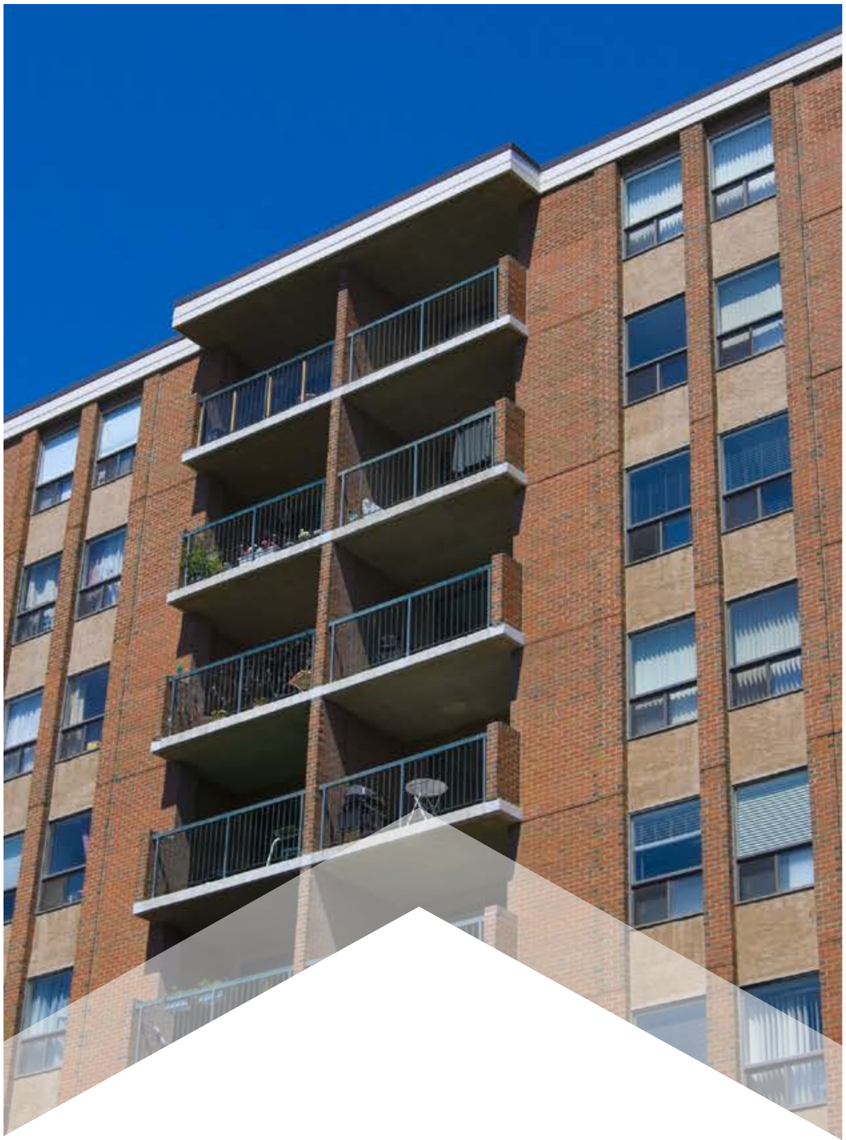


Energy and Water Efficiency in Multi-Unit Residential Buildings

A USER GUIDE FOR PROPERTY MANAGERS AND OWNERS

Canada

CMHC SCHL

CMHC helps Canadians meet their housing needs.

Canada Mortgage and Housing Corporation (CMHC) has been helping Canadians meet their housing needs for more than 70 years. As Canada's authority on housing, we contribute to the stability of the housing market and financial system, provide support for Canadians in housing need, and offer unbiased housing research and advice to Canadian governments, consumers and the housing industry. Prudent risk management, strong corporate governance and transparency are cornerstones of our operations.

For more information, visit our website at **www.cmhc.ca** or follow us on **Twitter, LinkedIn, Facebook** and **YouTube**.

You can also reach us by phone at 1-800-668-2642 or by fax at 1-800-245-9274. Outside Canada call 613-748-2003 or fax to 613-748-2016.

Canada Mortgage and Housing Corporation supports the Government of Canada policy on access to information for people with disabilities. If you wish to obtain this publication in alternative formats, call 1-800-668-2642.

Table of Contents

Introduction

Save money in the long run by boosting energy and water efficiency.

Great potential for savings

Some say that "they don't make 'em like they used to." When it comes to the efficiency of buildings, this can be a good thing. In recent decades, buildings were designed with energy and water efficiency in mind.

However, over 75 per cent of multi-unit residential buildings were built before 1990, a time when building standards did not account for efficiency. In particular, older buildings don't have the envelope thermal performance of today's construction. Older buildings can also have outdated mechanical, electrical and plumbing equipment that contributes to water and energy inefficiency. In many multi-unit residential buildings, indoor air quality and occupant comfort could also be improved.

Well worth doing

It's in your interest to conserve energy and water. These costs can account for 25 to 50 per cent of total operating costs in a multi-unit residential building. Improving energy and water efficiency can also mean lower tenant turnover, higher durability and increased property value. Tenants win too. They could save money, while finding their home more comfortable to live in. In fact, it's in everyone's interest—multi-unit residential buildings account for 20 per cent of total residential energy use, so saving energy and water helps protect the environment.

Timing and planning are important

There's no single way to make energy and water efficiency improvements, because every situation is different. Multi-unit residential buildings come in many forms and with different resources available. Some buildings are publicly owned, while others are privately owned. Some buildings operate in provinces where rental rates are regulated. Condominium properties have their own cost considerations, and improvements within a condominium unit are the responsibility of the owner.

Even with all this diversity, most property managers can see the value of investing in energy and water efficiency. The key is finding the right mix of cost-effective solutions. Cost-effective, for most, means a payback period of less than five years.

Whatever the situation, one of the easiest ways of managing costs is to always consider energy and water efficiency when upgrading or replacing equipment. Also, in planning a reserve fund, set aside money for energy and water efficiency upgrades.

The building as a system

You should think of the building as a system. Potential improvements should not be looked at in isolation. Changing one element of the building will often have an effect on other systems within the building. So, when making changes, consider the full impact on the whole building—energy and water consumption, indoor air quality, occupant comfort, building durability, building environmental impact and asset value.

For example, improving the building envelope can reduce infiltration and heating costs, while making the units more comfortable. It could also improve the appearance of the building. However, it may also require a controlled ventilation system. At the same time, upgrading ventilation can increase building durability by reducing condensation. In another example, high-efficiency lighting will help conserve electricity and make spaces better lit, but with less heat coming from the lights, there could be increased need for space heating.

It's best to consider the big picture and broader goals rather than one-off improvements. Seeing your building as an interrelated system will help maximize the benefits of your efficiency investments.

What you'll find in this document

Owners, property managers and building superintendents will find useful information for developing energy and water conservation programs in mid- and high-rise multi-unit residential buildings. You can use this information to decide which measures work best for you and to get started on planning and implementation.

The User Guide will show you how to conduct a preliminary assessment, decide on the right conservation measures, estimate payback from the investment and begin planning your actions.

The Multi-Unit Residential Building – Energy and Water Efficiency series provides detailed explanations on 51 energy and water conservation measures that will help determine the right solutions for the particular requirements of your building. These aren't "how to" guides, but they show the range of options available and provide information on the potential financial impact of each measure.

Tuning-up keeps costs down

Before developing your energy and water conservation plan, a basic tune-up in energy and water efficiency can quickly yield considerable savings. A comprehensive tune-up can cut energy and water costs by up to 20 per cent. For a high-rise building with 40 apartments, that could mean savings of about $8,000. A comprehensive tune-up would include the building envelope, HVAC systems, lighting, appliances and other systems.

There are other benefits as well. Tune-ups improve the long-term condition and safety of the building. They can make the building more comfortable and healthier for residents.

Better retrofit decisions

There's another way that tuning-up can save money—better retrofit decisions. In fact, some tune-ups could save so much energy that the cost of the retrofit can be deferred.

If you do consider buying new equipment, you want to have a clear picture of the improvement it will deliver. Part of that decision involves comparing operating costs for new versus old equipment. That comparison will be more accurate if the old equipment is operating as well as it can.

Tune-ups also help you understand the building better. You may generate new ideas for retrofit savings during the tune-up.

Take care of your equipment and it will take care of you

Equipment that is maintained will last longer. This is true of HVAC and other building equipment. More than that, equipment that's in good condition is more likely to limit air and moisture penetration, which leads to further gains in cost, building longevity and occupant satisfaction.

Home safe

Sealing the building envelope could help save lives. Leaky high-rise buildings allow more uncontrolled air flow throughout the building, which could contribute to the spread of fire and smoke. Buildings damaged by moisture can also be dangerous, particularly if pieces of the cladding system fall off.

Happier tenants

Some occupants might say it's too hot, some might say it's too cold. Tuning up the building's envelope and HVAC systems will improve your ability to control temperature and humidity in the building. This will reduce the staff time required to address occupant complaints. Even more significantly, occupants who are more satisfied with building comfort will tend to stay longer, reducing the cost of turnovers.

Healthier tenants

Humidity outdoors can be uncomfortable. Humidity indoors can lead to serious health problems. Tuning up a building improves the ability to control moisture in the air. If the relative humidity is below or above the 40 to 60 per cent range for long periods of time, airborne bacteria, viruses and fungi can all thrive. Properly operated ventilation systems control humidity and provide fresh air.

Clean air also means keeping pollutants out. Uncontrolled leakage can allow exhaust fumes to enter the building from the garage or through air intakes near the ground floor. Tiny particles and contaminants in car exhaust irritate the lungs. They are particularly dangerous to people with respiratory conditions. Tuning up the building envelope will help prevent these fumes and particulates from entering the building.

A healthier environment for all

Tuning-up combustion appliances in the building will reduce energy use, which also means fewer emissions of pollutants. Tuning-up can save on water use, the most precious resource there is.

Showing you care—owner commitment

Regular building tune-ups and maintenance show your commitment to the building. Occupants tend to respond positively to this commitment and become more willing to help take care of the building. The result is happier occupants, less complaints and reduced turnover rates.

The tune-up sequence

CMHC offers detailed guides on *Energy and Water Tune-ups for Multi-Unit Residential Buildings*, which will help ensure that energy and water are not being needlessly wasted. Explore and implement ideas that might work for you.

Because buildings operate as a system, tuning-up should follow a logical sequence.

Start with the building envelope. This will reduce the load on the heating and cooling system and ensure air is being directed to where it should be going.

Once uncontrolled heat loss through the building envelope has been reduced, move on to heating and air conditioning systems, which often account for close to 50 per cent of annual energy use. Start with the primary heating source, such as a central boiler (if there is one), and work out to where the heat is delivered to the suites.

Tune up ventilation systems next. They are important to comfort and air quality. They also impact energy consumption through fan energy use and tempering (and sometimes cooling) of the ventilation air.

Domestic hot water is the next priority. Compared to other large buildings, multi-unit residential buildings are big consumers of hot water.

Then, move on to lighting and appliances. Not only will this lower electricity use, it will reduce internal loads on the cooling system.

Last, other systems in need of tuning-up might include swimming pools and in-suite plumbing.

A. Developing a full water and energy conservation program

There are established processes you can follow to create a successful energy and water efficiency program. The specific steps may vary, depending on the type of building, fuel consumption, ownership structure and technical knowledge of the property manager.

Step A1: Reduce air leakage

Leaking air means lost dollars when it comes to overall space heating costs. In some cases, you can take low-cost steps to seal leaks, and many repairs can be made without a major investment. CMHC's Air Leakage Control Manual for Existing Multi-Unit Residential Buildings[1] describes how to plan and implement an air leakage control program.

Step A2: Review and implement retrofit measures

CMHC published property manager's modules that share information on the economics of energy and water conserving measures. Some of these measures are simple and low cost. Others will need be done as part of major replacement or renovation projects. The individual energy and water measures are found in the guides on the building envelope, domestic hot water, electrical systems, heating and ventilation systems, lighting systems, renewable energy and water conservation.

PAYBACK

Many measures offer a simple payback of less than five years. While CMHC guides and expert advisors can offer estimates of the payback range, these can vary widely. Factors include local energy or water costs, climate, building characteristics, suitability of the measure for your building, capital costs and incentives offered by government, utilities or other parties.

BLENDED SERIES DELIVERS BEST RESULTS

It's often best to combine measures having shorter and longer paybacks into a total program. Implementing only low-cost, rapid payback measures is better than doing nothing at all, but you might be missing opportunities for longer-term planning on a blended series of measures that could have a real impact on overall savings.

You know your building best

Your experience and knowledge is the best resource in choosing energy and water conservation measures. In most cases, there are some "quick win" options that can be immediately considered because the potential payback is so attractive. Other measures may involve a more significant capital investment, but may still present the potential for an attractive payback. Very often, these improvements also deliver other benefits, such as occupant satisfaction.

Think long term to reap additional savings

Some measures might require a significant investment, but they should still be considered over time. However, as you perform ongoing repairs, replacements or renovations, there may be opportunities to reap water and energy conservation gains at a minimal additional cost. Reroofing or recladding, for example, provide excellent opportunities for adding insulation to the building envelope, while only marginally affecting the overall cost of the project. Other opportunities might include window replacement, bathroom upgrading or the installation of new mechanical equipment.

[1] http://www.cmhc-schl.gc.ca/odpub/pdf/65847.pdf?lang=en

Target the biggest bills

In assessing potential improvements, address those energy and water uses that are costing you the most, in both utility bills and maintenance. For instance, if you know that your lighting load is high, review and analyze the options available for improving lighting performance. Similarly, if your heating load is high, consider the measures presented for upgrading heating systems and the building envelope. This preliminary assessment should give you an appreciation of energy and water conservation options that hold greatest potential for enhancing building performance. It should also give you an idea of potential cost. The engineers, suppliers and contractors you work with should be able to help you more accurately estimate capital costs.

See the whole picture

Review and consider measures that will affect indoor environmental quality. Many conservation and retrofit measures can have a broader effect on the indoor and outdoor environment, either positive or negative. Before moving forward, make sure that, together with consultants and contractors, you are seeing how your plan could impact the whole building and its environment.

"HEALTHY HOUSING"

is good for the people who live in it, good for the community and good for the earth. To make housing healthier, you can:

- look for signs of moisture, chemical off-gassing, mould or leaks;
- choose low- or no-emission paints, finishes, cements, sealants and adhesives, and building materials and products (for example, cabinetry with no formaldehyde);
- choose hardwood, ceramic and linoleum flooring instead of carpeting, to reduce chemical emissions and dust; and
- choose materials with recycled content (insulation, flooring, shingles) from sustainable resources (cork flooring, engineered wood products), or from recycled materials (flooring, siding, doors, trim).

B. Pitching your plan to decision makers

Develop a proposal package for building owners to consider. It should clearly describe current energy and water usage and costs for the building. Show how there's a systems approach to improving building performance. Make it clear how changing one element of the building will have an effect on other systems. Balance short-term and long-term goals. Bundle rapid payback measures with longer payback measures to reach an average payback period that is attractive to building owners.

Step B1: Present proposal to building owners

Know the decision maker's priorities

Different forms of ownership will have different goals, objectives and constraints. Your proposal to improve building performance must be structured to appeal to the owners and decision makers and reflect their priorities.

Present your case clearly. The clearer the presentation and the closer it reflects ownership objectives, the more likely the chances are of approval. Decision makers should know that the proposal is preliminary—final decisions will be made with more detailed analysis and cost estimates.

Emphasize benefits such as:

- reducing operating and maintenance costs, which improves the bottom line;
- enhancing the asset value of property, which raises resale value;
- improving tenant comfort and satisfaction, which contributes to higher occupancy and lower turnover;
- extending the life expectancy of building components, which reduces maintenance costs; and
- making major repairs count, which means a higher return on investment.

You may need to defend your ideas, so anticipate the concerns that decision makers are likely to raise and prepare your counter arguments.

Getting to yes: Navigating the conversations

OWNERSHIPS	COMMON CONCERNS	COUNTER ARGUMENT
Agencies for social housing	Tenant comfort and affordability	Focus on reduced operating costs that defer the need to raise rent as energy and water costs rise.
	Costs	Piggyback energy and water saving measures where possible. Stress how reducing building operating costs may free up money for other improvements. Recommend measures that can be implemented by on-site maintenance staff where possible.
Condominium boards	Condominium fees	Emphasize measures that reduce operating costs / maintenance fees without adding costs.
	Safety and security issues	Focus on safety measures—for example, exterior and parking garage lighting improvement measures.
	Non-essential renovation costs	Emphasize benefits, such as enhanced comfort, improved air quality, environmental issues, etc.
	Reserve funds	Prepare a reserve fund study that incorporates energy and water efficiency measures into planned repair/maintenance activities.
Co-operative housing boards	Raising rents	Focus on reduced operating costs that defer the need to raise rent as energy and water costs rise.
	Safety and security issues	Focus on safety measures—for example, exterior and parking garage lighting improvement measures.
	Environmental concerns	Stress measures that reduce environmental impact.
Rental units	Operating costs	Emphasize reduced operating costs and return on investment.
	Occupancy/Turnover	Emphasize that benefits of energy and water efficiency activities can reduce turnover by improving building and occupant comfort and security.
	Payback	Blend measures to improve average payback. Integrate measures into ongoing repair and maintenance activities.
	Occupant complaints	Focus on measures to reduce drafts, improve comfort and security and improve indoor air quality.
	Maintaining property value	Piggyback energy and water efficiency measures onto renovation activities where possible.
	Maintenance costs	Include measures to reduce maintenance costs (for example, relamping programs that reduce bulb replacement).

Step B2: A sound plan

A detailed energy management plan should identify measures that can be implemented in both the short term and the longer term, as well as those measures that should be piggybacked onto repair and renovation projects. More comprehensive plans might include building audits, computer modelling and the development of alternative strategies based on a range of costs. If you don't have the expertise or experience yourself, seek out professional help. Accurate cost estimates—and projected savings—are essential to getting started.

Accessing expertise

To get these numbers right, there's lots of expertise out there. Suppliers and contractors should be able to provide comparable case studies to confirm savings. Lighting contractors should be able to give you detailed pricing and estimates of the energy saving potential of lighting replacement projects, just as plumbers should be able to detail water savings.

There are also consultants who can provide comprehensive energy management planning. You can hire an energy service company (ESCO) that has experience with all aspects of energy management. ESCOs will develop preliminary plans, seek approval from the owners and move forward into final proposals that are consistent with ownership direction. ESCOs also provide implementation and monitoring services. They may also finance the upgrades if they can recover their costs from the energy savings over a set period of time.

Step B3: Offset costs with incentives

Conservation is in everyone's interests. It helps preserve the natural environment and contributes to quality of life. That is why governments and non-governmental organizations, as well as some private sector organizations, support conservation.

Some provinces, such as Ontario, Quebec and Nova Scotia, have provincial agencies that have a specific mandate to promote energy efficiency through a variety of programs, including financial incentives. Provincial governments also look to energy and water distribution utilities to offer conservation programs. Many municipalities have water efficiency education or funding support programs, including support for fixture retrofits, such as low-flow toilets, shower heads and faucets.

This all means financial support may be available to help offset the cost of your energy and water efficiency improvements. Various stages of your project could qualify for some type of funding, including audit, feasibility study, technology or project financing, reporting and evaluation.

Natural Resources Canada's Office of Energy Efficiency, tracks available incentive programs by province.[2]

[2] http://www.nrcan.gc.ca/energy/products/energystar/why-buy/14136

C. Implementation and monitoring

Step C1: Bring occupants onside

Your detailed plan—including costs, projected savings and estimated payback—will need to be signed off on by the building owners. Once you get the "green light" to begin, you need to communicate the plans to those who live in the building.

Some measures can be completed with minimal disruption, but you may also need access to suites. Normal building operations could be disrupted. There are steps you can take to minimize inconvenience to occupants.

Communicate

If possible, try to involve a group of occupants in the planning stages. This will help you identify issues early in the process so they be addressed as part of planning. In any case, provide occupants with ongoing information regarding the work you're doing and the time frame. People living in the building need to know what to expect, especially if services will be disconnected or if you will need access to units. Provide contact information so tenants know where to bring their concerns.

Stress the benefits

Make sure tenants know why the work is being done and the benefits it will provide. Many will appreciate enhanced comfort, security and occupant control. Plans that will positively impact the environment, such as reducing greenhouse gas emissions and improving air quality, are likely to be supported.

Step C2: Implement with care and consideration

Even projects with great potential for saving energy or water can end up causing problems if implementation is not managed effectively. There are steps you can take to avoid problems.

Schedule work when people are out of the building

When possible, schedule work during the workday. Many occupants will be out of the building. Even for those at home in the day, restoring services at the close of the working day would make the disruption more manageable. Assure tenants that the people working in suites are fully bonded.

Schedule major work in rental buildings when units are vacant

Although tenants are often willing to put up with some inconvenience, especially for the sake of building improvements, it is that much easier if the unit is empty. Make the most of chances to undertake improvements that would be difficult or disruptive if the occupants were there. Major in-suite work, such as wall re-insulation and window replacement, is often best postponed until the unit is vacant, if possible.

Train operations staff

For improvements to be successful over the long term, your staff must know how to operate and maintain the new systems being installed. Ask suppliers for on-site training for building personnel. Make sure you receive manuals and encourage your people to use them.

Step C3: Monitor the impact

To know the value of your investment and to ensure equipment is performing as it should, monitor the impact of the measures you have implemented. Keep careful records and compare energy and water use before and after implementation. If you're not achieving your target savings, you'll need to determine whether the issue is improper installation or whether additional measures are needed.

Appendix

There are three basic steps that a property manager should perform to begin a comprehensive energy and water efficiency program. Details of each step may vary based on the type of building, energy source and consumption, ownership structure and technical knowledge of the property manager. These steps are:

1. Perform a level 1 audit
2. Benchmark your building
3. Assess potential measures and their cost benefits

1. Perform a level 1 audit

Understanding energy and water consumption patterns is a fundamental step in developing an energy and water efficiency plan for your building.

A level I audit will show consumption and cost for:

- space heating
- space cooling
- domestic hot water heating
- base electrical load
- lighting
- base water consumption
- summer water consumption (for lawn care, swimming pool, etc.)

Step 1-1: Record the data from each utility invoice

Record the monthly consumption and total cost for each water and energy utility for a period of at least 12 months. Where the building is all-electric, there will only be two utility types.

It is not essential that your billing dates match the monthly calendar, but make sure the period on the bill is not less than 28 days or greater than 33 days. You want to have approximately equal billing periods allocated to each month. If your building uses fuel oil, you will need to estimate monthly consumption from the delivery records.

In most cases, each utility will have a single meter. If your building has more than one electrical, gas or water meter, you may be able to allocate consumption by looking at the end use for that meter.

In some cases, particularly for electricity, you may be able to add a submeter for a defined period of time to evaluate consumption of specific loads, such as outdoor lighting, elevators or domestic hot water heating.

THE VALUE OF KNOWING YOUR HISTORY

Utility records are a valuable source of information. They provide a reasonable understanding of usage patterns and show the impact of climate on consumption and costs.

At least 12 months of historical utility records are needed to develop an understanding of consumption patterns. Having records for 24 or 36 months is even better. If you don't have records on file, ask your local utility. They can provide historical information.

Knowing historical consumption helps determine where to focus your efforts, whether those efforts are making a difference and if other factors, such as changes in occupancy, might have played a role.

From the total annual consumption and cost for each utility, calculate the average cost for each unit of energy and water. This will be useful for determining costs for each end use. The table below provides a format for recording consumption.

Table 1-1a: Sample record of utility data

In this sample, a multi-unit residential building uses natural gas for space heating and domestic water heating, and has space cooling using a central air-cooled chiller. The building has green areas that are watered occasionally, and occupants are permitted to use water for vehicle washing. Total floor space is 22,000 m^2 (236,800 sq. ft.).

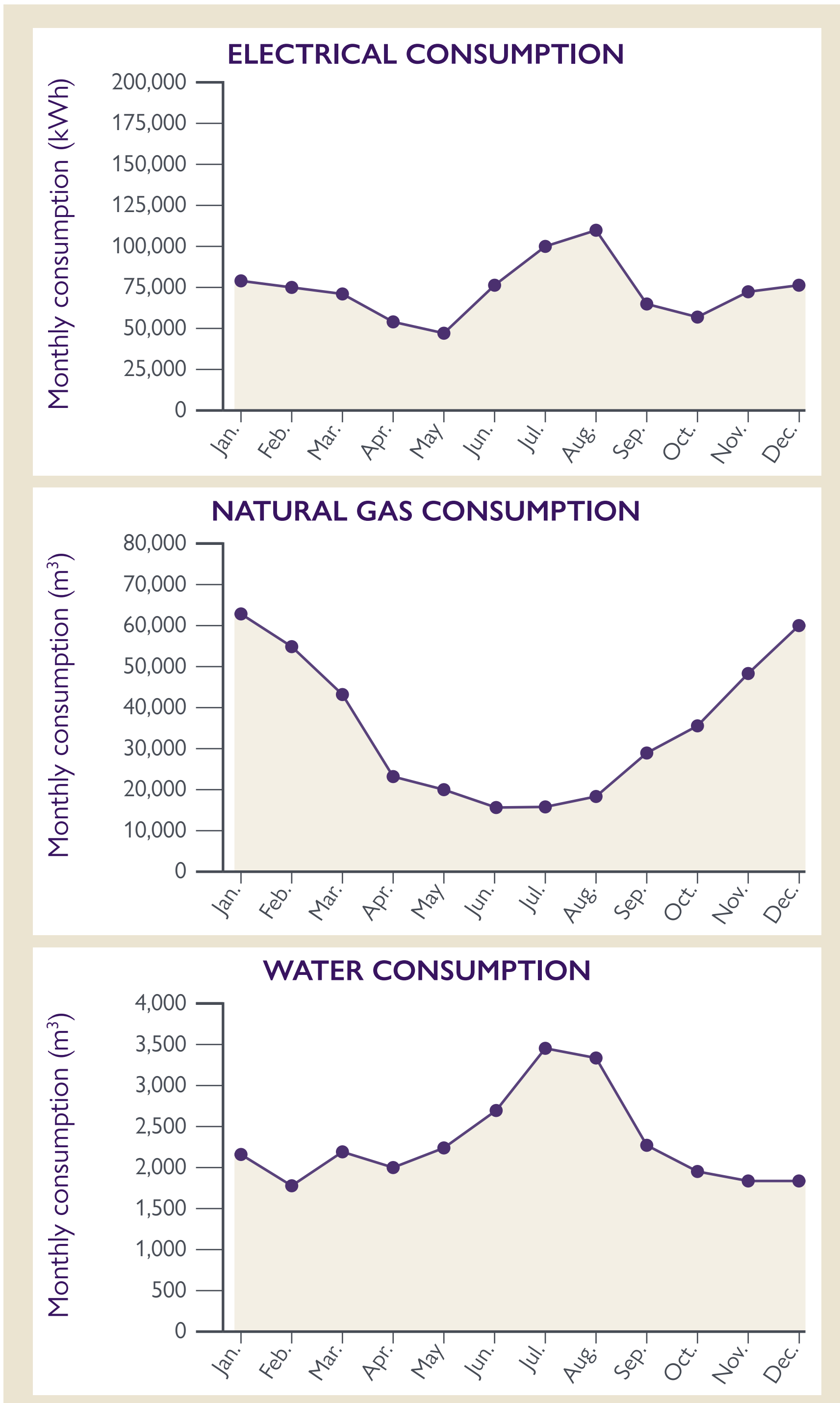
UTILITY RECORDS	ELECTRICITY		NATURAL GAS		WATER	
Month	kWh	$	m^3	$	m^3	$
January	80,000	4,800	60,000	15,000	1,750	1,750
February	75,000	4,500	52,000	13,000	1,400	1,400
March	70,000	4,200	40,000	10,000	1,800	1,800
April	52,000	3,200	20,000	5,000	1,600	1,600
May	45,000	2,700	17,000	4,250	1,800	1,800
June	75,000	4,500	12,000	3,000	2,200	2,200
July	100,000	6,000	12,000	3,000	2,900	2,900
August	110,000	6,600	14,000	3,500	2,800	2,800
September	62,500	3,750	25,000	6,250	1,900	1,900
October	55,500	3,300	31,000	7,750	1,600	1,600
November	72,000	4,300	45,000	11,250	1,500	1,500
December	76,000	4,500	56,000	14,000	1,500	1,500
TOTALS	873,000	52,350	384,000	96,000	22,750	22,750
Unit cost*		0.06/kWh		0.25/m^3		1.00/m^3

*Unit costs are for illustrative purposes only and do not reflect actual costs for each utility.

Step 1-2: Chart the recorded data

Chart the data for each utility for a 12-month period, as shown in figure 1-2a. Where you have data for 24 months or more, prepare a separate chart for each comparable 12-month period.

Figure 1-2a: Sample charting of utility records



Step 1-3: Spot the trends

Consumption will vary from season to season – heating energy requirements peak in the coldest months of the winter; cooling energy requirements peak in the hottest part of the summer; water consumption rises in the summer as a result of lawn watering, outdoor swimming pool needs, vehicle washing, etc.

Consumption will vary based on equipment in the building – a building with gas-fired domestic hot water heaters will have a base natural gas consumption in the summer months; a building with air conditioning will have peak electricity consumption in the summer; a building with an automatic lawn sprinkler system will have higher water consumption in the summer.

Consumption will vary from year to year – where more than one year of utility records are available, consumption patterns for more than one year can be compared. These patterns will reflect climate differences from year to year, such as a particularly cold winter or hot summer. However, year-to-year comparisons can also show significant changes in building operations.

Consumption will vary as occupancy or equipment and systems change – charting building performance from year to year will help identify operational changes. There may be a need for increased maintenance, or equipment may be deteriorating.

Step 1-4: Determine where energy is being used

The information you've gathered will help to see the amount of energy consumed by some of the major loads. To do this, you need to determine the base load for each utility.

Monthly base load

Monthly base load is that part of the total load that is not affected by changes in season. To determine the monthly base load, calculate the average of the usage in those months having the lowest consumption.

In the sample building data, base load for each utility is determined as follows:

Electricity: Take an average of the consumption for May and October:

Base electrical load = (45,000 + 55,500)/2 = 50,250 kWh/month

Natural gas: Take an average of the consumption for June, July and August:

Base gas consumption = (12,000 + 12,000 + 14,000)/3 = 12,650 m^3/month

Space heating load and cost

In the sample building, space heating and domestic water heating are provided by natural gas. Therefore:

Space heating load = Total load minus base load

= 384,000 m^3 - (12,650 m^3 x 12) = 232,200 m^3/year

Therefore, space heating cost = 232,200 m^3 x \$0.25/m^3 = \$58,050/yr

* Unit costs are for illustrative purposes only and do not reflect actual costs for each utility.

Space cooling load and cost

Space cooling load is the difference between electricity use in the summer months and the base load for those months. Therefore:

Space cooling load = Electricity for June + July + August + September minus base load
= (75,000 + 100,000 + 110,000 + 62,500) - (4 x 50,250) = 146,500 kWh/yr

Therefore, space cooling cost = 146,500 kWh x $0.06/kWh = $8,760/yr

* Unit costs are for illustrative purposes only and do not reflect actual costs for each utility.

Domestic hot water load and cost

In the example, natural gas is not used for space heating but is used for domestic hot water.

Domestic hot water load = Total load minus space heating load
= 384,000 m^3 - 232,200 m^3 = 151,800 m^3/year

Therefore, domestic hot water cost = 151,800 m^3 x $0.25/$m^3$ = $37,950/yr

* Unit costs are for illustrative purposes only and do not reflect actual costs for each utility.

Lighting load and cost for common areas

Figuring out the common area lighting load takes a bit more work. The goal is to estimate the total electricity used annually for lighting.

You will need to conduct a lighting audit. This means taking inventory of the number and type of fixtures and lamps installed, and then estimating how much the lighting is used. You will need to estimate power rating (in watts). You'll find a sample lighting audit in this appendix. It provides information on common fixture/lamp combinations.

Other electrical loads

Energy used by other electrical loads, such as fans, pumps and elevating devices, can be estimated by deducting the lighting load from the base electrical load.

Step 1-5: Determine where water is being used

Monthly base water load

You can use a similar method to determine the monthly base water load.

Find the average of the water consumption for December, January and February

Monthly base water load = (1,500 m^3 + 1,750 m^3 + 1,400 m^3)/3 = 1550 m^3/month

Summer water load and cost

In the sample building, additional water use in the summer is for lawn care, the outdoor swimming pool and occupant personal uses such as vehicle washing.

Summer water load = Water for May + June + July + August + September minus base load for each month

= (1,800 m^3 + 2,200 m^3 + 2,900 m^3 + 2,800 m^3 + 1,900 m^3) - (5 x 1,550 m^3) = 3,850 m^3/yr

Summer water cost = 3,850 m^3 x $1.00/$m^3$ = $3,850/yr

* Unit costs are for illustrative purposes only and do not reflect actual costs for each utility.

Annual base water load and cost

In the sample building, the base water load includes all water consumed for domestic purposes by the occupants and by the building staff.

Base water load = Total water load minus summer water load

= 22,750 m^3 - 3,850 m^3 = 18,900 m^3/year

Base water cost = 18,900 m^3 x $1.00/$m^3$ = $18,900/yr

* Unit costs are for illustrative purposes only and do not reflect actual costs for each utility.

In-suite water use

You can estimate the amount of water used by occupants using standard estimates for each fixture. Toilets typically represent about 30 to 40 per cent of total water consumption per dwelling unit.

Determine the amount of water volume in a normal flush by measuring the length, width and height of the water volume in the toilet tank that empties during a normal flush (turning off the water inlet during the test flush can improve the accuracy of this measurement). A typical volume is 18 to 22 litres for older toilets and as low as 4.8 litres for newer models. Assume nine flushes per suite, per day, which is typical for three occupants.

For a toilet using 18 litres per flush, annual water consumption (cubic metres per year) would be equal to the number of litres per flush multiplied by the number of flushes per day multiplied by 365 divided by 1,000.

Therefore, annual toilet water consumption equals (18 lpf x 9 flushes x 365 days)/1000 m^3/L = 59.1 m^3/yr

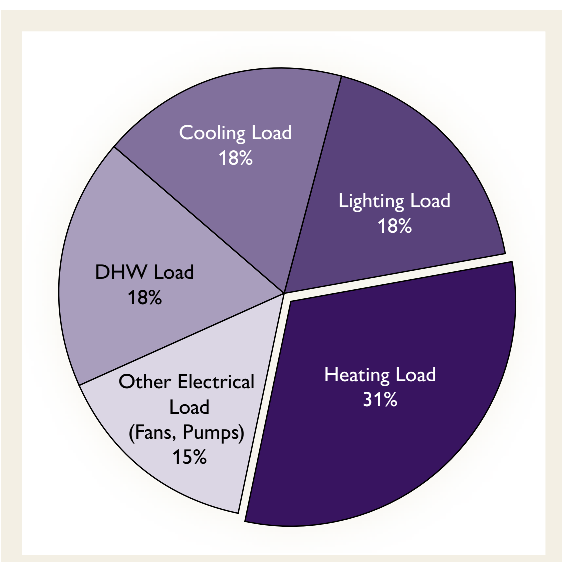
For a dwelling unit having one toilet, and assuming that the toilet represents 35 per cent of total water consumption:

Annual in-suite water use equals 59.1/0.35 = 169 m^3/yr.

Step 1-6: Chart your building's energy use

A pie or bar chart can illustrate the energy uses in the building and their share of costs. You will want to show your calculated loads for space heating, cooling, domestic hot water (DHW), lighting and "other electrical loads." The chart shows where energy is being used and where any disproportionately high uses may occur. The sample chart in figure 1-5a provides a typical breakdown of energy use for space heating.

Figure 1-5a: An example of annual energy consumption by end-use



2. Benchmark your building

Benchmarking is about comparing consumption to other multi-unit residential buildings similar to your own. This helps assess your building's performance, and pinpoint areas where your building consumption patterns are questionable.

Step 2-1: Develop the energy intensity profile for your building

It is easier to compare energy use with other buildings if you convert all energy use to a single unit of energy intensity, which is equivalent kilowatt hours per square metre of floor space per year (ekWh/m^2/yr). The use of "equivalent" kilowatt hours recognizes that we are mixing energy sources when we convert them to consistent units.

To convert consumption to ekWh/m^2/yr, you will need to know the type and amount of fuel used in the building and the total area of floor space.

Note: 1 cubic metre of natural gas = 10.36 ekWh, 1 litre of fuel oil = 7.10 ekWh

For the sample building from step 1-1, the total annual energy consumption from table 1-1a is as follows:

Electricity:	873,000 kWh/yr
Natural gas: 384,000 m^2/yr x 10.36 ekWh/m^2 =	3,978,200 ekWh/yr
Total annual energy use =	4,851,200 ekWh/yr

Based on a total floor space of 19,000 m^2, the energy intensity of the sample buildings is: 255 ekWh/m^2/yr

Step 2-2: Knowing the difference your climate makes

Climate conditions vary widely across Canada, and this has a significant effect on energy use for space heating. Figure 2-2a shows a climate map of Canada with four zones. These can be used to adjust the consumption of your sample building to reflect the impact of local climate.

Figure 2-2a: Canadian climate zones

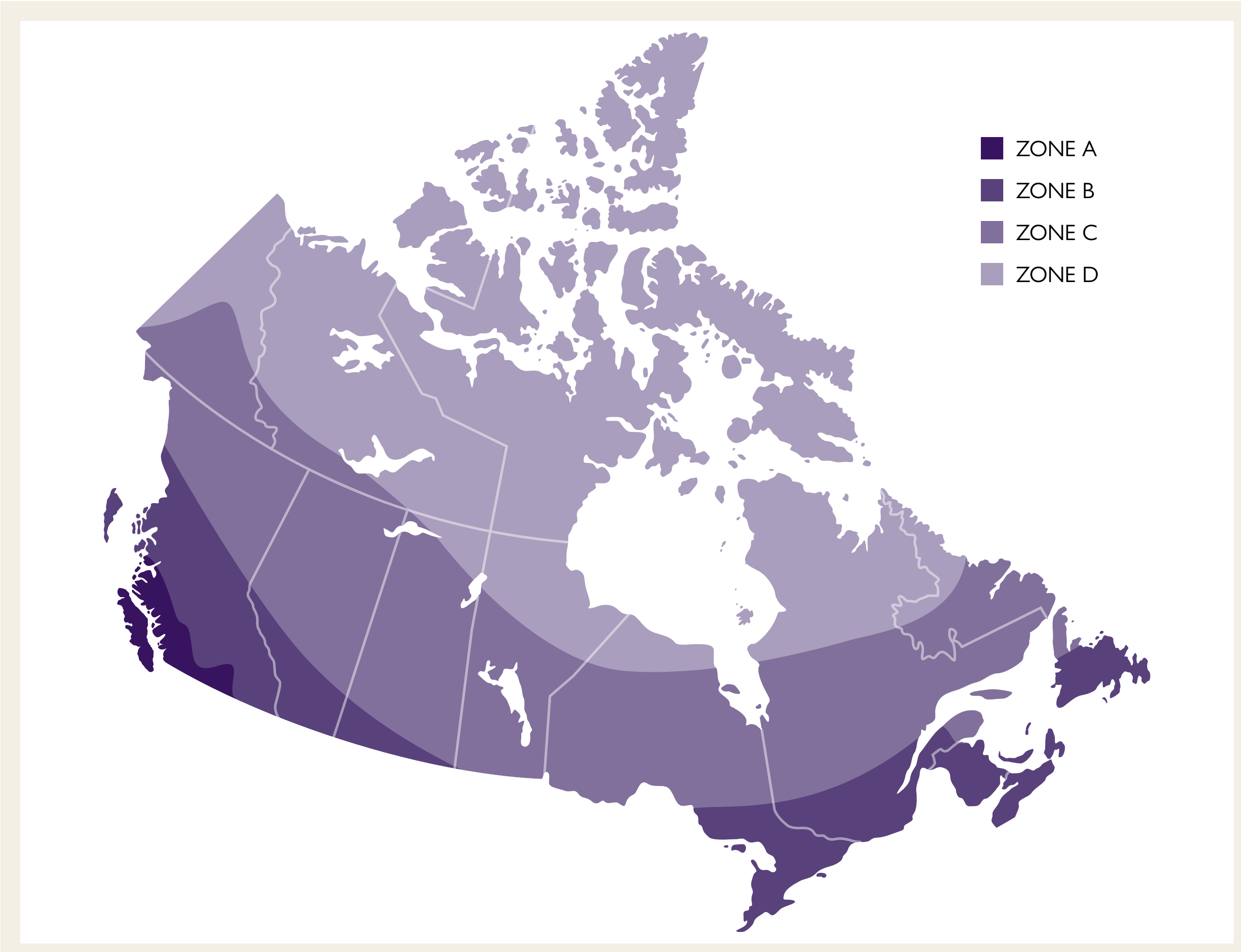


Table 2-2a shows the factors that can be used to adjust the space heating consumption to reflect the local climate, in order to compare your building to the benchmark performance.

Table 2-2a: Climate adjustment factors

CLIMATE ZONE	ADJUSTMENT FACTOR
Zone A	1.1
Zone B	1.0
Zone C	0.6
Zone D	0.4

In step 1-3, the amount of natural gas used for space heating for the sample building was determined to be 232,200 m^3/yr. We'll assume that the building is located in zone C.

The adjusted space heating consumption will be as follows:

Space heating consumption adjusted to zone C
= 232,200 m^3/yr x 0.6 = 139,300 m^3/yr

This represents a difference in overall energy consumption for the same building if it was located in zone B as follows:

Reduction in overall energy intensity = (232,200 – 139,300) x 10.36 = 962,400 ekWh/yr

Overall energy consumption adjusted for zone B = (4,851,200 – 962,400) = 3,888,800 ekWh/yr

Energy intensity adjusted for zone B = 3,888,800 ekWh/yr/19,000 m^2 = **204 ekWh/m^2/yr**

Step 2-3: Compare your building to similar buildings

Table 2-3a presents typical ranges of energy intensity for different sizes of multi-unit residential buildings located in zone B.

Table 2-3a: Energy intensity for MURBs in zone B

UNITS	MID-RISE MURB (3 TO 8 STOREYS)			HIGH-RISE MURB (>8 STOREYS)		
	Low	Average	High	Low	Average	High
ekWh/m^2	164	**184**	283	197	**221**	340
ekWh/suite	8,800	**17,200**	27,800	10,600	**20,700**	33,500

This shows that our sample building is operating at an efficiency higher than that of other similar buildings in the same climate zone—the normalized energy intensity is 204 ekWh/m^2/yr, on the assumption that the building has more than eight storeys, which falls between average and low.

This would not suggest that everything has been tuned up, air sealed and all possible measures completed. There are always steps that can be taken to improve energy and water efficiency.

The best benchmarks are those you develop for your own building by tracking energy consumption monthly and comparing the current consumption and annual patterns with that of previous periods. This information, combined with knowledge about changes that have occurred or been implemented in the building, will provide the best guide to building performance. When comparing to the past performance of your building or other nearby buildings, no climate adjustment factors are needed.

3. Assess potential cost benefits

Once you have performed the level 1 audit and the benchmarking, you should have a better idea of where to start. This information will identify the largest components of energy use so you can easily see where your efforts might best be spent. In assessing potential improvements, concentrate first on those energy and water use areas that have the greatest energy consumption and cost. If you know that your lighting load is high, analyze the options available for improving lighting performance. Similarly, if your heating load is high, look at the measures presented for upgrading heating systems and the building envelope.

Here is a sample of estimating annual savings on a domestic hot water conversion:

REMEMBER

The technical modules provide a reference guide for the numerous measures that can be integrated into maintenance, repair, replacement and renovation activities. They also provide general guidance about the economics of these energy and water conserving measures.

Annual operating cost of electrical domestic hot water system:	$23,500
Annual operating cost of natural gas	$9,000
Annual rental cost of new gas system	$7,000
Total operating cost of new gas system $16,000	($16,000)
Total annual savings	$7,500

Lighting audit forms

Form 1: A sample Lighting Audit Form

A	B	C	D	E	F
Area Audited	Type of Fixture	Watts/Fixture	# Fixtures	On Time Hours/Day	Total Annual Electricity Consumption (kWh/yr) $\frac{C \times D \times E}{1000} \times 365$
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
Total Lighting Consumption					Total =

Form 2: Lamp/Fixture Energy Consumption Chart

LAMP TYPE	LAMP TYPE	WATTS/ LAMP	# LAMPS/ FIXTURE	BALLAST TYPE	WATTS/ BALLAST	WATTS/ FIXTURE
Fluorescent T-12	F-40	40	5	magnetic	13	93
	F-40	40	4	magnetic	13	186
	F-40	40	6	magnetic	13	279
	F-40	40	8	magnetic	13	372
	F-34	34	2	magnetic	13	81
	F-34	34	4	magnetic	13	162
	F-34	34	6	magnetic	13	243
	F-34	34	8	magnetic	13	324
	F-40	40	2	es magnetic	5	85
	F-40	40	4	es magnetic	5	170
	F-34	34	2	es magnetic	5	73
	F-34	34	4	es magnetic	5	146
	F-34	34	1	magnetic	13	47
	F-20	20	1	magnetic	13	33
	F-20	20	2	magnetic	13	53
	F-30	30	1	magnetic	13	43
	F-30	30	2	magnetic	13	73
	F-25	25	2	magnetic	13	63
	F-25	25	1	magnetic	13	38

LAMP TYPE	LAMP TYPE	WATTS/ LAMP	# LAMPS/ FIXTURE	BALLAST TYPE	WATTS/ BALLAST	WATTS/ FIXTURE
Fluorescent T-8	F-32	32	1	electronic	0	32
	F-32	32	2	electronic	-6	58
	F-32	32	3	electronic	-6	90
	F-32	32	4	electronic	-12	116
	F-25	25	1	electronic	0	25
	F-25	25	2	electronic	-6	44
	F-17	17	1	electronic	0	17
	F-17	27	2	electronic	-6	28
	F-32	32	1	magnetic	8	40
	F-32	32	2	magnetic	8	72
	F-32	32	3	magnetic	8	112
	F-32	32	4	magnetic	8	144
	F-25	25	1	magnetic	8	33
	F-25	25	2	magnetic	8	58
	F-17	17	1	magnetic	8	25
	F-17	17	2	magnetic	8	42
Metal halide	Watts/lamp = Wattage given on bulb plus 15% to account for ballast					
Mercury vapour	Watts/lamp = Wattage given on bulb plus 15% to account for ballast					

23-01-17

68979

cmhc.ca