

Renewable Energy

CO₂RE Publications



Take Action on Climate Change



CO₂RE
Carbon Dioxide Reduction Edmonton



About CO₂RE

Created by Edmontonians for Edmontonians...

Carbon Dioxide Reduction Edmonton (CO₂RE) is the City of Edmonton's community-based strategy to permanently reduce local greenhouse gas emissions.

The CO₂RE Strategy was developed by representatives from the residential, business, industrial, institutional sectors and not-for-profit organizations who worked with the City to develop a single, coordinated plan. The group, known as the CO₂RE Team, consulted extensively with many local groups and organizations to develop a consensus on the best approach and strategies. CO₂RE was launched to the public in 2004.

The CO₂RE mission is to work with Edmonton residents, businesses, institutions, non-profits and industry to provide services, programs and initiatives to assist in reducing energy use, thereby reducing the levels of the greenhouse gas (GHG) emissions that are responsible for climate change.

The original CO₂RE goals include:

- up to a 6% reduction in GHG emissions (from 1990 levels) by the year 2010 and
- a 20% reduction in GHG emissions (from 1990 levels) by the year 2020.

Current Status

Edmonton's GHG emissions increased from 13.9 million tonnes in 1990, to 18.2 million tonnes in 2008 (the most recent year of data), an increase of approximately 38%. Much of this increase is attributable to Edmonton's 24.3% population growth, as well as significant economic growth during this period.

On a per capita basis, GHG emissions appeared to have peaked in 2001 at 29 tonnes of CO₂ per person per year. Since then per capita emissions have continued to fall.

Do your part...

We can do many things to reduce our emissions – and that includes making our homes and lifestyles more energy efficient. CO₂RE's Home\$aver series and other publications are a first step, providing Edmontonians with information and specific how-to guides on improving home energy efficiency, saving money and reducing GHG emissions.

For more ideas on how to become more energy efficient, log onto our website at **www.edmonton.ca/co2re**!

Free Membership

Why get a membership? Becoming a CO₂RE member is free and the more people who join us in taking action on climate change, the faster we will achieve our goals. CO₂RE is working with local companies to offer incentives on energy-efficient products and programs to further assist residents. You'll also receive a regular newsletter with new ideas and updates. Sign up today at **www.edmonton.ca/co2re**.

Industrial and commercial/institutional companies can contact our commercial coordinator by calling 311.

Introduction

Renewable energy is energy derived from sources that are not depleted by using them. Examples include solar, wind and earth energy.

This booklet focuses on renewable energy systems that are available for installation in your home or business including: solar water heating systems, solar photovoltaic panels, ground source heat pumps and personal wind turbines.

This guide includes descriptions of the types of renewable energy systems currently available, average installation costs and potential energy and CO₂ savings. Before considering the different types of renewable energy systems, it is important to look at energy conservation.

Energy Conservation

Many people think of solar panels and windmills when they think about saving energy, but renewable energy is currently among the least cost effective ways to reduce your energy bill. Reducing your energy use can have a significant impact in terms of both cost savings and greenhouse gas emissions. It is the best place to start as solutions are readily available and well established when compared to renewable energy systems.

Conservation is, dollar for dollar, the best way to save energy and money. The top conservation measures, in terms of dollars spent per unit of energy saved, vary depending on a variety of factors including home size, number of occupants and lifestyle.

In most homes, the biggest cost savings will come from turning off and unplugging unused lights and appliances, installing compact fluorescent lights, caulking and air-sealing, adding insulation, purchasing an energy efficient furnace and other appliances and upgrading windows.

In terms of cost versus impact, the alternative energy options discussed in this guide would generally fall to the end of this list. While renewable energy could reduce your monthly bills, the biggest impact comes when we maximize energy efficiency.

A qualified energy advisor can perform an energy audit on your home or business. The advisor will then provide you with a personalized list of the biggest reductions in energy use you can achieve for every dollar you

spend, and help you to apply for available grants. You can find a listing of qualified energy advisors on our website at www.edmonton.ca/co2re or by calling 311.

The CO₂RE Home\$avers guides, available in hardcopy or in PDF format on our website, will also give you plenty of great ideas on how to lower energy usage resulting in both cost savings and CO₂ reductions.

Renewable Energy for Space Heating and Water Heating

Heating air and water, especially in our cold climate, is one of the most intensive uses of energy. Up to 80% of the energy used in a typical Alberta home is used for space heating and hot water heating.¹ Although it is possible to heat your home and hot water using renewable energy, it is an expensive prospect for most existing homes.

The systems discussed below reduce the amount of electricity and natural gas needed to produce heat with conventional systems by supplementing those systems with renewable energy.

Using Solar Energy to Produce Heat

Passive Solar – Free Solar Energy

Passive solar is the energy that warms and lights our homes through our windows. You might already be using passive solar energy by opening the curtains during the day to let the sun's heat and light in and closing them at night in the winter and doing the reverse in the summer. More complex ways of using passive solar include planning the direction that your new home faces, where to plant trees and where to install windows.

Some super-efficient homes derive a great deal of their heat from passive solar energy. The Riverdale Net Zero home in Edmonton, for example, gains 40% of its space heating requirements from passive solar.² This is due to a high level of insulation, air sealing and incorporating high levels of thermal mass like stone and concrete to slowly release the solar heat that is absorbed during the day.

Without major renovations you can use passive solar energy effectively by using your blinds or curtains to allow or block the sun from entering the windows, planting deciduous trees on the south side of your home and

coniferous trees on the north and west sides and hanging clothes to dry outside.

If you are planning a new home or major renovation, make sure to incorporate passive solar into your design. Figure 1 illustrates some of the common elements to consider; however, a qualified contractor will help design the best home for your situation.

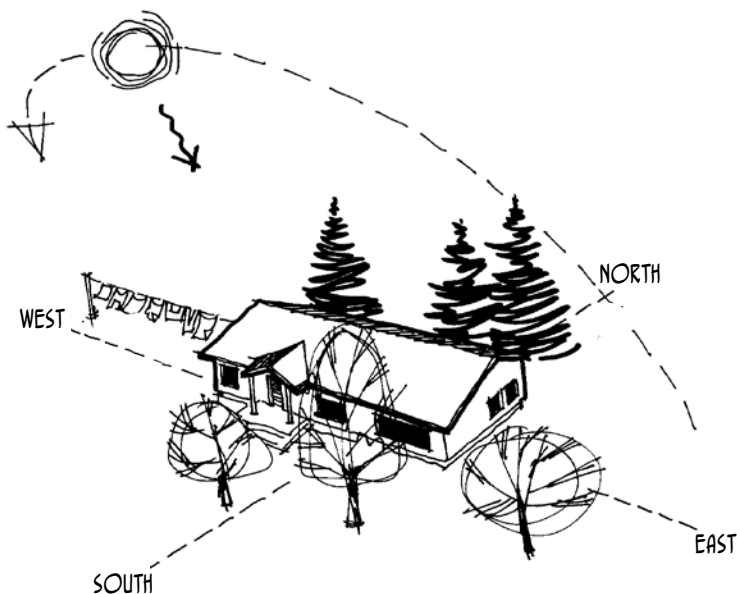


Figure 1

Solar Hot Water Heating

Next to passive solar, solar water heating is the most economical use of renewable energy. Heat from the sun warms a fluid, usually anti-freeze mixed with water, which in turn preheats water in a specialized hot water tank (Figure 2).

In Edmonton, solar hot water systems typically need to be coupled with another type of hot water heating system. This will boost the temperature of the water on cold, dark winter days. Even with Edmonton's long winters, solar water heaters can provide more than half of your household hot water needs annually.

There are two main types of solar hot water systems to choose from: flat plate and tube collectors. **Flat plate collectors** are less expensive and

less efficient. **Tube collectors** are initially more expensive but are more efficient at producing hot water when the sun is at a lower angle or when the panels are partially shaded or clouded. Both systems are very durable and are expected to last 20 years or more.

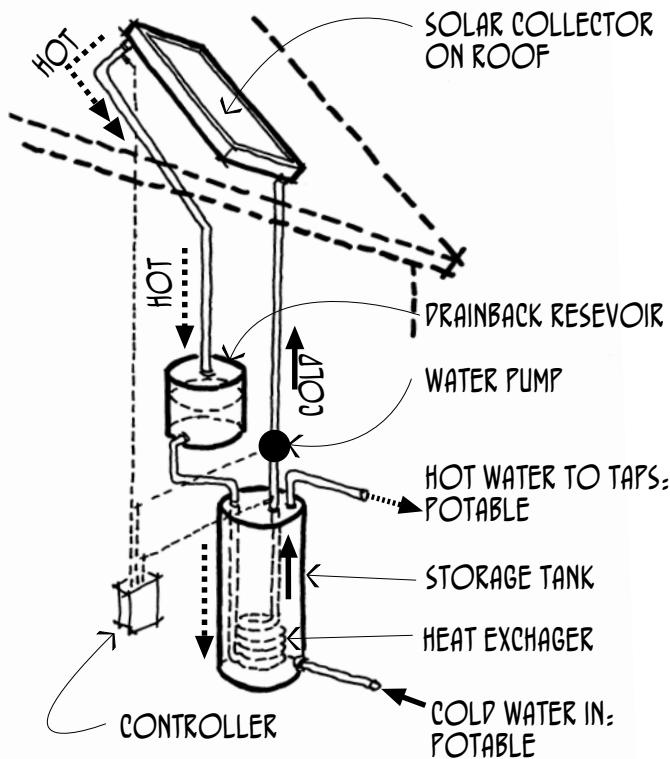


Figure 2

The following tables show the expected cost and potential savings of the two systems for an average Edmonton household.³

Average Installed Cost including Two Flat Plate collectors and Tank	Annual Energy Savings	Annual Dollar Savings	Annual CO ₂ Emission Reduction
\$8,000-10,000	15 GJ	\$150	0.75 tonnes

Average Installed Cost including Evacuated Tubes and Tank	Annual Energy Savings	Annual Dollar Savings	Annual CO ₂ Emission Reduction
\$12,000-\$15,000	20 GJ	\$200	1 tonne

Solar panels in the Northern Hemisphere always need to face south and work best if installed at an angle equal to local latitude, or approximately 54 degrees from horizontal in Edmonton.

Home Heating With Solar

Retrofitting an existing Edmonton home to be completely heated by solar energy is currently an expensive and difficult task. But if you are considering building a super-efficient new home, heating your home primarily with solar is possible. Solar home heating is employed in the Riverdale Net Zero home in Edmonton, for example. Most of this home's heating needs are provided using solar heating of one form or another.

Some other buildings in Edmonton are using solar thermal panels to preheat the water in a boiler (Figure 3), which then boosts the water temperature using gas or electricity prior to circulating it through the building.

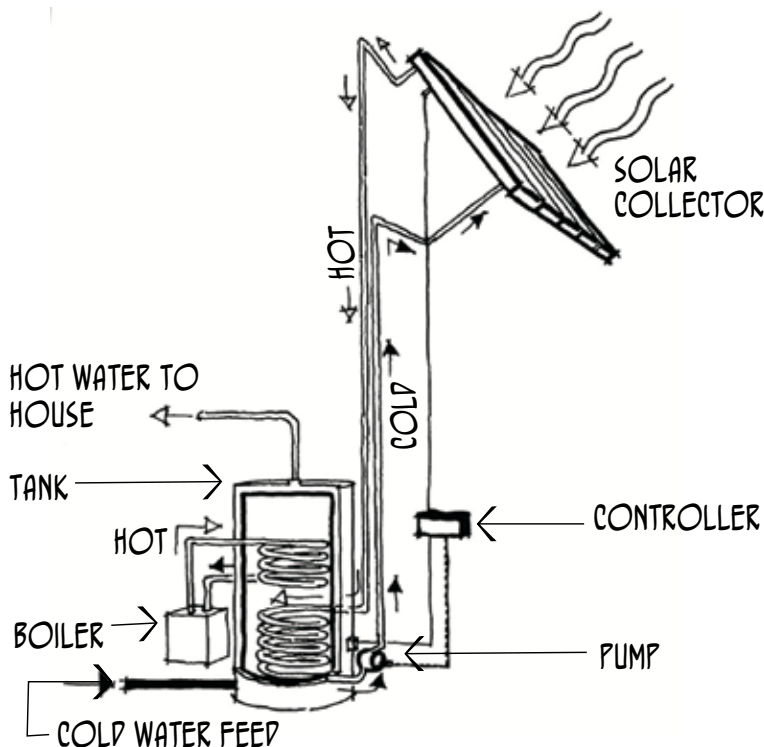


Figure 3

As with solar hot water, a heating fluid is circulated through solar panels located on your roof or another suitable sunny area close to your home. The heated fluid is then run through a coil in a large storage tank. The coil heats water in the tank which is then circulated through pipes under your floor or through radiators.

There are also systems which run the coil into a blower that circulates the heat around your home like a typical furnace.

Heating Your Home with Earth Energy

A few metres beneath ground level, the temperature stays constant year round at about 6°C in Alberta. This stored energy, or earth energy, may be used to help heat your home and hot water. (This type of energy may be referred to as geo-thermal energy; however, geo-thermal usually refers to the energy derived from areas much deeper beneath the earth's surface.) A ground source heat pump (GSHP) is required to access this heat and amplify it to temperatures high enough to heat your home and hot water.

A heat pump operates much like a refrigerator. Where a refrigerator gathers heat from the food in your refrigerator and dissipates it into the air in your kitchen, a ground source heat pump collects heat from the ground and uses it to warm your home and hot water. Heat from the earth is gathered by running a series of pipes under the ground and pumping a fluid through them. Heat is then removed from the fluid and concentrated using a condenser. This heat can then be used to heat your home and hot water.

There are several types of systems available involving closed or open pipes in a vertical or horizontal configuration. The most practical system in Edmonton is the closed loop system (Figure 4) because most city homes have a limited land area. If you are interested in descriptions of the other types of systems available, see the publication *Residential Earth Energy Systems*, published by Natural Resources Canada. (See the Additional Information Sources section of this booklet.)

Although the heat in an earth system comes from a renewable energy source, the electricity to operate a GSHP in Alberta often comes from burning coal, unless other offsets and systems are used in the home. This means that, in Alberta, more CO₂ is produced by the average electrically-powered earth energy system than would be produced by a high-efficiency

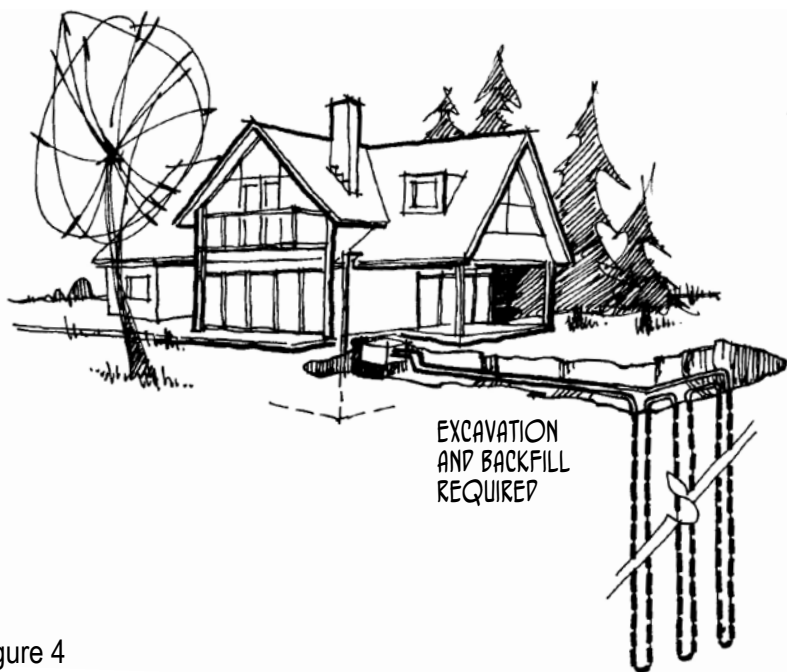


Figure 4

gas furnace in the same home. In terms of financial cost, a recent study by Climate Change Central shows that earth energy systems are also, at best, a break even prospect at current gas and electricity prices.

As well, there are some additional costs that should be considered before deciding to install a ground source heat pump in your home:

- Air ducts in existing homes in Edmonton are often not big enough to provide the extra volume of air required for a forced-air ground source heat pump system and must be upgraded.
- Existing hydronic heating systems like in-floor heating or baseboard heaters will generally not work well as the temperature generated by the heat pump is too low to heat most existing homes using these systems. Systems tailored to heat using earth energy generally have larger pipe diameters due to lower operating temperatures.
- Landscaping and clean-up costs can be considerable after drilling is complete. Unless you are already considering a major landscaping upgrade or you are installing the system when building a new home, make sure you get a quote for how much this will cost.

Be sure to have your contractor include all costs, including drilling, installing pipes, clean-up, installing the condenser and heating system and any additional upgrades required.

The following table shows estimates of what a high quality GSHP would cost for a new home in Edmonton.

Average Installed Cost	Annual Gas Savings	Additional Electrical Costs	Annual CO ₂ Emission Reduction
\$30,000-\$35,000	\$1,110*	\$835	0 tonnes

** Based on a cost of \$10 per GJ including fixed charges, variables, GST, etc.*

This is based on a well-insulated new home with a high-efficiency furnace using 111 GJ of gas and 635 kWh annually versus the same home with a GSHP using 9,000 kWh annually. The additional kWh are to run the GSHP.

Although this table shows a savings of \$245 per year for operating costs in favour of the GSHP, the installation costs for the GSHP are much higher than the average cost to install a high-efficiency gas furnace.

If air conditioning is considered for a new well-insulated home, the costs and associated greenhouse gas emissions still come out slightly in favour of the natural gas furnace option as air conditioning requirements are limited in Edmonton.⁴

In the future, as more renewable energy is added to Alberta's electricity grid, and as gas prices increase and gas supplies decrease, earth energy systems will likely become a more economical and sustainable choice.

Producing Electricity using Renewable Technologies

Photovoltaics

Photovoltaic solar panels use the sun's energy to produce electricity. That electricity can be used immediately, stored in batteries for later use or fed back to the electricity grid for use by others. There are three basic types of systems to choose from, each of which are described briefly below.

Independent off grid systems – Most existing systems up to now have been independent of the public electrical grid since residential solar systems have only recently been allowed to connect to the grid.

These systems have the advantage of continuing power to your home during grid blackouts. The major disadvantage of this system is that the systems can run out of power during long cloudy spells or during the dark winter months. As a result, a back-up generator is required – something that is not allowed by the City and is extremely noisy.

These systems require higher maintenance, are more expensive and generally require significant conservation measures to be practical. They are usually installed in areas that have no grid access.

Grid tied system – This system (Figure 5) has no batteries and you can install as many or as few solar panels as you want.

When the sun shines, the energy from the panels is used to power your home. Any excess power that you produce is sent back to the grid for use by others. When the sun is not shining, or in the middle of winter, you get your energy from the grid as in any typical Edmonton home.

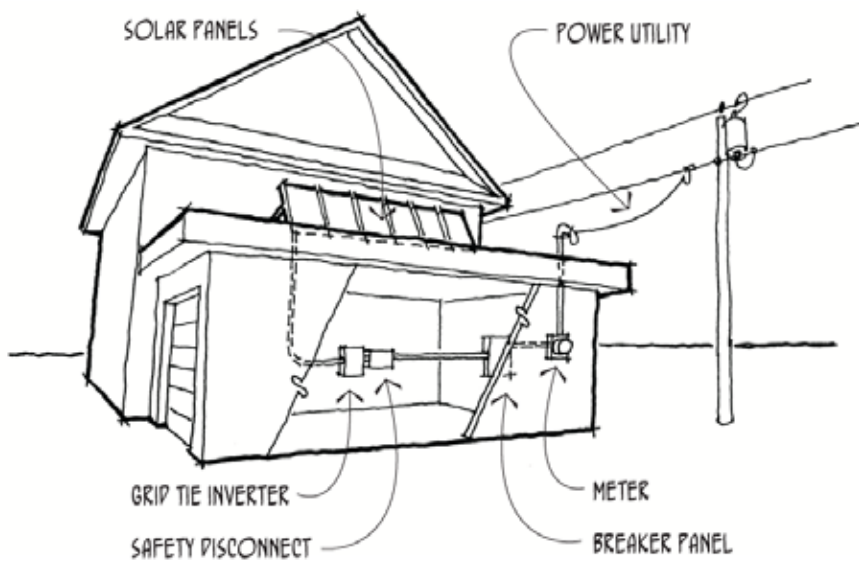


Figure 5

This is the lowest maintenance and least expensive option. Being completely dependent on the grid offers no protection in the case of a blackout, but blackouts are currently very rare in Edmonton.

Grid tied system with battery back-up – This system is capable of storing enough energy to get you through the average blackout but is

also connected to the grid so you can get away with a smaller number of panels and batteries.

It is more expensive and requires more maintenance than a grid only system, but offers some short-term protection from blackouts.

Here are some examples of what you can expect to pay for the different systems. Price ranges are wide as different installation conditions can dramatically affect the cost.

Approximate Installation Cost Grid only	Annual Energy Savings	Annual Dollar Savings	Annual CO ₂ Emission Reduction
\$20,000-\$30,000	2,500 kWh	\$250	2.7 tonnes

Approximate Installation Cost Grid with backup	Annual Energy Savings	Annual Dollar Savings	Annual CO ₂ Emission Reduction
\$35,000-\$40,000	2,500 kWh	\$250	2.7 tonnes

Approximate Installation Cost Battery only	Annual Energy Savings	Annual Dollar Savings	Annual CO ₂ Emission Reduction
\$50,000-\$60,000	2,500 kWh	\$250	2.7 tonnes

Notice that the systems compared above produce only 2,500 kWh per year on average whereas the average Albertan uses 7,800 kWh of power. It is possible for a family of four to get by on 2,500 kWh of power if significant conservation measures are taken. You can always buy more panels to offset your use, providing you have the space, but as discussed in the first section of this booklet, conservation combined with renewable technology is a much more reasonable option.

Photovoltaic panels, like solar thermal systems, must be installed facing south to be effective in Edmonton, and perform best when angled around 54 degrees from horizontal. A qualified and knowledgeable installer should only recommend south facing panels. There are mounts available that track the sun, but due to the comparatively low angle of the sun in Edmonton and higher installation and maintenance costs, these mounts may not be cost effective in Edmonton. Often, it is possible to install

more panels for the same price as a tracking system, without the added maintenance.

Personal wind power turbines

Wind power is produced by the wind turning rotors mounted to a turbine. This energy is converted to electricity which can be used in your home immediately, stored in batteries or fed back onto the power grid in much the same way as photovoltaic power (Figure 6).

Giant wind turbines are becoming more common in areas that have abundant wind resources, like the foothills in southwestern Alberta. Unfortunately, from a wind power perspective, Edmonton is not ideally situated. If you look at a map showing the average wind speed in Alberta, Edmonton appears as an island of low wind speed within a region of only moderate wind speed.

The average wind speed in Edmonton is about 18 km/h or about 5 m/s annually at 50 metres above the ground. This low average speed is mostly due to the shelter created by city buildings and mature trees. There are only a few areas in Edmonton, like the top of tall buildings and houses on the edge of the river valley or on hills, that produce moderate amounts of wind.

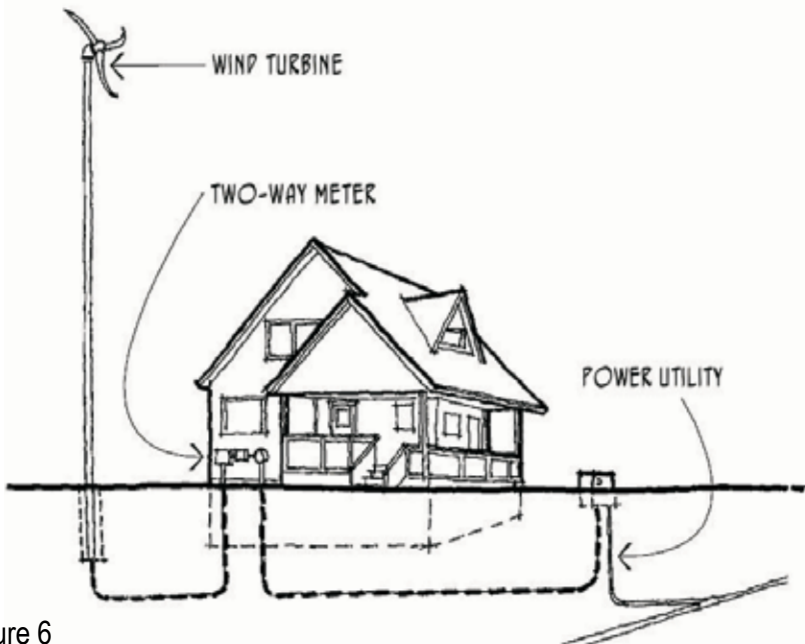


Figure 6

On average, small wind turbines require wind speeds greater than 4.0 to 4.5 m/s to be cost effective, putting most locations in Edmonton right on the edge in terms of benefits. Just outside the city and its suburbs, the situation is significantly better with average annual wind speeds of 5.5 to 7 m/s.

Consult the Canadian Wind Atlas, referenced at the end of this booklet, for details on your region. The atlas will give you a good indication of average wind speeds; but before installing wind turbines, you should get a more detailed assessment of the wind resources at your site.

The table below shows the approximate cost including tower, turbine and installation, as well as potential energy savings and greenhouse gas emission reductions.

Approximate Installed Cost	Annual Energy Savings	Annual Dollar Savings	Annual CO ₂ Emission Reduction
\$25,000-\$30,000	2,500 kWh	\$250	2.7 tonnes

This estimate includes the cost of erecting a minimum 14 to 18 m tower to hold the turbine above both your house and any turbulence created by surrounding trees and buildings. Although the initial costs are similar, be cautious about comparing the cost of personal wind power to solar photovoltaic. The maintenance costs associated with wind turbines are much higher, and while some solar PV systems last well over 30 years, the life expectancy of a wind turbine is 10 to 15 years.

The biggest benefit of personal wind power is the fact that it produces the most energy in the winter when average wind speeds are highest in Edmonton. This happens to be the same time of year that photovoltaic panels are producing very limited amounts of energy.

Despite their expense, personal wind turbines can be used to offset energy needs on a year-round basis. Globally and locally they have a significant role to play in renewable energy systems.

City Regulations for Installing Renewable Energy Devices

The City of Edmonton is currently examining potential bylaws to regulate the installation of renewable energy devices. Until definitive regulations are adopted by City Council concerning such devices, an interim

practice will be followed in Edmonton. This practice will accommodate the development and use of renewable energy devices while taking reasonable actions to minimize their impact on neighbouring properties and land uses.

For the purposes of the interim practice, wind turbines will be discouraged in most zones, particularly residential zones. Solar panel systems will be allowed if they are integrated within a building structure and/or they are aesthetically compatible with the proposed and surrounding development.

Building and Safety Codes

You may require building, plumbing, electrical or heating/ventilating permits for a renewable energy device installation on your property. Structural loads not covered by the Alberta Building Code such as weight, wind or snow drift must be considered, which may result in, for example, the need for appropriately designed roof trusses or an engineer's review of existing structure and connections to a building.

Presently, applicable Alberta codes do not specifically recognize any particular renewable energy device, so the system you wish to install must be signed and sealed by an Alberta professional engineer.

Design details are to be provided with the permit application for examination by a Safety Codes Officer prior to beginning work. The specialist working with you on your renewable energy device installation may be able to assist you, and building code technical advisors are available to provide further guidance.

Provincial Regulations – Alberta's Micro Generation Legislation

As of January 1, 2008 in Alberta, you can get paid for the excess energy your renewable energy devices produce. The new Provincial Micro-Generation Legislation requires energy retailers to pay small renewable energy producers for the energy they feed into the grid.

The first step when planning to install a renewable energy device on your home is to refer to the Micro-Generator Application Guideline from the Alberta Utilities Commission. This document details the steps required to have systems installed in Alberta. A simplified version of these steps is included here.

1. Contact Your Wire Service Provider (WSP). The WSP for Edmonton is EPCOR. Contact the Customer Engineering Section at 780-412-3500. Review the Information Package that your WSP sends you.
2. Consult with one or more qualified contractors. (See the resource section in the back of this guide.)
3. Obtain municipal permits. Wind installations may require approval from additional regulatory bodies including NAV Canada, Transport Canada and Alberta Transportation.
4. Prepare site plan and single line (electrical) diagram.
5. Confirm equipment certification. Check the electrical certification mark on all equipment to ensure it is approved to the appropriate Canadian standards.
6. Complete and submit the Micro-Generator application. Visit www.auc.ab.ca/rule-development/micro-generation to obtain a copy. Your WSP will provide you with confirmation that the Micro-Generator application is approved.
7. Select your electrical contractor and obtain your electrical permit.
8. Install your renewable energy device and apply for electrical inspection.
9. Advise your energy retailer of the connection date and arrange compensation for extra electricity generated.
10. Submit a copy of the certification of inspection to your wire service provider. They will make any modifications that may be required to the meter or electrical service entrance.

These steps may seem daunting, but if you are having your system installed by a qualified contractor, they will take care of many of these steps. For full details and flowchart, visit www.auc.ab.ca.⁵

Green Power

If you are not ready to take the leap of installing a renewable energy system to your home, you can still purchase renewable power for your home.

The bulk of the electricity in Alberta is currently produced by burning coal, with large-scale alternative energy sources, such as wind power,

accounting for less than 5% of electricity production in Alberta. When you purchase wind power from your utility or green power suppliers, such as Bullfrog Power, they are obligated to obtain that power from green energy sources.

These purchases encourage the long-term growth of large-scale green power such as wind power. This is an inexpensive way to reduce your carbon footprint and help increase the amount of renewable electricity generation.

The Future

The efficiency and affordability of renewable energy systems is constantly improving. Other methods of producing and storing electricity are on the horizon. We will do our best to keep abreast of these changes and keep this information current. If you require up-to-date information, or have feedback to provide on anything you have read in this booklet, please visit our website at www.edmonton.ca/co2re or call us at 311.

Financial Incentives for Renewable Energy

Like the technologies themselves, incentives available for renewable energy are constantly evolving. Again, the best way to get accurate up-to-date information is by visiting our website or calling us.

Renewable energy incentives may be available through Natural Resources Canada's ecoENERGY program. Please see the resource section at the end of this booklet for details.

Additional Information Sources

Canada Mortgage and Housing Corporation

www.cmhc.ca – The CMHC Order Desk is a one-stop shop for all free and priced publications, fact sheets, reports, videos and other CMHC resources. You can order online, or through their call centre at 1-800-668-2642.

Climate Change Central

www.climatechangecentral.com – Climate Change Central has information and resources to help Albertans save energy and reduce the greenhouse gas emissions that contribute to climate change.

Environment Canada

www.ec.gc.ca – Environment Canada's website provides weather and environmental information to help connect Canadians, exchange information and share knowledge or environmental decision-making.

www.windatlas.ca – Environment Canada also provides a wind energy atlas.

EPCOR

www.epcor.ca – This website contains information on energy and water efficiency with calculators, tools and downloadable publications to help you in reducing your energy and water consumption. Tools include a do-it-yourself home audit with a library of resources; EPCOR House, an animated tour of a typical home with efficiency information; calculators for most major appliances; and a simple electricity calculator and water audit tool. Tools are located in the EPCOR-Customer Service drop down menus.

Natural Resources Canada – Office of Energy Efficiency

www.oeenrncan.gc.ca – OEE offers a wide range of free publications, programs and services to help Canadians save energy and reduce the greenhouse gas emissions that contribute to climate change. You can also find information on federal grants and incentives.

Solar Energy Society

www.solaralberta.ca – A non-profit society dedicated to the awareness, understanding and promotion of the use of solar energy and energy conservation technologies.

Home Pure Solar

www.homepuresolar.com – A designer and installer of renewable energy systems in the Edmonton area.

Trimline Design

www.trimlinedesigncentre.com – A designer and installer of renewable energy systems in the Edmonton area.

Recommended Reading

Keeping the Heat In is a comprehensive source of energy efficiency how-to information for homeowners. This free publication is available from Natural Resources Canada. Call toll free at 1-800-387-2000.

The Renewable Energy Handbook – The Step By Step Guide to Making (And Selling) Your Own Power from the Sun, Wind, and Water. William H. Kemp. Aztext Press, 2003.

The Carbon Buster's Home Energy Handbook. From Carbon Miser to Carbon Buster®, learn how you can save US\$17,800 and reduce your carbon dioxide emissions. Godo Stoyke. New Society Publishers, 2007.

Endnotes

¹ Government of Alberta

www.energy.gov.ab.ca/About_Us/1132.asp

² Riverdale Net Zero Overview CMHC

www.riverdalenetzero.ca/Riverdale_NetZero_house_--_project_profile.pdf

³ Alberta Government

“Average Albertan uses 135 GJ of natural gas per year.”

www.servicealberta.gov.ab.ca/1014.cfm

Government of Canada

“Water heating accounts for between 20 and 25 percent of the average household's energy use.”

ecoaction.gc.ca/news-nouvelles/20080620-eng.cfm?rss

Based on \$10 /GJ cost for Natural Gas

⁴ Feasibility of Ground Source Heat Pumps in Alberta

www.climatechangecentral.com/publications/discussion-papers

⁵ Alberta's Micro Generation Legislation

www.auc.ab.ca/rule-development/micro-generation

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The information contained in this publication is provided as a public service and represents current research results and information sources available to CO₂RE and has been externally reviewed. CO₂RE and the City of Edmonton however, assume no liability for any damage, injury or expense that may be incurred or suffered as a result of the use of this publication.

Become a CO₂RE Member

We all contribute to climate change and each of us can contribute to the solutions. Become a CO₂RE member. Membership is free and you can sign up on the CO₂RE website at www.edmonton.ca/co2re.

CO₂RE Carbon Dioxide Reduction Edmonton

Publications Currently Available

Attic Insulation	General CO ₂ RE Brochure
Basement Insulation	Heating Systems
Caulking and Weatherstripping	Renewable Energy (online only)
Condensation Concerns	Ventilating Your Home
Conserving Electricity	Water Conservation
Eco-Landscaping Brochure	Windows



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