabled savings from the program to be re-invested in further conservation measures: the program, thereby largely paying for itself.

To date, Ecotrek has reduced core campus energy use by over 20% and saved:

- \$590,000 in electricity costs
- \$1.8 million in steam heating
- \$1.5 million worth of water (30% reduction)
- 11,625 tonnes of GHG (reduction of 80%).

[www.ecotrek.ubc.ca](http://www.ecotrek.ubc.ca)

#### **Better lighting pays off...**

Pennsylvania Power and Light upgraded the lighting in drafting engineers' offices to high efficiency lamps and ballasts and reconfigured them to eliminate glare. Controls were installed to selectively light specific work areas. Total cost was \$8,362. Observed benefits were:

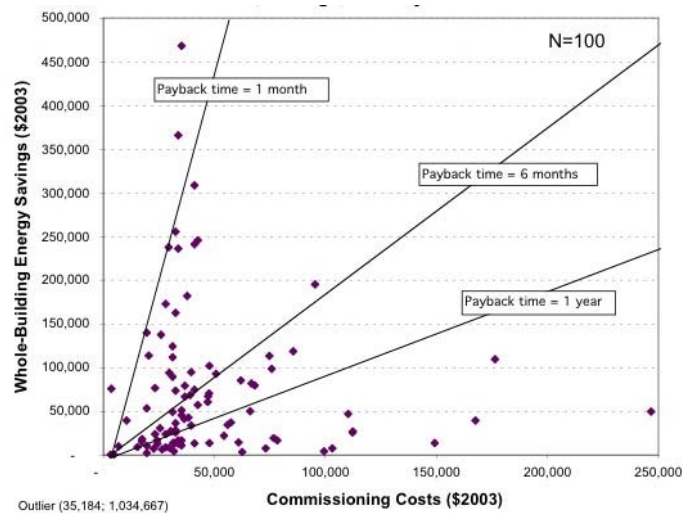
- Productivity increased 13.2% - \$42,240/yr, a 69 day payback
- 25% decrease in sick leave
- Reduction in errors estimated at a value of \$50,000/yr
- Lighting energy use dropped by 69%; annual operating costs fell 73% from \$2,800 to \$765; total annual savings of \$2,035 (4-year payback).

**Greening the Bottom Line: Increasing Productivity Through Energy-Efficient Design By: Joseph J. Romm and William D. Browning**

#### A.4. Improving Energy Use 3: Commissioning

Building commissioning is gaining acceptance as an emerging form of quality assurance. Commissioning is conventionally associated with the need to detect and remedy operational deficiencies stemming from design flaws, construction defects, malfunctioning equipment, and deferred maintenance. However, in high-performance buildings, commissioning is a necessary part of the retrofit project to ensure that the owner's operational needs are met, building systems perform efficiently, and building operators are properly trained.

##### Commissioning costs, savings and payback times<sup>35</sup>



Scattered case studies and anecdotal information form the basis of the conventional wisdom among Canadian energy-management professionals that commissioning is highly cost-effective. However, there is a lack of standardized information on costs and benefits of detecting and correcting deficiencies in Canada. The most comprehensive data comes from a 2004 US report completed by Lawrence Berkeley National Laboratory.<sup>36</sup> The study found that median commissioning costs were in the range of US\$0.27/sf, that whole-building energy savings averaged 15 percent and that average payback times were

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<sup>35</sup> Lawrence Berkeley National Laboratory

<sup>36</sup> "The Cost-Effectiveness of Commercial Buildings Commissioning: A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States" Lawrence Berkeley National Laboratory, the Portland Energy Conservation Inc. and the Energy Systems Laboratory at the Texas A&M University for the Assistant Secretary for Energy Efficiency and Renewable Energy, Building Technologies Program, U.S. Department of Energy, December 2004 [eetd.lbl.gov/emills/PUBS/PDF/Cx-Costs-Benefits.pdf](http://eetd.lbl.gov/emills/PUBS/PDF/Cx-Costs-Benefits.pdf)

0.7 years<sup>37</sup>.

#### **A.1.4. Case Study: Commissioning**

The 213,000sf Portland State University Science II building underwent commissioning in the mid-1990's, which yielded a high-quality HVAC system. The process revealed that an incompatible chiller starter was causing chiller mis-starts. Other results included:

- Chiller mis-starts corrected
- Chiller oil temperature false alarms eliminated
- Cooling tower fan VFD adjusted
- Cooling tower defects (low sump water levels, fans, louvers installed improperly) eliminated
- Air handler outside air dampers repaired
- Chiller controls reprogrammed

The total cost of commissioning was \$11,750 or \$0.05/sf. The estimated long-term savings are \$39,830 with a payback of 2.2 years.

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<sup>37</sup> The study analyzed results from 224 buildings across 21 states, representing 30.4 million square feet of commissioned floor area (73 percent in existing buildings and 27 percent in new construction). These projects collectively represent \$17 million (\$2003) of commissioning investment.

### A.1.5. Other Examples

#### Commissioning case study: ODAS Public Service Building, Salem, Oregon



The 1995 renovation of the six-storey 170,000sf Oregon Department of Administrative Services office had resulted in a number of problems with the HVAC system.

A building commissioning project was completed in 2000 which identified 16 significant issues. Fixing a faulty high-temperature cutout circuit on the boiler alone reduced electricity usage by 100,000 kWh per year, and increased gas usage by 4,600 therms per year, with a net increase in overall efficiency.

Other problems included the lack of economizer optimization, lack of chilled water temperature reset and malfunctioning daylight dimming controls in the perimeter lighting.

- Commissioning cost: \$20,900 (\$0.12/sf)
- 1<sup>st</sup> year cost benefit: \$18,380 (\$0.11/sf)
- Annual energy savings: \$9,330 (\$0.05/sf)

[egov.oregon.gov](http://egov.oregon.gov)

#### Commissioning case study: Gallagher School of Business Administration Building, University of Montana



The 110,380sf school was re-commissioned in 2002 after 4 years of operation. The process diagnosed and recommended actions for 346 problems including damper and linkage binding that prevented full opening and closure, leaky or non-closing valves, plugged filters, and adjustment of controls.

The recommissioning cost \$24,380. The first-year cost benefit was \$10,6002, with annual energy savings of \$26,3003.

## **A.5. Improving Energy Use 4: Employee Trip Reduction Program**

Emissions from vehicles comprise approximately 30 per cent of Greater Vancouver's GHG emissions. Average commuting times within the region are increasing and gas prices are going up. The average vehicle in Canada costs \$1,200 to \$1,400 to fuel every year (2005).

Employee Trip Reduction Programs are increasingly supported by building owners and tenants as a means to reduce emissions, save energy, manage monthly parking costs, help employees save money and demonstrate corporate leadership. Organizations can bulk purchase tax-deductible transit passes for staff at a discount, establish ride-share matching programs and co-ordinate carpooling programs reasonably cost effectively (case study data, where available, offer annual program administration cost ranges in the region of \$175 per employee per year).

### **A.5.1. Case Study: Trip Reduction Program**

Commencing 1996, the Greater Vancouver Regional District (GVRD) initiated an Employee Trip Reduction Program (ETRP) for staff located at its head office at 4330 Kingsway, Burnaby. The objectives were to provide support to staff seeking to save money by using alternative modes of transportation and to demonstrate civic leadership by helping improve regional air quality and reduce traffic congestion. The components of the program include:

- Discounted (15 per cent) fares for annual transit passes through enrolment in the TransLink Employer Pass Program (EPP).
- 10 per cent employer incentive for annual passes or 25 per cent towards the purchase of monthly and daily passes.
- Reserved parking, flexible working hours, ride-matching service and guaranteed ride home service for carpool members
- Corporate vehicles (7) to employees for commuting purposes
- Free transit passes for local business travel
- Secured bike cages and shower/locker facilities
- Bicycle safety and maintenance workshops
- Internal information and resources website

In 2004, program administration cost \$35,075 and returned cost savings of \$479,000 to participants. Other benefits include 225 tonnes of CO<sub>2</sub> emissions saved and enhanced corporate profile through case study promotion<sup>38</sup>.

**Annual costs to employer for ETRP incentives 2004<sup>39</sup>**

<b>Transit</b>	<b>Cost</b>	<b>Trips avoided</b>	<b>Savings per trip</b>
Annual pass	\$3,066	9,000	\$0.34
West Cost Express	(\$621)	(675)	(\$0.92)
Monthly pass <sup>40</sup>	\$9,657	8,325	\$1.16
FareSaver tickets <sup>41</sup>	\$4,698	3,375	\$1.39
<b>Total</b>	<b>\$17,421</b>	<b>20,700</b>	<b>\$0.84</b>

<b>Carpool</b>	<b>Cost</b>	<b>Trips avoided</b>	<b>Savings per trip</b>
3-Person (100% subsidy)	\$5,130	4,950	\$1.04
2-Person (50% subsidy)	\$7,524	3,375	\$2.23
Corporate Rideshare	\$5,000	3,375	\$1.48
<b>Total</b>	<b>\$17,654</b>	<b>11,700</b>	<b>\$1.51</b>

**Annual cost savings for ETRP participants 2004<sup>42</sup>**

	<b>Commute distance</b>		<b>Driving costs<sup>43</sup></b>	
	<b>Average (km)</b>	<b>Median (km)</b>	<b>Average</b>	<b>Median</b>
Per employee per year	3,960	3,175	\$1,996	\$1,600
Total participants	950,310	762,075	\$478,956	\$384,085

**Annual greenhouse gas emission reductions 2004<sup>44</sup>**

<sup>38</sup> [www.fhio.gc.ca/default.asp?lang=En&n=F081DBD0-1](http://www.fhio.gc.ca/default.asp?lang=En&n=F081DBD0-1)

<sup>39</sup> Projected annual costs based on available data to end of 3<sup>rd</sup> Quarter 2004- Does not include GRH service costs.

<sup>40</sup> Based on cost for 2-Zone pass

<sup>41</sup> Based on cost for 2-Zone pass

<sup>42</sup> Projected annual costs based on available data to end of 3<sup>rd</sup> Quarter 2004- Does not include GRH service costs.

<sup>43</sup> Canadian Automobile Association Driving Costs (2004 Edition) - Based on Cavalier Z24 driven 18,000 km annually

	Single occupant vehicle trips avoided		Average GHG <sup>45</sup> reductions (tonnes/year)	
	2003	2004	2003	2004
Transit	18,000	20,700	106	122
Carpool/Rideshare	14,175	11,700	103	85
Cycling	3,375	3,375	11	11
Walking	7,875	7,875	6	6
<b>Total</b>	<b>43,425</b>	<b>43,650</b>	<b>226</b>	<b>224</b>

## A.6. Energy Resources

BOMA International's GREEN ((The Green Resource Energy and Environment Network)

[www.boma.org/AboutBOMA/TheGREEN](http://www.boma.org/AboutBOMA/TheGREEN)

The Office of Energy Efficiency of Natural Resources Canada has a number of energy efficiency programs and offers financial assistance in certain circumstances.

[www.oeec.nrcan.gc.ca](http://www.oeec.nrcan.gc.ca)

Terasen Gas Efficient Boiler Incentive Program

[www.terasengas.com/Promotions/Current+Promotions/ EfficientBoilerProgram](http://www.terasengas.com/Promotions/Current+Promotions/ EfficientBoilerProgram)

BC Hydro PowerSmart Product Incentive Program

[www.bchydro.com/business/incentive/incentive8821](http://www.bchydro.com/business/incentive/incentive8821)

Renewable Energy Deployment Initiative (REDI)

[www.nrcan.gc.ca/redi](http://www.nrcan.gc.ca/redi)

GVRD SmartSteps

[www.gvrd.bc.ca/smartsteps](http://www.gvrd.bc.ca/smartsteps)

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<sup>44</sup> Note: 2004 emissions reductions projected based on data to the end of the 3<sup>rd</sup> quarter.

<sup>45</sup> 2000 Emission Inventory for Lower Fraser Valley Air Shed (GHG = CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O)

## **Appendix B - Water Conservation**

## B. Water Conservation

### **GO GREEN REQUIREMENTS**

**A water audit of the applicant's building must have been performed within the past three years.**

**Building management must have a written policy that is intended to minimize water use and encourage water conservation.**

### **KEY FINDINGS**

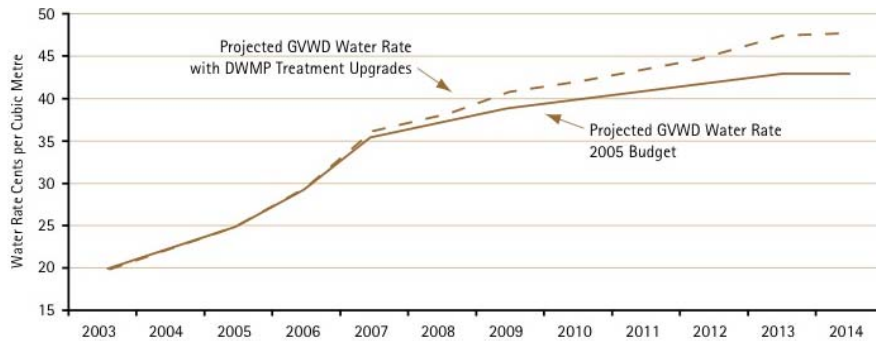
For most water efficiency upgrades, payback is less than 2 years. Findings include:

- On average, Go Green Plus buildings use 93 litres of water per square foot of floor area per year (data ranges from 56 litres average in Quebec to 100 litres average in Toronto).
- Go Green Plus buildings consume 18% less water than average Canadian office buildings.
- To date, Go Green Plus buildings have recouped average annual savings in the region of \$0.01/sf from water conservation strategies.
- While data is available for buildings in Alberta, Quebec and Ontario, more data collection is necessary to understand water consumption in BC.
- Landscape irrigation is the largest consumer of water in Greater Vancouver office buildings.
- Water saving measures can deliver rapid project paybacks (less than 2 years) when the cost benefit analysis takes into consideration associated energy use reductions for hot water and reduced costs of treatment (e.g. swimming pools, etc).
- Switching to non-potable water sources for irrigation and building cooling where applicable can deliver rapid payback (less than 2 years).
- Water efficiency may result in reduced energy use for heating hot water. Improved blowdown controls on boilers have been shown to can deliver rapid payback (less than 2 years).

## B.1. Water Conservation Overview

Water rates within the GVRD are currently among the lowest in North America. However, businesses and other water consumers are expected to face increases of about 24 per cent by 2008 and about 40 per cent by 2014 relative to 2005 costs.

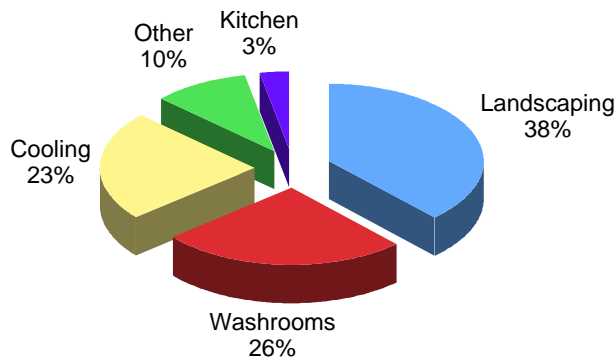
### Water rate forecasts for Greater Vancouver region<sup>46</sup>



Because of the \$600 million cost to construct the Seymour-Capilano UV-based Filtration Project, the Greater Vancouver Water District's water rate is expected to increase to more than 37 cents per cubic metre in 2008.

Water conservation can help to lower energy and maintenance costs. The following chart shows that the most significant water uses are usually: landscaping, cooling/refrigeration, and domestic uses. Water is also consumed by leaks or other unaccounted-for system losses, which are classified as "other".

### Lower mainland commercial office water consumption<sup>47</sup>



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<sup>46</sup> Chart Courtesy GVRD Drinking Water Management Plan, August 2005

<sup>47</sup> Source: the Pacific Institute

The extent of operational savings from water conservation strategies depend on the billing and metering arrangements of a particular building. However, in most cases, savings can be realised through the reduction in energy use associated with efficiencies in hot-water generation.

### **B.1.1. Improving Water Use 1: Landscaping**

Landscaping irrigation is the largest consumer of water in BC's commercial office buildings, using approximately 40 per cent of a building's total annual water consumption. According to Environment Canada<sup>48</sup>, more than 50 per cent of the water applied to lawns and gardens is lost due to evaporation, or run-off because of over-watering. As a general rule, most lawns and gardens require little more than 1 inch of water per week. Soil-moisture sensors and controllers and a drip irrigation system to reduce water use for landscaped areas. The Irrigation Association of BC provides a wealth of information on evapotranspiration (ET) rates, publications and an irrigation-scheduling calendar for various locations in BC<sup>49</sup>.

Transitioning to drought-tolerant "waterwise" or "xeriscape" landscaping strategies will substantially reduce or even negate the reliance on irrigation.

### **B.1.2. Improving Water Use 2: Domestic Uses**

Water-saving improvements can be achieved through competitively-priced and functionally identical low-flow showerheads, faucet aerators and other high-efficiency appliances and equipment. Faucet aerators mix water and air and can lower the water flow from 9-18 litres a minute to less than 5 litres a minute.

Continuous- or timed-flush urinals in restrooms with low-flow manual flush or sensor-controlled equipment can be installed easily, paying back their cost within two years. This can be as simple as retrofitting the flush valve with a new spring and diaphragm. In new installations waterless urinals, which do not consume any water (eliminating water supply lines and flush valves), can be easily installed, are generally accepted by regulators and meet prevailing public health standards.

Older toilets which use up to 22 litres per flush can be replaced with ultra-low-flush toilets (6 litres per flush) or dual-flush toilets (6 litres for solid waste, 3 litres for liquid

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<sup>48</sup> [www.ec.gc.ca/water/en/info/pubs/FS/e\\_FSA6](http://www.ec.gc.ca/water/en/info/pubs/FS/e_FSA6)

<sup>49</sup> [www.irrigationbc.com](http://www.irrigationbc.com)

waste). EnergyStar rated water-using appliances such as dishwashers not only save energy but also use significantly less water than the conventional alternative.

### **B.1.3. Improving Water Use 3: HVAC Systems**

Cooling consumes approximately 23 per cent of total water use in commercial buildings. Frequently, water is passed through the cooling system only once before it is discharged. Control systems and technologies are now available to enable water to be recycled as well as to reduce the amount of water required for cooling. Specifically, controls can be updated to reduce the amount of blowdown water required to maintain cooling towers and boilers.

Retrofit once-through cooling water used for air conditioning and refrigeration equipment (chillers, compressors, condensers, etc.) with recirculating systems. When replacing equipment, consider installing air-cooled equipment in place of water-cooled equipment.

## B.2. Case Study: Water Conservation Upgrade



Project	Upper Canada College
Location	Toronto, ON
Age at time of retrofit	Up to +100 years
Size	15 buildings on 17 hectare (43 acre) campus
Client	Upper Canada College
Project cost	\$28,600
Project completion	Water efficiency upgrade and retrofit 2002
Savings (\$)	\$20,861 per year
Payback period	< 2 years

Upper Canada College (UCC) is Canada's oldest independent boys' school, located on 38 hectares of land in midtown Toronto, with 1,100 students and 240 employees. In 2002, UCC conducted a 60-day study to measure and document the school's water use. UCC subsequently achieved water savings by modifying or replacing equipment and fixtures. In the first year of its water-saving program, UCC reduced use by 38,000 litres per day

and received more than \$10,000 in rebates from the Toronto WaterSaver Program. The rebates helped to offset the cost of installing water-saving fixtures and equipment. Additional savings to the College included lower water and utility bills. Conservation strategies included:

- **Swimming pool water makeup:** due to the design of the original pool filter system, water would overflow from the weir and discharge directly into the drain wasting 16,000 litres of water a day. With a new filter system, some of the water was captured, treated and sent back into the pool, saving \$6,315 per year.
- **Conversion of water-cooled units to air-cooled:** the original fridges and freezers as well as the air-conditioning units, used once-through water-cooled systems. Appliances and air- conditioning units were converted to air-cooled and now use no water.
- **Water recovery:** previously, water that was used to cool the boiler pump was discharged to the sewer. A new water-recovery system now reuses it as boiler makeup water.

### Summary of Water Efficiency Strategies

Water-saving measures	Cost	Rebate	Savings (L per day)	Annual cost savings	Payback Period
Swimming pool makeup	\$1,700	\$2,884	11,535	\$ 6,315	Instant
Conversion of water-cooled air-conditioning/freezer units to air-cooled	\$10,500	\$2,246	8,984	\$ 4,920	1.7 years
Water recovery from boiler pump	\$1,400	\$818	3,270	\$ 1,790	4 months
28 water-efficient toilets	\$7,000	\$1,680	3,528	\$1,930	2.8 years
Replace 5 flush urinals w/ 11 waterless urinals	\$5,500	\$2,200	7,200	\$3,942	10 months
Replace 3 flush urinals w/ 6 flushometers	\$2,400	\$600	3,500	\$1,916	11 months
Pre-rinse spray nozzle	\$ 100	\$ 22	88	\$ 48	1.6 years
<b>Total</b>	<b>\$28,600</b>	<b>\$10,450</b>	<b>38,105</b>	<b>\$20,861</b>	<b>&lt; 1 year</b>

### B.3. Other Examples

#### Control systems upgrade case study: Blackstone Steam Plant at Harvard University



In 2004, Harvard University installed controls to reduce blowdown volume by 10 per cent at the University's Blackstone Steam Plant. All boilers require blowdown systems to remove the solids that build up from impurities in boiler water.

Older systems were operated by manually operated valves, which led to more water being used than necessary. Blowdown water has been heated so wasted water meant wasted energy. The new continuous blowdown system measures the conductivity of the water then triggers only as much blowdown water to be discharged as necessary.

- Project Cost: \$21,394
- Annual Savings: \$46,211
- Payback: 0.5 years
- Saved 562,240 lbs CO<sub>2</sub> per year

[www.greencampus.harvard.edu/gclf/casestudies](http://www.greencampus.harvard.edu/gclf/casestudies)

#### Water efficiency case study: Canadian Centre for Inland Waters, Burlington, Ontario



The 524,780sf CCIW complex houses 700 staff and contains over 200 laboratories ranging in size from one room to a 330ft long wide-wave flume. Between 1985 and 1991, the site underwent energy conservation refits and upgrades to maximize water conservation.

- Drawing water from the harbour instead of municipal water system reduced cooling water requirements. Refitting the cooling system cost \$101,000 (\$0.19/sf) but resulted in annual savings of \$53,000 (\$0.10/sf) annually. Paybacks were realized in less than two years.
- Water requirements of the fish tanks were reduced by controlling algae growth, thereby reducing the need to continually add municipal water. The rerouting of the water flow for the fish tanks required an outlay of \$32,350 (\$0.06/sf), but resulted in annual savings of \$22,600 (\$0.04/sf).

[www.nwri.ca](http://www.nwri.ca)

## **B.4. Water Resources**

BOMA BC's Water Self-Assessment

[www.boma.bc.ca/downloads/GG%20Water%20Audit%20Form%2006-04.pdf](http://www.boma.bc.ca/downloads/GG%20Water%20Audit%20Form%2006-04.pdf)

Pacific Institute for Studies in Development, Environment and Security Waste Not, Want Not: The Potential for Urban Conservation in California Appendix C: Industrial and Commercial Water Use.

[www.pacinst.org/reports/urban\\_usage/appendix\\_c.pdf](http://www.pacinst.org/reports/urban_usage/appendix_c.pdf)

Water Wiser, the Water Efficiency Clearinghouse:

[www.waterwiser.org](http://www.waterwiser.org)

Global Environmental Management Initiative – Connecting the Drops Towards Creative Water Strategies: A Water Sustainability Tool:

[www.gemi.org/water](http://www.gemi.org/water)

Water Efficiency Manual for Commercial, Industrial and Institutional Facilities:

[www.P2pays.org/ref/01/00692.pdf](http://www.P2pays.org/ref/01/00692.pdf)

Environment Canada's Freshwater Resources

[www.ec.gc.ca/water](http://www.ec.gc.ca/water)

British Columbia's Integrated Water Management Plan

[www.waterbucket.ca/waterbucket/index.asp](http://www.waterbucket.ca/waterbucket/index.asp)

## **Appendix C - Construction Waste**

## C. Construction Waste

### GO GREEN REQUIREMENTS

**Building management must have a written policy that is intended to minimize construction waste being sent to landfill.**

### KEY FINDINGS

Savings can be realized from reduced tipping fees and increased revenue from the sale of salvaged materials. Specific findings include:

- On average, 67 per cent of construction waste is diverted in the GVRD which is higher than the Canadian average (50 per cent).
- BOMA Go Green Plus buildings have diverted 17 per cent more waste than average although waste diversion rates in recent tenant improvement projects in the GVRD have exceeded 70 per cent.
- The GVRD has one of the most comprehensive construction waste management programs in Canada providing resources and assistance to businesses and the construction industry.
- A coordinated waste management program can deliver savings on waste disposal costs by as much as 30 per cent.
- Savings from waste diversion are maximized through early planning, clear communication with the contractor and ongoing communication with trades.
- While diversion strategies for larger volumes tend to be easier to justify, projects that involve only one or two materials (such as flooring) can be structured to save up to 50 per cent disposal costs, resulting in an immediate project payback.
- Est. average annual savings of \$0.02/sf from reduced haulage trips and tipping fees.
- Manufacturers and suppliers are increasingly shifting to service-based models which involve product take-back programs.

## C.1. Construction Waste Overview

In BC's lower mainland, 1.6 million tonnes of construction waste is generated annually of which 67 per cent is recycled<sup>50</sup>. Approximately 35 per cent of landfill waste is from demolition, landclearing and construction (DLC) debris. Most contractors are concerned about the cost of the labour that is needed to deconstruct materials for reuse or recycling. However, it has been shown that effective DLC waste management on both new construction and retrofits not only helps protect the environment, but can also generate significant economic savings. Demonstration projects within the GVRD have shown that waste diversion rates over 75 per cent can be achieved cost effectively<sup>51</sup> with some innovative projects achieving as much as 90% thereby reduce waste disposal costs by up to 30 per cent<sup>52</sup>. Benefits of recovering DLC materials include:

- Reduced project costs through avoided disposal costs, avoided purchases of new materials, revenue earned from materials sales, and tax breaks from donations.
- Reduced environmental effects of extraction, transportation, and processing of raw materials
- Enhanced public image of companies and organizations that reduce disposal.
- Conserves space in existing landfills.

A number of cost-effective approaches are now available that combine practical renovation, construction and demolition decisions with environmental considerations. To take advantage of the value of waste materials as a resource, the following steps should be followed:

- Include DLC recovery plans in the project design: reuse of wall panels, ceiling panels, and doors in can be made possible if the architect plans the new interior to use the same sizes and types of materials used in the building before the renovation.
- Include recovery requirements and goals in project specifications and contracts.
- Educate contractors and crews on materials recovery procedures such as sorting and storage methods, recoverable materials, and removal techniques can eliminate contamination problems and increase recovery rates.

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<sup>50</sup> [www.gvrd.bc.ca](http://www.gvrd.bc.ca)

<sup>51</sup> rates are dependent on the size, type and location of project

<sup>52</sup> [www.gvrd.bc.ca/buildsmart/MaterialsandResources](http://www.gvrd.bc.ca/buildsmart/MaterialsandResources)

- Hold subcontractors accountable for materials recovery – a common tactic is for the client to not process payments to its general contractor until the contractor submitted forms summarizing its debris recovery efforts.
- Provide incentives for recovery: the client can choose to allow their contractors to retain a portion of the revenues and savings from materials recovery.
- Follow up with contractors and crews during the project: without feedback, crews may forget correct recovery procedures or grow lax about implementing them.

**Where GVRD waste goes:**

- 1.6 million tonnes is recycled
- 470,000 tonnes to the Vancouver Landfill
- 380,000 tonnes to Cache Creek Landfill
- 370,000 tonnes to private landfills (mainly demolition and land clearing waste)
- 270,000 tonnes to Waste-to-Energy incinerator

**Top waste stream materials:**

- Wood – 22%
- Paper and paperboard – 14%
- Food – 13%
- Plastics – 9%
- Rubber, leather, textiles – 8%
- Inorganics – 7%
- Yard and garden – 5%
- Bulky objects – 5%
- Metals – 4%
- Small appliances – 4%
- Roofing – 3%

[www.gvrd.bc.ca](http://www.gvrd.bc.ca)

## C.2. Case Study: Construction Waste Management



Project	13 <sup>th</sup> floor flooring demolition contract, Natural Resources Canada, 580 Booth Street	
Location	Ottawa, ON	
Size	21 storey tower, total building floor area 411,853sf 13 <sup>th</sup> Floor total area 15,679sf	
Client	Public Works and Government Services Canada	
Completion	Green Floors Project 1996	
Project cost	\$15,600 estimate	\$1.00/sf
	\$8,000 actual cost	\$0.51/sf
Savings (\$)	\$7,600	\$0.48/sf
Payback period	Immediate	

The Department of Public Works and Government Services Canada (PWGSC), the owner of 580 Booth Street in Ottawa, scheduled the 7th and 13th floors for base upgrades and space optimization in 1995. The “Green Floors Project” was developed in order to demonstrate improved energy efficiency and to incorporate the best available lowered

environmental impact construction products and processes during demolition and construction.

Of concern to all participants was that the application of green practices would slow down the construction schedule. It was found that the demolition of the 13th floor took 8 person days longer than a standard demolition that was carried out for the 15th floor of the same building, with increased labour costs of \$2,000. However, savings that were achieved through reuse and recycling offset all additional costs.

PWGSC used a variety of procedures to achieve significant reductions in construction waste:

- Careful removal of the glass fibre ceiling tiles resulted in over 90 per cent of them being diverted for reuse.
- All of the blinds, tracks and associated hardware were salvaged for reuse and resale.
- Demountable partitions were carefully dismantled for reuse.
- Insulation can easily be reused on future construction sites. As the contractor was conducting another renovation in the same building, over 320sf of insulation was reused.
- Serviceable areas of the carpet were cut into 10ft x 20ft sections and sent for resale.
- Over 40 doors per floor were stockpiled from this site and sent for resale and all of the associated hardware was salvaged for later use.
- Over 20 cu.yds per floor of wiring, conduit and electrical boxes were stockpiled then recycled.
- All of the metal mechanical ductwork was recycled.
- Scrap metal has a high financial value and is easily salvaged and recycled. Recycled metals included reusable steel studs (250 reused on site), metal framing and miscellaneous scrap.

Tipping fees were substantially reduced by the intensive diversion practices. Revenue was generated through the sale of materials that were delivered to the recycler. The class "A" estimate for the demolition of the 13th floor was originally \$15,600. Following the project, it was determined that the actual costs were less than \$8,000. Considering this information, the class "A" estimate for the 7th floor demolition was reduced to \$10,000.

The success of this project demonstrated that the application of green demolition procedures can be successfully and economically accomplished when supported through careful planning and facilitation.

### C.3. Other Examples

#### Omicron Tenant Improvement, Vancouver



The new 15,400sf office of Omicron AEC occupies the entire 5<sup>th</sup> floor of the 32 storey Bentall Tower Three in Vancouver, BC. The total fit-out was completed in 2005 and cost \$850,000 (\$55/sf).

Recycling and reuse of construction waste resulted in 73 per cent of construction waste being diverted from landfill. Disassembly and rehabilitation of materials from the previous office location resulted in a reuse of 27 per cent of the total project.

While costs were not tracked, it is estimated that two 40 cu yard bins of waste was diverted resulting in a cost saving of \$2,000 in haulage and tipping fees which equates to \$0.10/sf.

### C.4. Construction Waste Management Resources

GVRD - Project Waste Management Master Specification

[www.gvrd.bc.ca/buildsmart/pdfs/WasteManagement.pdf](http://www.gvrd.bc.ca/buildsmart/pdfs/WasteManagement.pdf)

GVRD Building Deconstruction Master Specification

[www.gvrd.bc.ca/buildsmart/pdfs/DeconstructionSpec.pdf](http://www.gvrd.bc.ca/buildsmart/pdfs/DeconstructionSpec.pdf)

Resource Venture's Construction Waste Management Guide

[www.resourceventure.org/rv/publications/building/CWM-NonConstProfs.pdf](http://www.resourceventure.org/rv/publications/building/CWM-NonConstProfs.pdf)

Whole Building Design Guide's Construction Waste Management

[www.wbdg.org/design/cwm.php](http://www.wbdg.org/design/cwm.php)

## **Appendix D - Recycling**

## D. Recycling

### GO GREEN REQUIREMENTS

**Building management must have implemented a program that incorporates the recycling of all fibre and consumable products such as office paper, newspaper, cardboard, plastic, cans and bottles, for both tenants and operations at the site.**

### KEY FINDINGS

At this time, paper is the only significant material recycled from office buildings that has the potential to generate revenues, which can then subsidize the costs recycling other materials. Other findings include:

- The average office worker uses approximately 0.68Kg (1.5lbs) of paper each day.
- Go Green Plus buildings divert 17 per cent more waste than an average building.
- An estimated 583 tonnes of waste is diverted annually from one average Go Green Plus building which equates to 0.89Kg (0.96lbs) per square foot.
- 85 per cent of waste diverted from a typical Go Green Plus building is paper.
- Approximately 17 trucks avoided per building resulting in an average annual savings in the region of \$0.02/sf from reduced haulage trips and tipping fees.
- Payback from setting up and managing a recycling program can be immediate
- Recycling programs for plastics require additional investment given low weight to volume ratio, low value of waste material and subsequent high recycling costs.
- A tenant communication program is critical to the success of any recycling program.

## D.1. Recycling Overview

A total of 3.1 million tonnes of waste is generated in BC's Lower Mainland every year of which just over half is recycled<sup>53</sup>. The average office worker uses approximately 0.68Kg (1.5lbs) of paper each day<sup>54</sup>. In the GVRD, over 90 tonnes of waste mixed paper is generated every year and despite improved collection services and concerted education campaigns, only 55 per cent is recycled. Resources saved per ton of paper recycled<sup>55</sup>:

- 17 trees
- 275 pounds of sulphur
- 350 lbs of limestone
- 9,000 lbs of steam
- 60,000 gal of water
- 225 kilowatt hours
- 3.3 cubic yards of landfill space

Office buildings generate large volumes of recyclable wastepaper. In most buildings, recyclable paper typically represents 75 to 80 per cent of all waste generated. Of the waste diverted from landfill in Go Green Plus buildings about 85 per cent is paper, demonstrating that paper recycling is feasible and can make a difference to waste management practices.

At this time, paper is the only significant material recycled from office buildings that has the potential to generate revenues. Typically, office paper recycling services are either revenue generating or revenue neutral, depending on market conditions for mixed office paper and volumes generated. Therefore it is important to consider recycling program costs as a "basket of goods" when assessing costs and benefits.

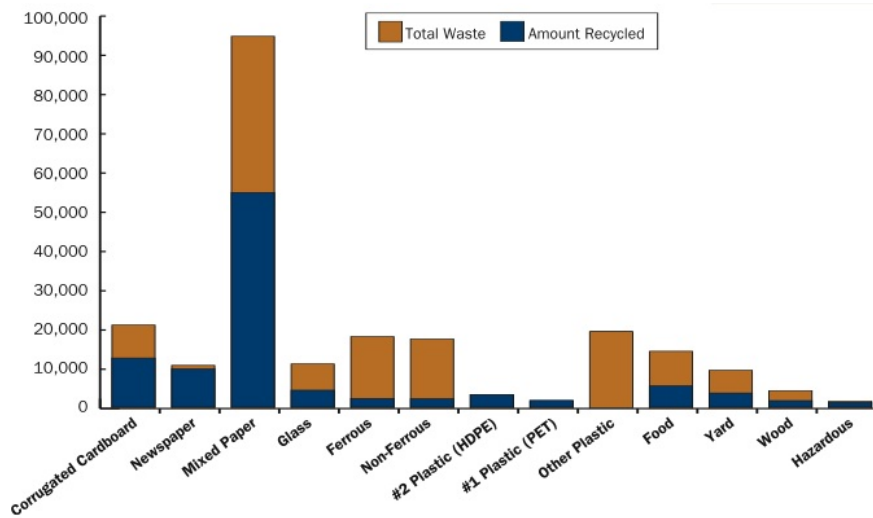
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<sup>53</sup> GVRD

<sup>54</sup> GVRD [www.smartsteps.ca](http://www.smartsteps.ca)

<sup>55</sup> The Public Recycling Officials of Pennsylvania, Developing a Waste Reduction and Recycling Program for Commercial, Industrial and Municipal Establishments, May 1995

**Recycling opportunities for offices in the GVRD<sup>56</sup>**



Successful waste diversion programs in office buildings go beyond diverting just wastepaper. These recyclable items can be collected at recycling centres established in convenient, high traffic areas and in food service areas (coffee station, lunchroom, cafeteria). Central stations are placed in convenient, high traffic areas such as by the elevators, near coffee stations, photocopiers, lunchrooms or close to washroom facilities.

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<sup>56</sup> GVRD Eco-efficiency Sector Guide: Offices [www.gvrd.bc.ca/smartsteps](http://www.gvrd.bc.ca/smartsteps)

## D.2. Case Study: Office Recycling

Project                      Telus Corporation: implementation of office recycling and asset management program

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Location                    All facilities across Western Canada

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Client                        Telus Corporation

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Project commencement    2002

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Savings (\$)                 \$385,000 avoided disposal charges  
                                  \$5.3m from sale of surplus furniture and equipment

In 2003, Telus Corporation, the largest telecommunications company in Western Canada, recycled 7,183 tonnes of material, producing a cost savings of \$385,000 from avoided disposal charges. The sale of used and surplus equipment and recycling initiatives generated \$5.3 million in 2003, a 10 per cent increase over 2002. An employee initiative called Make Pulp Fiction helped reduce the consumption of copier and printer paper by approximately 9 million sheets, resulting in a savings of \$86,000, and 200 trees or 36 tonnes of paper. Telus program includes:

- 184,000 cellular phones were repaired, refurbished or recycled and 88,946 telephones were repaired or refurbished.
- 100.4 tonnes of electronic and data equipment were recycled and 23.18 tonnes of circuit cards were recycled.
- All photocopiers are leased from vendors.
- All new computers are leased; older computers are then donated to the federal government's Computers for Schools program.
- 10.88 tonnes of toner and printer cartridges were returned to vendors or contractors for refurbishing or recycling.
- 2.7 tonnes of rechargeable batteries were recycled through repair operations. More than 350 Telus Mobility dealers and Telus Phone Stores in 100 communities participate in the Rechargeable Battery Recycling Corporation's Charge Up to Recycle program. The program accepts nickel-cadmium, nickel-metal hydride, lithium ion and small-sealed lead acid batteries for recycling.

### D.3. Other Examples

**Case study: Recycling at Mountain Equipment Co-op**



It costs MEC \$154 a tonne to landfill materials but only \$39 a tonne to recycle. This difference of \$115 a tonne creates a strong incentive to increase recycling. Measures included:

- Performed an in-store waste audit
- Obtained recycling/ and disposal statistics
- Set targets to reduce large-volume wastes
- Improved signage to prevent contamination of recycled materials
- Educated staff
- Total waste reduction of 91 per cent, with stores saving \$115 on every tonne diverted from landfill.

[www.mec.ca](http://www.mec.ca)

**Telus environmental procurement policy**



Telus supports the purchase of recycled and environmentally preferred products whenever they perform satisfactorily and are available at a reasonably competitive price.

Telus recognizes that employees can minimize environmental impacts relating to our work and they can make a difference in favour of environmental quality.

Consistent with Telus' objectives to reduce material going to landfills, reduce chemicals, and use post-consumer content for paper products, all Telus team members strive to ensure the use of recycled/recyclable supplies and materials. Achieving these objectives help manage or avoid costs for solid waste disposal.

**[www.telus.com](http://www.telus.com)**

## **D.4. Recycling Resources**

GVRD SmartSteps Eco-Efficiency program includes directories of recyclers and depots

[www.gvrd.bc.ca/smartsteps](http://www.gvrd.bc.ca/smartsteps)

Metro Waster Paper Recovery Inc

[www.metrowaste.com](http://www.metrowaste.com)

Recycling Council of BC and materials exchange

[www.rcbc.bc.ca](http://www.rcbc.bc.ca)

Habitat for Humanity Restore

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PHH ARC Environmental Ltd &  
Light House Sustainable Building Centre

[www.vancouverhabitat.bc.ca](http://www.vancouverhabitat.bc.ca)

## **Appendix E - Hazardous Materials**

## E. Hazardous Materials

### **GO GREEN REQUIREMENTS**

**Building management must have completed a hazardous materials survey and maintained an inventory of these materials. Where hazardous materials are present in the building, a hazardous materials management plan must be in place.**

### **KEY FINDINGS**

There are a myriad of hazardous materials that are common in the workplace. Managing hazardous materials (HAZMAT) is increasingly important as health risks related to building materials become better understood and increasingly valued by tenants. Other findings include:

- The costs of implementing a comprehensive HAZMAT communication and education program are more than offset by improved occupant well-being and reduced insurance claims.
- Management of HAZMAT components is sometimes challenged by lack of recyclers and disposal facilities: a disposal policy can be valuable for tenant communication.
- Tenant education programs, particularly with respect to new recycling programs (batteries, fluorescent lamps, electronics, etc) are critical for success.

## E.1. Hazardous Materials Overview

The average multi-tenant office facility can contain many different hazardous products. An inventory of the office buildings of Public Works and Government Services of Canada found that the average multi-tenant office facility has approximately 125 common hazardous products, including oils, glycol, fluorescent lamps, batteries, asbestos, lead, silica, man-made fiber, mould, and cleaning solvents. There are three key steps to developing a hazardous materials management plan:

- Develop an inventory and update yearly.
- Develop work practices and procedures for handling hazardous materials for either routine maintenance or major renovation/demolition.
- Develop and implement any required training. Those supervisors and/or workers involved with the handling of hazardous materials will require training as well as emergency response personnel.

When configuring tenant spaces, it is important to minimize and control pollutant or biological contaminant entry into the tenant space and later cross-contamination of regularly occupied areas. Where hazardous gasses or chemicals may be present or used (including housekeeping or laundry areas and copying/printing rooms), it is important to provide segregated areas with sealed partitions with separate outside exhausting, no air recirculation and operated at a negative pressure compared with the surrounding spaces.

Containment drains plumbed for appropriate disposal of hazardous liquid wastes should be considered for spaces where water and chemical concentrate mixing occurs for maintenance or laboratory purposes.

### **Typical types and locations of hazardous materials**

**Asbestos:** Possible materials include siding, pipe insulation, pipe tape, ceiling tile, drywall joint compound, vinyl sheet flooring, vinyl tiles, lag pipe, insulation asbestos board and linoleum.

**Underground Storage Tanks:** for fuel tanks for heating/cooling systems, look for fill pipes and vent pipes.

**PCBs:** Possible materials include fluorescent lighting ballasts, power transformers, generators and other power supply and management equipment.

**Abandoned Chemicals:** possible materials include paint, solvents, oils, cleaning products, flammable and combustible substances like gasoline, pesticides, herbicides, and medications.

**Others:** other hazardous materials may include Freon from cooling equipment and mercury switches.

## E.2. Case Study: Hazardous Materials Management



Project	Green Partnership Program including pool sanitization Fairmont Hotel, Vancouver
Location	700 West Georgia Street, Vancouver, BC
Size	556 rooms and suites ranging from 275 to 750sf 12 function rooms comprising 37,000sf 15,000sf of ground floor retail 15 storeys
Project commencement	2002
Savings (\$)	Annual net savings from pool sanitization program \$1,950 (72%)

The Fairmont Hotel Vancouver is situated in the heart of the city. The hotel has 556 rooms and suites, 12 meeting rooms, two restaurants, a health club, pool, spa and retail shops. Both costs and environmental impacts of hotel operations are reduced by Fairmont Hotel's Green Partnership Program. The hazardous waste management program includes:

- phasing out of equipment containing chlorofluorocarbons (CFCs) and polychlorinated biphenyls (PCBs),
- properly storing and maintaining fuel storage tanks,
- removal of paint sludge by a licensed waste management contractor

- recycling batteries and fluorescent lamps.

A saline pool sanitation system that is less harmful to guests and the environment was installed, eliminating the need to purchase concentrated chlorine. Chlorine is now generated by applying an electrical current to a baking soda/salt solution. Prior to installing this system, the hotel spent \$2,700 a year to purchase chlorine granules as compared to \$750 for rock salt and baking soda, an annual net saving of \$1,950, or 72 per cent.

#### **WHMIS – Fairmont employers' responsibilities**

##### **Labels and other forms of warning**

Employers must ensure that supplier-provided containers of controlled products are labelled with WHMIS supplier labels.

##### **Use of material safety data sheets (MSDSs)**

Employers are responsible for obtaining from suppliers an MSDS for each controlled product used in their workplaces. MSDSs are to be updated at least every three years or as soon as further information relating to the hazard become available for a material.

##### **Employee education and training**

Employers are to ensure that instruction is provided for employees who handle, are exposed to, or are likely to handle or be exposed to hazardous materials.

##### **Hazard identification and ingredient disclosure**

Employers are responsible for evaluating those products produced in a workplace process using the hazard criteria identified in the Controlled Products Regulations

#### **Fairmont Hotel & Resorts BC Green Purchasing Policy**

- Corporate policy encouraging the purchase of environmentally friendly products, including paper (unbleached and/or recycled content), ozone-friendly aerosol products, re-refined motor oil and re-inked printer cartridges.
- An environmental cleanup clause added to conference, trade show and exhibition contracts to encourage material return.
- Suppliers requested to generate fewer packing slips.
- Styrofoam generally banned as a packing material. Styrofoam chips used for packaging fragile supplies (such as glass china) typically reused as planter drainage materials by gardeners.

### **E.3. Other Examples**

#### **TELUS' Pollution Prevention**

Telus is reducing the risk associated with fuel storage tanks and systems through many factors including reducing the quantity of fuel stored, installing secondary containment, corrosion protection, alarms and emergency shut-off devices. In 2003, \$2.8 million for capital expenditures was allocated.

#### **Toyota Canada**

Toyota maintains a comprehensive hazardous waste management program:

- all staff are provided with comprehensive hazardous waste management training.
- hazardous products (oils, brake cleaners, paints, etc.) are stored separately in a sump contained, enclosed special products storage room.
- chemical response cards have been developed for each of the hazardous compounds handled at the facility.
- spills are collected, barrelled, labelled and scheduled for picked up by Clean Harbours, Toyota's hazardous waste management contractor, within 90 days for processing.

### **E.4. Hazardous Materials Resources**

BC's Environmental Protection Branch

[www.env.gov.bc.ca/epd](http://www.env.gov.bc.ca/epd)

Worker's Compensation Board of BC

[www.worksafebc.com](http://www.worksafebc.com)

Canada's Hazardous Waste Management Directions

[dsp-psd.pwgsc.gc.ca/Collection-R/LoPBdP/BP/bp323-e](http://dsp-psd.pwgsc.gc.ca/Collection-R/LoPBdP/BP/bp323-e)

MSDS Search.com Inc. is a web site information portal for material safety data sheet information.

[www.msdssearch.com](http://www.msdssearch.com)

## **Appendix F - Materials Selection**

## F. Materials Selection

### GO GREEN REQUIREMENTS

**Building management must have a written policy for the selection of building materials that attempts to reduce any potential negative impact on the environment.**

### KEY FINDINGS

A materials selection policy should, as much as possible, consider the environmental impacts throughout a material's entire lifecycle. Many manufacturers have made this task easier by creating industry-specific certification and labelling programs. Specific findings include:

- Material selection can impact occupant health, operation and maintenance contracts and building durability.
- The costs and benefits of material selection need to factor in life-cycle considerations: sometimes an additional up-front cost can be paid back quickly or may eliminate another cost down the line.
- The health and environmental impacts of building products is becoming better understood and valued by tenants.
- Manufacturers are rapidly rolling out competitively priced greener healthier options to their product lines.
- Suppliers are going green, enacting zero-waste policies for their products and offering servicing and take-back programs (e.g. carpet, furniture, etc).
- The growing number of different green product labels can cause confusion.
- Installation of greener products require education and communication programs for tenants and janitorial staff to ensure they are utilized and cared for correctly.
- The development of a consistent policy will enable clear communication of expected product standards and performance with designers, tenants and suppliers.

## F.2. Materials Selection Overview

Environmental impacts may occur throughout a material's lifecycle from the means by which raw materials are acquired through its manufacturing process to its installation, operation and disposal.

### Raw material acquisition

- **Renewable resources:** the product comprises a renewable resource such as wool, fast-growing wood such as poplar, bamboo, etc.
- **Recycled content:** a defined portion of a product's weight is composed of reprocessed post-consumer or post-industrial materials.
- **Remanufactured products:** remanufacture reduces the necessity to extract and process raw materials.

### The manufacturing process

- **Toxicity:** a product may be toxic to users, installers or to society at large. Despite compelling operational efficiencies, some products (such as fluorescent light bulbs, computers, etc) incorporate toxic materials during the manufacturing process that require careful disposal.
- **Greenhouse gas emissions:** many building materials such as glass, cement, steel require large amounts of energy during manufacture.
- **Ozone depletion:** products which contain or use ozone depleting substances such as chlorofluorocarbons (CFCs, HCFCs, HFCs) and Halon are extremely harmful. These substances occur in refrigerants, fire suppressants and as propellants for expanded foams (see 7: Ozone depleting substances below).

### Use, reuse and maintenance

- **Energy conservation:** Does the product help people conserve energy as a direct result of behavioral changes rather than technological intervention?
- **Energy efficiency:** Is this product the most energy efficient in its class?
- **Reduced water consumption:** Does the product help to reduce water consumption rates?

- **Indoor air quality (IAQ):** Does the product not contain or at least minimize:
  - Volatile Organic Compounds (VOCs)
  - Formaldehyde Emissions
  - Anti-Microbial and Fungicide Treatments
- **Reusable products** – Can the product be reused?
- **Durability:** Is the product durable, thereby prolonging the time before replacement?

### **Recycling and waste management**

- **Recyclable products:** Is the product recyclable or can it be taken back to the manufacturer?
- **Source reduction:** Does the product minimize packaging and/or can it be reused?
- **Degradable products:** Is the product biodegradable?

## **F.3. Green Product Labels and Standards**

### **Canadian Standards Association guideline CS Z760-94 Life Cycle Assessment framework**

**Phase 1 - Raw material acquisition:** includes the activities required to gather a raw material or energy source. It also includes the transportation of the raw materials to the point of manufacture.

**Phase 2 – Manufacturing:** includes material manufacturing, product fabrication, and filling / packaging / distribution

**Phase 3 – Use / Reuse / Maintenance:** is after the distribution of the product and includes any activity where the product is reconditioned, maintained or serviced to extend its useful life.

**Phase 4 – Recycle / Waste Management:** is after the product has served its intended purpose and going to enter the waste stream.

### **Green Product Labels**

1. **GREENGUARD** is an independent third-party testing program that focuses on indoor air quality and low-emitting products and materials. [www.greenguard.org](http://www.greenguard.org)
2. **Green Seal** is an independent third-party testing program that evaluates products (such as paints, glues, etc) using a life-cycle approach. [www.greenseal.org](http://www.greenseal.org)
3. **Ecologo** is Environment Canada's Environmental Choice Program, which requires independent third party testing for 300 categories. [www.environmentalchoice.com](http://www.environmentalchoice.com)
4. **Energy Star** is a self-certification program that focuses on energy efficiency. [www.energystar.gov](http://www.energystar.gov)
5. **Green Label** is the Carpet and Rug Institute's testing program that ensures carpets and rugs meet minimum air quality standards. [www.carpet-rug.org](http://www.carpet-rug.org)
6. The Forest Stewardship Council's **FSC certification** verifies the chain of custody of wood products to ensure that they are from a forest operated and harvested under principles of sustainable forestry [www.fsc.org](http://www.fsc.org)
7. MBDC's **Cradle-to-Cradle** Certification allows companies to have their materials and products not only evaluated, but also certified according to the Cradle to Cradle Principles [www.mbdc.com](http://www.mbdc.com)

### **F.4. Case Study: Materials Selection**

In June, 1996, the Natural Resources Defense Council (NRDC) moved into a new 20,000sf LEED Platinum space in Washington, DC that is one of the most environmentally-friendly offices in the United States. Material choices were critical to the success of the project and a systematic cost benefit analysis was undertaken to weigh the social, environmental and economic impacts.

## Cost benefit analysis of environmentally responsible material choices at NRDC<sup>57</sup>

Materials	Environmental benefit	Performance and cost
Compressed straw walls	The mining of 2,130 cubic feet of gypsum was avoided.	Installation time shorter, making the wall system \$0.30/sf of floor area but more expensive to install wires in the panels than a conventional wall, making the total cost more or less equal.
Synthetic gypsum walls	Avoided the mining of 4,680 cubic feet of gypsum and avoided the disposal of a similar amount of titanium dioxide (a manufacturing by-product)	The only price differential was the shipping cost. The only performance difference is that the synthetic product tends to have lower moisture content and therefore a little "thirstier" for paint.
Low- VOC paints	Outdoors, VOCs a key element in forming ground-level ozone. Indoors, VOCs can cause headaches, nausea and respiratory problems.	Cost the same as standard spray-on textured paint.
Tile	The <i>Alabaster</i> tile contains almost 70 per cent post-industrial and post-consumer glass	As easy to install as conventional tile. The low toxicity adhesive worked well. Alabaster tile costs about the same as conventional ceramic.
Carpet	100% recyclable, the non-toxic adhesive as avoids releases of undesirable chemicals into the indoor environment.	Interface carpet cost 15% more. This does not include the avoided disposal charges from using the Interface service model. Tile faster to install than sheet.
Wheatboard cabinets & shelving	Avoided a few trees worth of wood for making particle board (250 cu. ft). Avoided toxic emissions. Using water-based glues and adhesives reduced off-gassing, improved IAQ.	Wheatboard actually has greater strength and stability than conventional particle board. On a board-foot cost, the Wheatboard costs about 5% less than conventional MDF.

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<sup>57</sup> [www.nrdc.org/cities/building/dcofc/dcofcexc.asp](http://www.nrdc.org/cities/building/dcofc/dcofcexc.asp)

## F.5. Other Examples

### Hughes Condon Marler Architects office renovation



Materials selection procedures included:

- Any new construction used framing reclaimed during the demolition process
- 13% of construction materials contain some recycled content
- 22% recycled content in furniture and construction materials
- 16% of construction materials and furniture manufactured and extracted locally
- All millwork panels made from 100% recovered and recycled wood fiber with no added formaldehyde
- The carpet is 20% post-consumer recycled PET products (e.g. soda bottles)
- All drywall, carpet, lumber, countertops and steel door frames were recycled or reused.
- 84% of existing furniture and furnishings retained for re-use

[www.hcma.ca](http://www.hcma.ca)

## F.6. Material Selection Resources

Environment Canada has helpful information on environmentally friendly purchasing policies.

[http://www.ec.gc.ca/NOPP/DOCS/P2P/hbook/En/TAB6\\_E.cfm](http://www.ec.gc.ca/NOPP/DOCS/P2P/hbook/En/TAB6_E.cfm)

Environment Canada administers the Environmental Choice Program: a leading benchmark of environmentally responsible products and services.

[www.environmentalchoice.com](http://www.environmentalchoice.com)

Recycling Council of BC web site includes the BC Materials Exchange (MEX): a means of connecting recycling suppliers with consumers.

[www.rcbc.bc.ca](http://www.rcbc.bc.ca)

The Oikos green building web site includes extensive information on green building materials

[www.oikos.com](http://www.oikos.com)

GVRD green building product directory

[www.gvrd.bc.ca/buildsmart](http://www.gvrd.bc.ca/buildsmart)

## **Appendix G - Ozone Depleting Substances**

## G. Ozone Depleting Substances

### GO GREEN REQUIREMENTS

**Building management must have a documented plan for identifying and ultimately eliminating the use or storage of ozone depleting substances.**

### KEY FINDINGS

Ensuring that a building is not contributing to ozone-depletion begins by taking an inventory of materials and equipment containing CFC's and HCFC's, and then planning for their replacement. Specific findings include:

- Increasing awareness of the ozone depleting potential of CFC and HCFC refrigerants.
- Cost competitive non-ozone depleting alternative HFC refrigerants shown to perform to the same standards as traditional products.
- Management plan has been proven valuable to identify, coordinate and budget for the storage and phase-out of ODSs.

## **G.1. Ozone Depleting Substances Overview**

Safeguarding the earth's ozone layer and preventing the accumulation of greenhouse gasses are important international issues. In 1987, Canada signed the Montreal Protocol on Substances that Deplete the Ozone Layer. Under this agreement, the production, import, export, and certain uses of ozone depleting substances (ODSs) have been or will be restricted or prohibited. The Kyoto Protocol reinforces Canada's commitment to addressing climate change.

ODSs commonly occur as man-made gases in chillers, air conditioning and refrigeration systems and largely comprise chlorofluorocarbons (CFCs) and alternative refrigerants such as hydrofluorocarbons (HCFCs) and hydrochlorofluorocarbons (HCFCs). CFCs are one of the most detrimental ozone-depleting substances.

Halons are typically used in fire protection systems in fixed installations for computer equipment, electricity board switch gear, and in hand-held fire extinguishers. Unfortunately, halons are potent ozone destroyers. On a pound for pound basis halons are up to 16 times more destructive to the ozone layer than CFCs.

Key strategies to ensure that a building is not contributing to ozone-depletion include:

- List materials and equipment containing CFC's and HCFC's.
- Specify automatic or regular manual refrigerant leak detection and specify full recovery of refrigerant during maintenance
- Specify that foam and plastic products, such as insulation and furniture stuffing, must be blown with steam rather than CFC's, HCFC's or other ozone depleting substances.
- Investigate the potential for replacing equipment (such as refrigeration and chilling equipment) with systems that use refrigerants that do not use ozone-depleting substances.
- Design replacement equipment containing refrigeration gases to ensure zero leakage of gas to the atmosphere, as required by the Federal Halocarbon Regulations.

## G.2. Case Study: Ozone Depleting Substances



Project	Bank of Nova Scotia branch
Location	Toronto, ON
Client	Scotiabank
Consultant	Enermodal Engineering
Completion	2001

This Scotiabank branch was designed and built as a green alternative to the standard branch design. The goal was to achieve energy efficiency and better indoor working environment without deviating from bank design standards or increasing construction costs. Building heating and cooling is provided by four high-efficiency CFC/HCFC-free rooftop units with economizers. These units were among the first rooftop units available to use the refrigerant R410a, a non-ozone-depleting HFC refrigerant. Just as important, the cooling efficiency (at an energy efficiency ratio of 12) is 33 per cent better than standard equipment indicating energy efficiency need not be sacrificed when using non-ozone depleting refrigerants. The rooftop equipment was also downsized to meet reduced loads due to a superior envelope and ventilation air heat recovery.<sup>58</sup>

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<sup>58</sup> [www.enermodal.com](http://www.enermodal.com)

### **G.3. Ozone Depleting Substances Resources**

Government of Canada's present regulations on halocarbons

<http://laws.justice.gc.ca/en/C-15.31/SOR-99-255>

BC Ministry of Water, Land and Air Protection has a stratosphere ozone depletion web site that includes BC's Ozone-Depleting Substances Regulation

[www.gov.bc.ca/air/ozone](http://www.gov.bc.ca/air/ozone)

US EPA lists designated Class I (CFCs and halons) and Class II (HCFCs) substances.

[www.epa.gov/ozone/ods](http://www.epa.gov/ozone/ods)

## **Appendix H - Indoor Air Quality**

## H. Indoor Air Quality

### GO GREEN REQUIREMENTS

**Building management must have in place a documented means for addressing tenant/occupant concerns regarding indoor air quality.**

### KEY FINDINGS

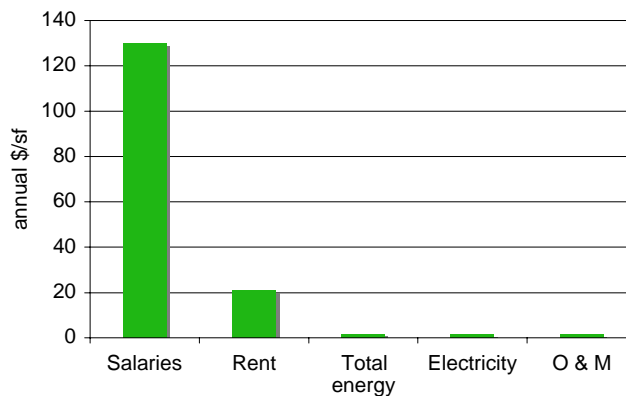
Increased indoor air quality (IAQ) improves occupant health, resulting in increased productivity and less absenteeism. Specific findings include:

- Worker productivity in green and healthy offices has been shown to improve between 2 and 16 per cent.
- Buildings renovated to high standards of IAQ and environmental performance have leased up 20 per cent faster and avoided as much as \$25/sf in tenant improvements.
- Green offices report lower vacancies and improved tenant retention.
- Green health care facilities with high IAQ standards have enjoyed a patient recovery rate of as much as 21 per cent faster than average.
- Increases in retail sales in the region of 40 per cent due to green renovations have been reported by companies such as Wal-Mart.
- Educational establishments have shown that test scores can improve by as much as 20 per cent in healthy, day lit classrooms.
- The creation and regular update of an IAQ profile will provide prompt feedback of potential issues.
- Balancing the costs and benefits of IAQ and energy efficiency can be challenging: an integrated design approach is essential.
- Improved ventilation strategies need to be incorporated into HVAC upgrade design considerations.
- While data for BC building upgrades is sparse, it has been shown elsewhere that ventilation and daylighting improvements can return paybacks of less than 5 years for energy savings and less 3 years in productivity improvements.
- Tenant communication is key to success.

## H.1. Indoor Air Quality Overview

On average, Canadians spend approximately 90 per cent of their time indoors. 15 per cent of North Americans suffer from some kind of environmental sensitivity<sup>59</sup>. A healthy workplace improves employee satisfaction, which translates into increased productivity. With salaries and wages accounting for approximately 90 per cent of a firm's building-related expenses, it has been proven that even a slight increase in productivity would be enough to justify the switch to a green building.

**Building expenses, annualized over 30 year lifecycle<sup>60</sup>**



Failure to respond promptly and effectively to IAQ problems can have costly consequences such as:

- increasing health problems such as cough, eye irritation, headache, and allergic reactions, and, in some rare cases, resulting in life-threatening conditions (e.g., Legionnaire's disease, carbon monoxide poisoning)
- reducing productivity due to discomfort or increased absenteeism
- accelerating deterioration of furnishings and equipment
- straining relations between landlords and tenants, employers and employees
- opening potential liability problems

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<sup>59</sup> US National Academy of Sciences

<sup>60</sup> BOMA EPRI Statistical Abstract in RMI "Greening the Building and the Bottom Line 1994"

Increasing the quality of the indoor environment can also pay significant dividends. Optimized daylight and indoor air quality reduces commercial vacancy rates and improve productivity by as much as 16 per cent<sup>61</sup>. Increases in retail sales in the region of 40 per cent due to green renovations have been reported.<sup>62</sup>

Surveys completed by the California High Performance Schools Program<sup>63</sup> and others find that average test scores tend to be higher in green schools – improvements of as much as 20 per cent have been reported.

Managing a building for good indoor air quality involves reviewing and amending current practices:

- **Properly operate and maintain HVAC equipment:** keep all equipment and controls in proper working order keep interior of equipment and ductwork clean and dry
- **Oversee activities of staff, tenants, contractors, and other building occupants that impact indoor air quality:** have management plans for smoking, housekeeping, building maintenance, shipping and receiving, pest control, food preparation and other special uses.
- **Maintain communications with occupants so that management will be informed of complaints about the indoor environment in a timely way:** identify building management and staff with IAQ responsibilities, use health and safety committees, educate staff, occupants, and contractors about their responsibilities in relation to indoor air quality, and look at lease arrangements contracts
- **Identify aspects of planned projects that could affect indoor air quality and manage projects so that good air quality is maintained:** projects could include redecorating, renovation, or remodeling, relocation of personnel or functions within the building, and new construction.

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<sup>61</sup> US Green Building Council – distilled from a range of studies

<sup>62</sup> Green Value [www.rics.org](http://www.rics.org)

<sup>63</sup> <http://www.chps.net>

## H.2. Case Study: Indoor Air Quality

Project	Philips Eco-Enterprise Centre	
Location	Minneapolis, Minnesota, USA	
Size	64,000sf	
Client	The Green Institute	
Project completion	1999: testing and monitoring ongoing	
Savings (\$)	\$60,000 per year from energy efficiency improvements	\$0.93/sf
Payback	2.5 years for energy-related improvements 3 years for productivity improvements	

This industrial office property was completed in 1999 and comprises 64,000sf split into approximately one-third offices and two-thirds industrial space. This was the first speculatively built green business centre in the US and required 50 per cent pre-leasing in order to secure debt financing for the project. There are now 18 tenants leasing space in the development, many of which are in the energy and environmental industry.

Regarding occupant health, daylighting was considered to be the most important green feature followed by operable windows. The occupant health features were estimated to have produced a 3 per cent productivity gain resulting in a 3-year payback and a return on initial capital investment of approximately 30 per cent.

Through ongoing measurement and analysis, the owners and occupants are committed to continuously improving the facility. The property boasts a variety of green building features, but those specific to indoor air quality and occupant health include:

- Active day-lighting systems
- Indirect artificial lighting
- Low-emission coatings
- Multiple zone climate control
- Air quality sensors and controls
- Operable windows

### Return on investment for green features for the Philips Eco-Enterprise Centre

	Developer capital cost differential <sup>64</sup>	Resulting annual return to tenants <sup>65</sup>	Resulting annual return to developer	Combined developer and tenant payback	Combined developer and tenant IRR <sup>66</sup>
Sum of occupant health features	\$144,000	\$43,000		3.3	30%
Ground-source heat pump	\$48,000	\$6,500		7.4	12%
Air-to-air energy recovery system	\$6,000	\$700		8.6	10%
Efficient lighting and controls	\$10,000	\$3,500		2.9	35%
Energy management system	\$36,000	\$4,000		9	9%
Salvaged material installations	(\$20,000)	None		Immediate	NA
Native landscaping	(\$55,000)	\$3,500		Immediate	NA
Active skylights – energy <sup>67</sup>	\$90,000	\$5,000		18	1%
Lease premiums	\$169,000	(\$39,700)	\$39,700	4.3	23%
<b>Total</b>	<b>\$169,000</b>	<b>\$26,500</b>	<b>\$39,700</b>	<b>2.6</b>	<b>39%</b>

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<sup>64</sup> Capital cost differential is the incremental increase (+) or decrease (-) in construction costs from current code-regulated building practice.

<sup>65</sup> Annual return is the estimated average savings to owners and tenants due to improved worker output, decreased utility bills and prevented facility maintenance.

<sup>66</sup> Internal rate of return is the implied return in per cent based upon the capital cost differential, annual savings and a 20 year holding period.

<sup>67</sup> Daylight costs are included occupant health features, this calculation evaluates the feature based upon energy-savings alone

### H.3. Other Examples



Lockheed Missile and Space Company undertook a \$2 million retrofit to increase daylight and energy efficiency. The result was \$500,000 per year in energy savings, a 15 per cent increase in production and a 15 per cent decrease in absenteeism.

**Summary of studies relating to the benefits of Indoor Environmental Quality, GVRD 2004**

#### **Vancouver Island Technology Park**

The 2001 conversion of a former hospital outside Victoria to a healthy and green multi-tenant commercial facility reaped benefits beyond lower operational costs. While the project met a traditional budget, it was found that:

- \$25psf TI avoidance
- 20% faster lease-up
- Analysis shows 30% productivity increase
- Lower vacancies – all tenants retained

**Source: Green Value**

#### **Patients recover faster in healthy hospitals**

A study by Sheffield University for NHS Estates compared patient outcomes in a newly refurbished orthopaedic unit at Poole hospital with those in a 1960s conventional ward.

The study found that patients treated on the refurbished ward required less analgesic medication than those on the older ward. **Patients** not undergoing operations were **discharged** significantly more quickly from the newer ward –after 6.4 days compared with 8.1 days.

**Source: CABE's The Value of Good Design**

**Air quality increases productivity**

Studies have shown that increasing air quality, by decreasing the pollution load or by increasing the ventilation rate, can improve the performance of office workers in the specific areas of text typing, addition and proof-reading.

“The results imply that doubling the outdoor air supply rate at constant pollution load, or a two-fold decrease of pollution load at constant ventilation rate, can increase overall performance by 1.9%.”

**“Pollution Source Control and Ventilation Improve Health, Comfort, and Productivity”**  
**Wargocki P, Wyon DP, Fanger PO (2000)**

#### **H.4. Indoor Air Quality Resources**

“Building Air Quality: A Guide for Building Owners and Facility Managers” This guidebook by the US Environmental Protection Agency contains many practical checklists and templates for developing an IAQ profiles and management plans.

[www.epa.gov/iaq/largebldgs/baqtoc](http://www.epa.gov/iaq/largebldgs/baqtoc)

“The Environmentally Responsible Construction and Renovation Handbook” contains some practical solutions and considerations for controlling indoor air quality.

[www.pwgsc.gc.ca/realproperty/text/pubs\\_erccr/toc-e](http://www.pwgsc.gc.ca/realproperty/text/pubs_erccr/toc-e)

Workers’ Compensation Board of BC provides its regulations on the Internet.

[www.worksafebc.com/Publications/OHSRegulation/Home](http://www.worksafebc.com/Publications/OHSRegulation/Home)

US EPA web site includes a number of indoor air quality publications, including a guide for building owners and facility managers.

[www.epa.gov/ozone/ods](http://www.epa.gov/ozone/ods)

The Healthy Building Network

[www.healthybuilding.net](http://www.healthybuilding.net)

**Appendix I - HVAC Maintenance**

## I. HVAC Maintenance

### **GO GREEN REQUIREMENTS**

**Building management must have in place a heating, ventilation and air conditioning (HVAC) preventative maintenance program.**

### **KEY FINDINGS**

A HVAC preventative maintenance program will save money in the long run and will help ensure that indoor air quality objectives are being met.

- A life-cycle approach to HVAC maintenance is key to success.
- Testing and performing regular adjustments to boiler combustion efficiency to ensure peak operating performance will result in maintaining optimum efficiencies range between 75 to 80 per cent. Boiler efficiency can fall to 50 per cent or less without proper maintenance and adjustment.
- Payback on regular maintenance usually less than 5 years.
- Ongoing, regular and budgeted HVAC maintenance can extend equipment service life and thereby defer capital investments.
- Well-managed buildings have generally implemented HVAC maintenance as part of the ongoing operation and maintenance schedule and budget.
- An HVAC maintenance plan is central to success.
- HVAC systems that are managed in “crisis-mode”, fixing problems as they occur and neglecting maintenance, have proven costlier over the long-run.
- Poor HVAC maintenance can impact indoor air quality and the health of occupants leading to insurance claims.
- Prompt upgrades of controls, replacement of filtration media and fine-tuning offer rapid paybacks (less than 3 years for controls; immediate payback on filters and cleaning when occupant well-being is factored in).

## **I.1. HVAC Maintenance Overview**

An HVAC system requires ongoing preventative maintenance and prompt attention to repairs in order to operate correctly and provide good indoor air quality. The HVAC system operator(s) must have an adequate understanding of the overall system design, its intended function and its limitations. The preventative maintenance program must be properly budgeted and implemented consistently and regularly. When maintenance is neglected or operated in “crisis-mode”: deferred until breakdowns occur or complaints arise, following the “if it isn’t broken, don’t fix it” philosophy. This type of program often increases the eventual cost of repairs.

Poor filter maintenance is a common example of this phenomenon. Filters that are not changed regularly can facilitate fungal growth, sometimes allowing particles or microorganisms to be distributed within the building. Also, as filters become clogged, the fans use more energy to operate and move less air. Poor air filter efficiency and poor maintenance may cause dirt to build up in ducts and become contaminated with moulds, possibly requiring an expensive duct cleaning operation.

Critical HVAC system components that require a project management plan in order to maintain comfort and deliver adequate ventilation air include:

- outdoor air intake opening
- damper controls
- air filters
- drip pans
- cooling and heating coils
- fan belts
- humidification equipment and controls
- distribution systems
- exhaust fans

### **I.1.1. ASHRAE Standards and Guidelines**

- **Standard 62-1989, “Ventilation for Acceptable Air Quality”** ASHRAE 62-1989 assists professionals in the proper design of ventilation systems for buildings.

- **Standard 55-1981, “Thermal Environmental Conditions for Human Occupancy”** covers several environmental parameters including: temperature, radiation, humidity, and air movement. Guidelines are also given for air movement, temperature cycling, temperature drift, vertical temperature difference, radiant asymmetry, and floor temperatures.
- **Standard 52-76, “Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter”** assists professionals in the evaluation of air cleaning systems for particle removal.
- **Guideline 1-1989, “Guideline for the Commissioning of HVAC Systems”** assists professionals by providing procedures and methods for documenting and verifying the performance of HVAC systems so that they operate in conformity with the design intent. The guideline presents a format for documenting the occupancy requirements, design assumptions, and the design intent for the HVAC system.

#### **I.1.2. HVAC Maintenance Tips**

- Lower set points in common areas and tenant zones that are in heating mode; set up maintained temps in interior zones that are in cooling mode.
- Tweak chiller OSA interlock temps to delay or eliminate start up where possible. Disable start during peak demand periods.
- Reduce DHW temps.
- Turn off HW boilers early and allow temps to coast.
- Tighten up optimal start/stop schedules.
- Duty cycle less critical equipment not susceptible to cyclic damage.
- Reduce fan static pressure where possible.
- Set up a reduced duty cycle for garage fans.
- Calibrate equipment to reduce hunting.
- Turn off non-essential auxiliary systems
- Start chillers and VAV heaters earlier in the morning to reduce the call for energy during the higher demand hours.
- Use auto load shedding to alternate and shut down loads at predetermined levels or at peak demand.

- Rebalance air CFM in hot zones to minimize need for DX cooling. Reset night minimum heating and cooling set points for wider span. [Note: If feasible, eliminate night set points.
- If DDC controls re-set temperature, set points. Turn off HW tanks, reduce temps or cycle them. Turn off non-essential circulating pumps.
- Reduce hours of operation for HVAC, lighting, etc.
- Perform operations and maintenance procedures to ensure that HVAC systems are performing at optimal levels. (e.g. clean filters.)
- Set hot water tanks below 105 deg and set auto shutoff for non-use times.
- Check HVAC runtimes and reduce or put on EMS optimum start program.
- Check to see if all unoccupied after-hour areas' HVAC have been set back or below 60 deg.
- Close or install thermal lined drapes. Reduce temperatures in occupied areas to 68 degrees.
- Check all entrances for tight weather seals on doors and windows.
- Reset heating only thermostats in common areas to lower than standard temperatures (below 65 deg) and lock out changes via DDC. This option should only be used if it does not activate cooling equipment.
- Check rooftop unit discharge air supply resets are not driven cooler by hot zones from office equipment next to thermostats.

### **I.1.3. Financial Implications of HVAC Maintenance<sup>68</sup>**

<b>Strategy</b>	<b>Financial considerations</b>	<b>Simple payback period</b>
Test boiler combustion efficiency and perform required adjustments on a regular basis to ensure peak operating performance. Optimum efficiencies range between 75 to 80%, boiler efficiency can fall to 50% or less without proper maintenance and adjustment.	Cost and savings can be influenced by: <ul style="list-style-type: none"> <li>• Size of the heating plant.</li> <li>• Number of boilers.</li> <li>• Severity of existing problems.</li> <li>• Condition and operation of the boiler prior to adjustments.</li> </ul>	5 to 7 years for atmospherically vented gas boiler (based on typical improvements).  4 to 6 years for gas boilers with power venting systems or oil fired boilers.

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<sup>68</sup> Source Ontario Ministry of Municipal Affairs and Housing and CMHC [www.cmhc.ca/en/inpr/bude/himu/waensati/index](http://www.cmhc.ca/en/inpr/bude/himu/waensati/index)

Strategy	Financial considerations	Simple payback period
	<p>The cost of testing and the implementation of typical remedial measures can range as follows:</p> <ul style="list-style-type: none"> <li>• Efficiency testing - \$60 to \$200</li> <li>• Chemical boiler cleaning - \$800 to \$1,500</li> <li>• Water treatment/year - \$1,000 to \$1,500</li> <li>• Burner adjustment - \$200 to \$500</li> <li>• Enlarge air intakes - \$500 to \$1,000</li> </ul>	
Seal Air leakage paths	Average cost for air sealing contractor and consultant - \$30,000 for medium sized building	< 8 years for electrically heating buildings +/- 10 years or more for gas heated buildings
Replace thermostats with thermostats having setback capability	<p>Cost of installing heating only thermostat - \$40 to \$70</p> <p>Cost of installing thermostat for electric heaters with 120 or 240 volt thermostats - \$140 to \$170</p>	less than 7 years
Rebalance or adjust air supply and exhaust systems to ensure air is evenly supplied and/or removed from each zone at rates required to maintain good indoor air quality.	Cost for air balancing - \$30 to \$40 per zone	Payback – Variable: savings will result if supply or exhaust air systems are excessive and could be reduced.
Replace or service grilles that are inadequately sized and/or obstructed to provide the required combustion and dilution air for boilers.	<p>Investment cost - \$0</p> <p>Normal savings - no more than 5% of heating energy cost</p>	Immediate
Seal and insulate warm air supply ducts located outside or in unheated spaces.	<p>Cost of installing duct insulation based on a 20 inch x 20 inch duct \$5 to \$14 per linear foot.</p> <p>Cost savings for air sealing and repairs will be influenced by:</p> <ul style="list-style-type: none"> <li>• Existing condition of the duct and duct insulation, if any.</li> <li>• Volume and temperature of air being moved.</li> <li>• Temperature of area surrounding the ducts.</li> </ul>	Immediate for simple jobs, 5 to 10 years for complex work

Strategy	Financial considerations	Simple payback period
Repair or add insulation to heating system piping and boilers.	<p>Cost to have pipework insulated by a contractor - \$5 to \$20 per linear metre (\$1.50 to \$6 per foot) depending on pipe diameter</p> <p>Results in savings can be influenced by</p> <ul style="list-style-type: none"> <li>• Surrounding air temperatures.</li> <li>• Value and condition of existing insulation.</li> <li>• Contribution of pipe heat loss to space heating.</li> </ul>	5 to 10 years
Control local exhaust fans by turning them off when operation is unnecessary using automatic timer switches, 24 hour or 7 day time clocks.	<p>Overall cost to install timeclocks to control exhaust fans - \$200 per fan</p> <p>Results in savings will be influenced by the number and size of local exhaust fans controlled.</p>	1 to 3 years for exhaust systems that previously operated continuously.
Install a timeclock control to shut down the operation of the central supply and/or exhaust fans during periods where ventilation requirements are minimal.	Cost of Measure: \$500 - \$1,000 (depending on number of timeclocks required and ease of installation).	Less than 1 year (electric heat); 1 to 3 years (natural gas) in cases where systems previously operated continuously.

## I.2. Case Study: HVAC Maintenance and Upgrading Controls



Control upgrade projects have been completed for 35 HVAC systems in nine buildings under the current energy management program at the University of New Brunswick. Projections indicate that these control upgrades will result in a reduction in steam

consumption of 11,000,000 lbs per year and an annual electrical consumption reduction of 407 000 kWh. Annual cost savings for the purchase of fuel and electricity is projected to be \$81,350, representing a simple payback of 3.87 years on the investment of \$314,890.

The strategies used in control upgrade projects included the following:

- Providing or enhancing occupancy scheduling
- Shutting down building relief fans during the heating season
- Providing mixed air and supply air temperature reset schedules based on outside air temperature
- Utilizing carbon dioxide sensors to monitor indoor air quality and make automatic adjustments to fresh air volumes being introduced to air-handling systems
- Replacing damaged mixing dampers
- Installing chemical storage cabinets so that fume hoods can be emptied and scheduled to be off when not in use
- Programming lockouts to eliminate simultaneous heating and cooling
- Providing enthalpy control of mixing dampers, allowing fresh air to provide free cooling and assist mechanical cooling when conditions are favourable
- Installing dedicated air-conditioning units for spaces that require air conditioning on a year-round basis to avoid operating central HVAC systems at low mixed-air temperatures requiring significant amounts of reheat
- Programming initialization of cooling stages to prevent frequent cycling of cooling equipment and overshooting of cooling set points and requirement for reheating
- Replacing worn and inefficient inlet vanes with variable frequency drives; and • removing redundant devices in air streams to minimize the static pressure requirements of the fans and reducing fan speed to adjust the air balance

### **I.3. HVAC Maintenance Resources**

American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) publishes Standard 62, 'Ventilation for Acceptable Indoor Air Quality'; available via the online 'Bookstore'

[www.ashrae.org](http://www.ashrae.org)

US EPA's Appendix B: HVAC Systems and Indoor Air Quality

[www.epa.gov/iaq/largebldgs/graphics/appenb.pdf](http://www.epa.gov/iaq/largebldgs/graphics/appenb.pdf)

Impacts of Increased Outdoor Air Flow Rates on Annual HVAC Energy Costs

[www.epa.gov/iaq/largebldgs/energy\\_cost\\_and\\_iaq/project\\_report4](http://www.epa.gov/iaq/largebldgs/energy_cost_and_iaq/project_report4)

“Preventive HVAC Maintenance is a Good Investment” Buildings, July 2006.

[www.unicco.com/downloads/news-events/unicco-in-print/Buildings%20-%20Shaker%20-%20HVAC%20Maintenance.pdf](http://www.unicco.com/downloads/news-events/unicco-in-print/Buildings%20-%20Shaker%20-%20HVAC%20Maintenance.pdf)

## **Appendix J - Communication Program**

## J. Communication Program

### GO GREEN REQUIREMENTS

**Building management must have in place a well-understood system for communicating with tenants/occupants on environmental issues specific to the building.**

### KEY FINDINGS

Tenant and employee engagement and participation are critical to the success of any Go Green program. Tenants can help identify indoor air quality problems, impact daily energy and water use and determine the success of a recycling program. Other findings include:

- Given current levels of energy wastage in lighting and office equipment operations and low recycling levels, there are significant savings to be gained from tenant communication programs.
- Tenant engagement, education and ongoing communication is critical to the success of any building performance improvement program.
- Tenant communication programs need to be adequately planned, budgeted and then maintained and monitored.
- Feedback opportunities for tenants are important as are a go-to-person to address complaints and provide prompt responses to questions.
- \$44 in savings per year per computer station by shutting off computers and monitors during evenings and on weekends which extrapolates to a saving in the region of \$0.30/sf for an office building at an occupancy of 1 worker per 150 sf.
- Sophisticated programs, appropriately structured, have been shown to pay for themselves out of the savings they generate.

## **J.1. Communication Program Overview**

The support and engagement of tenants are crucial to program success. Effective communication of the objectives and goals that will be achieved by turning off lights and computers, sorting waste and recyclables, and so on will ensure that capital investments in building systems will continue to deliver optimal results.

The key aspects of an effective communication program are frequency, accuracy, comprehensiveness, and inclusiveness. Promotional items, such as posters and news releases can provide timely and effective communication about the business's commitment to green practices. Company newsletters and company/building announcements can also keep tenants informed about green goals and how they can both help and benefit.

Communication strategies may include:

- The creation of a management-tenant task force to develop the initial program
- Initial program launch comprising:
  - Announcement letter to each tenant
  - Tenant meetings
  - Education programs that explains the benefits of green operations.
- Communicating management activities and results
  - Post and distribute audit results, new programs, and new policies
  - Use the buildings' website and/or intranet
- For new tenants
  - Modifications to lease agreements where possible
  - A tenant handbook
  - Continuing education program

## **J.2. Case Study: Tenant Communications**

GWL Realty Advisors Inc. has committed to reducing its real estate's energy consumption and energy costs, and thereby its greenhouse gas emissions. GWL's energy efficiency plans are projected to cut total energy costs for GWL's buildings across the country by about \$17 million for an average savings of \$0.29/sf and reduce total CO<sub>2</sub> emissions by about 70,000 tonnes, or about 5 per cent per year for the next five years.

GWL's Calgary property management office developed an energy management action plan that includes details on training staff to make them aware of energy costs, alternative products and ways to increase energy efficiency.

For buildings to be truly energy efficient, the people who use them have to be committed to saving energy. To encourage tenant buy-in, GWL created a service for tenants that monitors and manages electricity use. Through its Tenant Energy Management Service, GWL is promoting an energy conservation partnership with all of its tenants by providing them with an on-line electricity management tool and an in-house consulting service.

The aim is to reduce electrical consumption, operating costs and total CO<sub>2</sub> emissions. This will, in return, increase the tenants' net operating income, the property's marketability to tenants and the investment community, and the net operating income of the property. Tenants at Commerce Court in Toronto and La Tour CIBC in Montréal are already individually metered, with TEMService being considered by the local management team.

### **J.3. Other Examples**

#### **UBC's Energy Efficiency Social Marketing Program**

The UBC Sustainability Office Sustainability Coordinator Program saves UBC \$75,000 worth of electricity annually. These savings fund the SC's activities and other campus-based sustainability programs

The SC program comprises 145 faculty and staff who enthusiastically spread a message of conservation and, in as little as 2-4 work hours per month, take practical steps to save resources by:

- Acting as early sustainability adopters
- Modeling new behaviors
- Helping colleagues understand the impacts of their daily activities
- Identifying more sustainable alternatives

UBC SO now offers a Sustainability Coordinator workshop for building owners and operators.

**[www.sustain.ubc.ca](http://www.sustain.ubc.ca)**

#### **Savings to be made through tenant education**

The U.S. Environmental Protection Agency (EPA) estimates that 80 percent of the printers used in offices, 70 percent of copiers, and 20 to 30 percent of computer monitors and task lights are left on overnight.

#### **Zellers communication program**



In 1999, Zellers embarked on a retrofit project comprising of a pilot project in 10 representative stores across the country, followed by a replication project in an additional 50 stores. The total project cost about \$5 million, and the company is saving over \$1.5 million annually in energy costs.

Measures included changes to the lighting systems, use of demand controls, installation of high-efficiency motors and changes to the HVAC plants and an awareness program.

The awareness program was launched through a series of road shows presented to store managers in each of its 24 districts. It also produces employee newsletters, offers monthly tips and distributes its "Protecting Our Future" energy reports to all regional, district and store managers. Zellers also rewards district store associates by offering financial to those who achieve the highest year over-year improvement on energy efficiency.

[www.zellers.com](http://www.zellers.com)

#### **J.4. Tenant Communication Resources**

BOMA International has a publication entitled, 'BOMA's Do It Yourself Guide to Producing a Tenant Handbook', available for downloading in their Products & Research area.

[www.boma.org/ProductsAndResearch](http://www.boma.org/ProductsAndResearch)

Portland's G-Rate program offers a tenant improvement guide to ensure high performance commercial tenant improvement projects.

[www.portlandonline.com/shared/cfm/image.cfm?id=112733](http://www.portlandonline.com/shared/cfm/image.cfm?id=112733)



### **About PHH ARC Environmental**

PHH ARC Environmental Ltd. (PHH ARC) is an environmental health and safety services consulting firm, which provides a wide range of engineering, geosciences and environmental health and safety solutions across Western Canada and Europe.

PHH ARC Environmental operates as an industry leader in the provision of environmental services by integrating and practising three disciplines:

- **Service:** We will consistently provide our clients with quality, professional and efficient consulting.
- **Integrity:** We will consistently honour all commitments to our clients, our Company and each other.
- **Excellence:** We will consistently excel in all endeavours, exceed our clients' expectations and conduct our activities ethically.

Our Company recognizes, through fair and honest treatment, the vital importance and well-being of each employee to its successful operation.

PHH ARC operates twelve offices including Richmond, Victoria, Prince George, Keremeos, Nakusp, Kelowna, Calgary, Edmonton, Red Deer Saskatoon, Yellowknife, and Cardiff in the UK.

Visit **[www.phharcenv.com](http://www.phharcenv.com)** for more information.



## **About Light House**

Light House Sustainable Building Centre is an enterprising non-profit society dedicated to advancing sustainability within the built environment. Light House's purpose is to:

- To provide British Columbians with an information point of service where the public and industry professionals can obtain information on green building practices, policies, and projects as well as green building professionals
- To provide education, training and outreach that will foster a deeper awareness of and commitment to sustainable building practices
- To support and advance public sector programs and initiatives through research, development and implementation of tools and resources applicable to and optimized for the British Columbian construction and real estate industries
- To advocate for and catalyze the sustainable building sector in British Columbia

Light House Sustainable Building Centre was founded as an enterprising non-profit society in November 2005. The Light House Resource Centre is located in the heart of Vancouver's Granville Island. Visit [www.sustainablebuildingcentre.com](http://www.sustainablebuildingcentre.com) for more information.