SHAPING EDMONTON'S RENEWABLE ENERGY FUTURE

REPORT OF EDMONTON'S RENEWABLE ENERGY TASK FORCE

THE CITY OF Edmonton

TRANSFORMING | EDMONTON
BRINGING OUR CITY VISION TO LIFE

CONTENTS

EXECUTIVE SUMMARY

Renewable energy resources — solar, wind, biogas, biomass and geothermal — are drawn from the natural world around us. The ready availability of renewable energy resources offer communities like Edmonton new opportunities for the future and greater security over energy supply, costs and environmental effects of energy production.

A steady and multi-fold increase in the use of renewable energy over the coming decade is required to affect a shift from what is currently seen as a fringe option to becoming a mainstream supply of energy.

> Energy efficiency is the most affordable way to significantly reduce energy bills and carbon emissions, but energy efficiency alone cannot address our energy challenges. An optimum combination of efficiency and renewable energy would eliminate our dependence on fossil fuels entirely. This is a lofty goal but a transition to an ever increasing percentage of renewables as our sources of energy is within our power.

This analysis found that using current renewable energy technologies, a conservative estimate indicates that it is possible to generate up to 20 per cent of current electricity consumption in the city, and 10 per cent of the natural gas consumption. Though these are significant opportunities, they highlight the importance of improving energy efficiency as well as efforts to improve the overall sustainability of energy supply in the province.

In 2010, Edmonton City Council directed City Administration to create a Renewable Energy Task Force. The task force was charged with outlining opportunities and barriers for the City of Edmonton and recommending actions to accelerate the adoption of renewable energy technologies in the city. Local professionals from a cross-section of industries and interest groups were engaged to create a task force membership that would represent a broad range of stakeholders.

Edmonton has much to be proud of as it strives to become a more sustainable and resilient city. The planned City Centre Lands development, which will be a showcase of sustainability, the world-class Waste Management Centre, the expansion of Light Rail Transit, maintenance and expansion of one of the world's largest urban tree canopies, and ongoing city-wide conversion to LED street lighting have been important in improving the city's environmental performance. With this lengthening record of sustainable municipal decisions, enabling the adoption of renewable energy technologies would take Edmonton yet another step toward a reputation for creative and practical urban management.

How does Edmonton position itself to benefit in a global renewable energy economy?

The opportunities recommended in the Renewable Energy Task Force report provide for the development of a renewable energy strategy, with actionable items to ensure Edmonton can take advantage of a rapidly-growing global renewable energy economy. Each meets one or more of the following goals:

- Realise the potential of our municipal renewable energy resources
- Position the City's economy to benefit from the design, manufacture, purchase, installation and support of these technologies for local markets and beyond.
- Engage the City to encourage and incubate workforce training and the development of local expertise in renewable energy.
- Invest in our sustainable future and its long-term spin-off of economic development, labour and energy diversity.
- Provide leadership by adopting and enabling clean, renewable energy.

These recommended actions align with the bold goals of Edmonton's sector plans (see report section 1.4), particularly *The Way We Green* and its strategic actions to establish, implement and maintain a Renewable Energy Plan for Edmonton detailing the best options and transition strategies for the City.

The Task Force found numerous opportunities that would move the City, its residents and businesses closer to energy sustainability and resiliency. From these, a priority list has been identified which is key to developing a sustained, fundamental adoption of renewable energy into our lives and businesses.

INITIATIVE 1: ADDRESS MUNICIPAL POLICIES TO ENABLE RENEWABLE ENERGY

Action: Identify elements in municipal codes, policies and legislation that present barriers to renewable energy. Revise as necessary to enable renewable technologies.

Opportunity: Incorporate renewable energy systems in City-owned buildings and facilities to demonstrate leadership and generate the benefits of cost savings and greenhouse gases reduction among others.

Opportunity: Formalize standards in the land-use bylaw to allow renewable energy systems to be accommodated through discretionary uses. Where necessary, change the bylaw for specific renewable energy configurations.

Opportunity: Implement a program for energy performance and energy-source labelling on all residential building types whenever they are built, sold, leased or rented. A labelling program increases the visibility of renewable energy systems and the link to energy efficiency. In addition transit and walkability scores could provide a more complete energy picture for homebuyers.

INITIATIVE 2: PROVIDE A STRONG ECONOMIC PLATFORM FOR RENEWABLE ENERGY

Renewable energy requires a strong policy and incentive framework to level an economic playing field that currently favours other energy resources in attracting market share, economic development and investment.

Action: Coordinate financial incentives to build renewable energy markets and supply-chain capacity until technologies become mainstream and no longer require rebates or subsidy.

Opportunity: Apply the Local Improvement Charges tool for installation of renewable energy systems on structures owned by community groups. Evaluate this funding design for privately-owned structures.

Opportunity: Establish a stable funding source such as an increase to the local access fee (electricity) or municipal franchise fee (natural gas). Use this additional fee revenue to provide ongoing funding for renewable energy incentives.

Opportunity: Implement a production-based incentive, similar to a feed-in tariff,[1] for renewable heat and renewable electricity. The rate and timeframe of the incentives would reflect the actual cost of generation with a reasonable return on investment.

INITIATIVE 3: PROVIDE LEADERSHIP IN RENEWABLE ENERGY

Action: Support and initiate community projects that demonstrate and promote renewable energy.

Opportunity: Spearhead development of community-level renewable energy groups:

- Support access to solar energy where residents could share ownership and benefit from systems on community buildings

[1] Also known as a CLEAN Contract. CLEAN is the acronym for "clean, local, energy, available, now".

- Implement small-scale district heat and electricity co-generation stations for the benefit of the surrounding community
- Implement a solar roof program, since they have been instrumental in establishing a strong momentum for the growth of the solar energy elsewhere

Opportunity: Continue to develop programs to increase renewable energy awareness:

- Through the City of Edmonton's CO_2RE program, expand the existing website including material for schools, the general public and businesses.
- Provide material that clarifies the environmental and economic benefits of renewable energy and the process for installing systems.
- Work with the Edmonton Real Estate Board to certify Realtors on the use and interpretation of home energy performance labels.
- Provide scholarships and funding to local educational centres to develop renewable energy training programs
- Work with the agencies to facilitate hiring by businesses of technology students from renewable energy training programs.
- Promote renewable energy careers at the post-secondary level for students considering trades, technology or undergraduate training.

INITIATIVE 4: PARTNERSHIPS FOR RENEWABLE ENERGY POLICIES AND PROGRAMS

Alberta is an example of how the development of energy resources is possible when done in collaboration with neighbouring communities and other levels of government.

Action: Challenge and partner with neighbouring communities to co-ordinate requests for a range of progressive renewable energy policies to accelerate the commercial uptake of renewable energy in Alberta.

Opportunity: Engage municipal partners to maximize resources and share successful programs.

Opportunity: Advocate that the Government of Alberta create strategies and funding mechanisms (similar to that done previously for the fossil fuel industries) for the rapid development and smooth implementation of Alberta's vast renewable energy resources.

SUMMARY

The Renewable Energy Task Force has identified simple, specific action items that will advance the City's municipal leadership in renewable energy. These action items will see the City use a range of tools already within its power to ensure that Edmonton and its citizens are well-positioned for a clean, prosperous, sustainable and resilient future supported by renewable energy.

1.0 INTRODUCTION

Canada is an emerging energy superpower. But our real challenge and our real responsibility is to become a clean energy superpower. … We want to be a world leader in the fight against global warming and the development of clean energy.[2]

— Prime Minister Stephen Harper, Sydney, Australia, 2007 September 7

How does Edmonton prepare itself to prosper in a global renewable energy economy?

In 2010 at the direction of Edmonton City Council, the Renewable Energy Task Force was formed to develop a report with recommendations to accelerate the adoption of renewable energy technologies. Local professionals from a cross-section of industries and interests were invited to join the Task Force. The group was challenged to identify barriers, then research and tailor solutions with practical value for Edmonton.

The broad range of Task Force members[3], including representatives from business, community, financial, education, utility and environmental organizations as well as representatives from City administration, met monthly for one year and examined many issues of relevance. While consensus was not reached on the priority order of all the recommendations, the short list and total inventory of recommendations was created through a democratic process. The opportunities for the City to consider in this report are the result of strong leadership and expertise provided by the members of the Task Force.

The role of cities is to provide the vision and create a framework for action. This framework can take the form of a carrot (incentives/subsidies) or stick (legislation, bylaws, permits). A range of opportunities for action are possible. Decisions on implementation need to be based on a number of factors including co-ordination with long-term City goals for energy sustainability and resiliency as well as a business case using triple-bottom-line principles.

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[2] Notes for an address by Prime Minister Stephen Harper to the APEC Business Summit. 2007 September 7. Sydney, Australia. **http://pm.gc.ca/eng/media.asp?id=1814**

[3] See Appendix C, "Members of the Renewable Energy Task Force"

This renewable energy report is an important call to action to people and businesses in Edmonton. The opportunities detailed in this report provide for the development of a renewable energy strategy with actionable items to guide Edmonton in a rapidly-growing global renewable energy economy. These actions encourage Edmonton to:

- Realise the potential of our municipal renewable energy resources
- Position the City's economy to benefit from the design, manufacture, purchase, installation and support of these technologies
- Use the influence of City government to incubate workforce training and the development of local expertise in renewable energy
- Invest in our sustainable future and its long-term spinoff of economic development and job and energy diversity.

To these ends, the report's key initiatives focus on assembling the relevant building blocks that Edmonton needs to enable the widespread adoption of renewable energy — policy, monetary, partnerships, citizen, and qualified workforce — to implement the renewable energy goals of its Sector Plans.

Moving to a low-carbon economy that increasingly includes renewable energy offers significant opportunities to a municipality. Ideally it will be a transformational change that not only helps protect the climate and ensure energy security, but also re-focuses Edmonton's economy on an environmentally sustainable footing.

Edmonton's work is in the early stages. The beginning of this process is about setting policy and improving the economic environment, inspiring people, building capacity, setting achievable targets and continuously raising the bar. As the cost of renewable energy declines and markets grow, environmental imperatives will continue to be clarified and policies and targets can be adjusted to new realities and opportunities.

1.1 PURPOSE

The purpose of this document is to summarize the results of the Renewable Energy Task Force.

The mandate of the Task Force was to undertake the research, preparation and delivery of a report to the City identifying key opportunities and the technical, economic, and policy barriers to renewable energy generation and its use.[4]

The priority list of recommendations is detailed in Section 4. The balance of the inventory of opportunities identified for Edmonton is captured in Appendix A.

1.2 GOALS

The opportunities identified by the Renewable Energy Task Force consider environmental, health, and socio-economic goals.

Environmental

The opportunities contained in this report support *The Way We Green*, Edmonton's environmental strategic plan, which examines challenges to energy and climate change, water, food, air, solid waste, and biodiversity. Among these, the critical issues of energy and climate change pose the greatest challenges for Edmonton.

Health

In addition to a reduction in greenhouse gas emissions, the use of low or zero-emission renewable energy improves human health and health care budgets by reducing emissions of mercury, particulates, NOx and SO_2 and other chemicals caused by the generation of electrical and heat energy from fossil fuel stocks.

[4] Appendix B, "Terms of Reference of the Renewable Energy Task Force"

Socio-Economics

While life-cycle economic feasibility is a focus of all the key initiatives in this report, an additional strategic goal of the Renewable Energy Task Force is to create jobs and stimulate and diversify the local economy. The task force also sought to prepare the city and Edmonton industries to meet the demand for renewable energy systems in the future.

1.3 DEFINITION

Renewable Energy:
energy that is replenished within the typical lifetime of a person

Examples of renewable energy include energy generated from solar radiation, wind, flowing water, biomass, biogas, and geothermal heat.

The common definition for renewable energy includes energy from resources that are not depleted as a result of their usage.[5] Renewable resources are thus naturally regenerated within a reasonable period of time, such as a person's typical lifetime. For example, plants and animals reproduce and provide biomass and biogas; water is constantly being cycled and provides hydro electricity; the sun provides solar radiation and secondarily, wind energy and ocean wave energy. The moon's orbit generates tidal energy.

1.4 CONTEXT WITH EDMONTON'S SECTOR PLANS AND PROGRAMS

The use of renewable energy in Edmonton is supported by City of Edmonton sector plans that are moving the city in the direction of sustainability and resiliency. The Task Force has worked to align with and advance these plans by detailing the potential of renewable energy to meet their goals and objectives. These sector plans include:

1.4.1 *THE WAY AHEAD*: STRATEGIC PLAN 2009 – 2018 [6]

This is the City's 30-year strategic operational vision. Strategic goals in support of the renewable energy include:

10-year Environmental Strategic Goal:

In partnership with its citizens, businesses and institutions, Edmonton is the nation's leader in setting and achieving the highest standards of environmental preservation and sustainability both in its own practices, and by encouraging and enabling the practices of its partners.

10-year Economic Strategic Goal:

Edmonton is recognized as an economic powerhouse, maximizing the diversity of its economic advantages, including its location as Port Alberta and as a portal to the north; as the urban centre of regional industrial development; as a knowledge and innovation centre for value-added and green technologies and products; and as a place that attracts and supports entrepreneurs.

Three Year Priority Goals include:

- Increase use of renewable energy (in City operations)
- Reduce greenhouse gas emissions (in City operations)

1.4.2 *THE WAY WE GROW*: MUNICIPAL DEVELOPMENT PLAN [7]

While Edmonton is a city heavily dependent on fossil fuel development, it is also looking for ways to diversify its economic base and increase its long-term sustainability and resiliency. This includes developing a "knowledge and innovation centre for value-added and green technologies and products."[8]

5 The Pembina Institute, "*Renewable Energy Potential for the City of Edmonton: A Report for the City of Edmonton's Renewable Energy Task Force*", 2011 February, 63 pp.

6 City of Edmonton, "*The Way Ahead:* Strategic Plan 2009 – 2018", 20 pp. **www.edmonton.ca/city_government/city_wide_initiatives/strategic-plan-2009-2018.aspx**

7 City of Edmonton, "*The Way We* Grow: Municipal Development Plan", Bylaw 15100, 2010 June, **www.edmonton.ca/city_government/city_wide_initiatives/municipal-development-plan.aspx**

8 *Ibid.*, pg. 169.

Key policies in support of renewable energy include:

4.1.1.1 Develop and implement design guidelines for new neighbourhoods including sustainable building design; and

5.1.1.5 Take a leadership role in facilitating the creation of environmentally sustainable buildings.

1.4.3 *THE WAY WE LIVE*: EDMONTON'S PEOPLE PLAN [9]

Key policies and objectives in support of renewable energy include:

Objective:

6.2 The City of Edmonton is an environmentally sustainable society.

6.2.4 Builds on the City's leadership role in environmental best practices

6.2.5 Provides programs and education to businesses and residents about the importance of individual environmental responsibilities

6.2.7 Enforces community standards through municipal bylaws for environmental best practice

6.2.10 Promotes environmental best practices in urban design, construction and re-use of materials

6.2.11 Promotes the use of the highest environmental standards through a civic culture of environmental planning, conservation, preservation and protection.

1.4.4 *THE WAY WE MOVE*: TRANSPORTATION MASTER PLAN [10]

The Way We Move references renewable energy as follows:

Green Technology Opportunities

Consider purchasing green electricity offsets or constructing renewable electricity generating facilities from which key infrastructure such as the LRT can be operated.

Strategic Action

10.1 f. Assessing green technology opportunities and using the technology when appropriate.

1.4.5 *THE WAY WE GREEN*: ENVIRONMENTAL STRATEGIC PLAN [11]

The Way We Green addresses Edmonton's sustainability and resilience challenges relating to energy and climate change, water, food, air, solid waste, and biodiversity. References to goals, objectives and strategic actions include:

The Way We Green
edmonton.ca/TheWayWeGreen

Energy Policy Options — Top Preferences

When stakeholders were asked to indicate policies they favoured for addressing Edmonton's energy challenges, they included in their top three choices: policies that favour a distributed/decentralized energy system that uses renewable energy, e.g., ones that support incentives for solar, municipal feed-in tariff; incentives for renewable energy use; and substitute renewable sources for coal-fired generation.

6.0 Energy and Climate Change

Goal: Edmonton's sources and uses of energy are sustainable.

[9] City of Edmonton, "*The Way We Live*: Edmonton's People Plan", 2010 July, 76 pp. www.edmonton.ca/city_government/city_wide_initiatives/edmontons-people-plan.aspx

[10] City of Edmonton, "*The Way We Move*: Transportation Master Plan", 2009 September, 116 pp. www.edmonton.ca/city_government/city_wide_initiatives/draft-transportation-master-plan.aspx

[11] City of Edmonton, "*The Way We Green*: Environmental Strategic Plan", 2011 April, 90 pp. www.edmonton.ca/city_government/city_wide_initiatives/environmental-strategic-plan.aspx

Objective 6.1: Edmonton's overall built environment (…buildings, roads, and infrastructure) is designed to minimize energy consumption.

6.1.1 Establishes, implements, and maintains a Energy Strategy comprising:

a. Renewable Energy Plan
b. Green Building Plan
c. Energy Transition Plan
g. Green Infrastructure Plan
h. Sustainable Fleet Management Plan

Objective 6.4: A significant and increasing proportion of Edmonton's energy comes from renewable sources, with as much as reasonably possible produced locally.

6.4.2 Establishes, implements, and maintains a City-wide Energy Transition Plan detailing how Edmonton (including City operations) will reduce its energy demand through conservation and efficiency and transition from fossil fuels to renewable energy sources.

6.4.3 Establishes, implements, and maintains a Renewable Energy Plan detailing the renewable energy options and corresponding transition strategies that are best for Edmonton.

Goal: Edmonton is resilient to disturbances that could affect its energy supplies and distribution system.

Objective 6.8: The energy generation infrastructure that Edmonton relies upon is increasingly decentralized and distributed.

6.8.1 Promotes a more distributed energy generation system for Edmonton including micro-generation systems in private homes and commercial/industrial operations

Objective 6.9: Edmonton, the energy city, is a leader in studying, testing, and adopting new energy technologies.

6.9.1 Actively studies, tests, and adopts new energy technologies that reduce the City's dependence on fossil fuels and energy consumption.

6.9.2 Encourages and assists community partners to explore, test, and adopt new energy technologies that will reduce Edmonton's dependence on fossil fuels and energy consumption.

6.9.3 Encourages the growth of Edmonton's renewable energy industry.

1.4.6 GREEN BUILDING STRATEGY [12]

The City of Edmonton is preparing a Green Building Plan that will detail a set of actions to improve the environmental, health, and socio-economic performance of all types of buildings in the city: commercial, institutional, industrial, mixed-use, and residential.

1.4.7 ECO-INDUSTRIAL TOOLKIT

Industrial buildings and facilities are a significant portion of the building sector in Edmonton. An Eco-Industrial Toolkit is in development aimed at embedding a systems approach and lessons from nature in the entire industrial life cycle. Eco-Industrial principles address green buildings as well as sustainable infrastructure, storm water, sewer and energy systems.

[12] City of Edmonton Green Building Strategy, www.edmonton.ca/environmental/planning/green-building-strategy-task-force.aspx

1.4.8 PLANS AND PROJECTS WITH A POTENTIAL RENEWABLE ENERGY COMPONENT

Solar-Electric Pilot Program [13]

In 2010, the City of Edmonton offered rebates for home and business owners willing to install a grid-connected solar-electric system on their home or business. The purpose of the project was to evaluate barriers in City policies and gauge the response of the community to the technologies. The project had a budget of $200,000 divided equally between residential and commercial participants. In total, 15 residential and seven commercial systems were installed under the program.

The Quarters Redevelopment [14]

The Quarters Plan proposes that a high level of sustainable building practices be incorporated into the re-development of the area.

Station Pointe Green [15]

Targeting "net-zero energy" status while remaining affordable.

City Centre Lands (Airport) Redevelopment [16]

A sustainable community that proposes to use 100 per cent renewable energy, is carbon neutral, significantly reduces its ecological footprint, and empowers residents to pursue a range of sustainable lifestyle choices.

Horsehill Energy and Technology Park [17]

The Horsehill Energy and Technology Park is a 4,857 ha city plan centered on the eco-industrial concept including specialized custom zoning that requires an Eco-Industrial Design Plan to be submitted with or prior to each development permit to address green performance standards.

The Renewable Energy Task Force has created a report designed with recommendations to support and enhance the clean energy potential of these programs.

[13] City of Edmonton, Edmonton Solar-Electric Pilot Program, 2011. www.edmonton.ca/environmental/programs/solar-electric-pilot-program.aspx

[14] The Quarters Redevelopment, www.edmonton.ca/city_government/planning_development/the-quarters-downtown.aspx

[15] Station Pointe Green, www.edmonton.ca/business/business_with_city/buying_from_city/landsales/station-pointe-on-fort-road.aspx

[16] The City Centre Airport redevelopment, www.edmonton.ca/city_government/planning_development/edmonton-city-centre-airport-land-redevelopment.aspx

[17] Horsehill Energy and Technology Park, www.edmonton.ca/city_government/news/energy-and-technology-park-app.aspx

2.0 THE CASE FOR ACTION

> There is no question if the world is going to transition to renewable energy, the question is the pace in which it occurs. Strong leadership and action are needed by decision makers in the public and private sector. Current sustainability leaders are future winners.
>
> — Yvo de Boer, KPMG

The need for an Edmonton energy strategy with a role for renewable energy may seem unnecessary considering the fossil fuel resources in Alberta.

However, the City's objective of pursuing renewable energy is driven and supported by an understanding of the risks in doing nothing. As the City takes steps to choose energy sources with improved environmental performance, it will be increasingly important to articulate a persuasive case for action.

The huge drain society causes on its environment is not an issue that can be ignored. Taking concerted action now to begin the long-term change from a high emission, short-term fossil-feedstock energy to clean zero or low-emission sustainable renewable energy will reduce the impact that our energy requirements have on the environment and help ensure that Edmonton has a sustainable energy supply mix.

Fundamental to the case for action is that renewable energy provides environmental, health, social and fiscal benefits. In the coming decade, as costs continue to decline, these benefits will have growing appeal to stakeholders.

Even before the discovery of oil at Leduc #1 in 1947, Albertans have been keenly aware that energy resources are the backbone of our economic development. Increasingly, the use of renewable energy to supply this work has the potential to be the backbone of the future global economy. This change has resulted from:

- The ability of renewable energy technologies to provide reliable power capacity
- The ability of renewable energy technologies to be reliable distributed producers of energy
- The increasing ease of adding renewable energy technologies to the local energy mix
- The rapidly decreasing costs of renewable energy technologies and corresponding renewable energy prices
- The decline of cheap fossil fuel from existing sources and higher costs of extracting it from new sources
- Recognition that renewable energy can provide stable energy prices
- Experience with the effects of volatile and unpredictable fossil fuel prices
- Benefits of low-carbon renewable energy that minimize greenhouse gas emissions
- Concerns about non-carbon emissions from fossil fuel energy and the effect on the environment and health care

- An interest in diversifying energy sources beyond the big three: coal, oil and natural gas
- Recognition that renewable energy sources are more equitably distributed across the planet.

Increasing numbers of municipalities are responding with their own local reasons for adapting to renewable energy, which include:

- Opportunities for economic development that allow local industries to successfully respond to global demand for renewable energy
- Interest in increasing the security of local and regional energy supply
- Interest in reducing the negative effect on local economies of global corporate and political energy decisions
- Significant shifts in social values that are driving the acceptance of environmental costing and new paradigms for urban energy systems[18]
- Political and social pressure for governments and corporations to be environmentally responsible
- Increased awareness that municipalities can make a substantial difference without waiting for other governments to act.[18]

For these reasons, and in order to meet the renewable energy and emission goals in several of its sector plans, Edmonton has a significant opportunity to develop a pioneering strategy for adopting renewable energy systems and begin the City's long-term, orderly transition to increasing renewable energy generation.

The questions then are: "How can Edmonton proactively prepare for these quickly rising changes? How can its abundance of wealth from fossil fuel stocks leave a legacy of sustainability that is attractive to the next generation?"[19]

Municipal action, combined with global awareness, can be effective in answering these questions. A rapidly-growing number of municipalities are indeed acting and developing policies, plans and programs that facilitate the development of renewable energy. Some of these are noted in Appendix E. Prominent among them are Medicine Hat, Dawson Creek, North Vancouver, Vancouver, Richmond, Sunshine Coast, and Victoria.

An energy strategy is needed with actionable items that can make a measurable difference and engage citizens and businesses in guiding Edmonton to meet its economic development and environmental goals. The key objective for an energy strategy is to position Edmonton as an early adopter of renewable energy technologies.

2.1 BENEFITS OF RENEWABLE ENERGY

The supply of energy to Edmonton is pollution-intensive and can be detrimental to human health and our region's biodiversity.[20] It is also less than optimal for supporting the City's local economy in that it does not promote community resiliency against global energy price volatility, and perpetuates a focus on sources of energy that are not sustainable.

Though all energy producing technologies can be said to have an environmental impact to some degree (as does the existence of humankind itself) the benefits arising from the production and use of renewable energy are:

- Reduced emission of noxious substances into the air, water, and soil
- Integration of solar technologies into the built environment thereby not sacrificing greenfield land for other purposes
- Installation of other renewable technologies on land not useable for agriculture and/or not in sensitive wildlife areas
- Diversion of municipal solid waste from landfill and converting it into energy
- Recovery of biogas products
- Low maintenance costs
- Low performance risks
- Reduction in on-site energy costs
- Long-term stable energy prices
- Local distributed investment and jobs rather than concentration in central locations

[18] QUEST: Quality Urban Energy Systems of Tomorrow, "*Moving Forward: The Integrated Energy Systems Approach in Canadian Communities*", 2009 March, 24 pp. pg 11 and 18.

[19] NextGen: Edmonton is a vibrant, welcoming city shaped by the lives and leadership of the next generation, ages 18 to 40. It is creating a city that attracts and gives voice to the next generation in the life and growth of our community.

[20] See Reference Section for a brief listing of supporting documents.

- Potential for high level of participation from citizens and businesses
- Demonstration potential of renewable technologies
- Measurably reduced environmental footprint
- Net job creation at a greater rate than jobs in the fossil fuel energy sector[21]
- A net increase in jobs throughout the energy supply chain: from research and development to manufacturing; renewable fuel production and supply; marketing; system design, equipment installation and maintenance
- Greater municipal control over the financial and environmental effects of the energy produced for their municipality.

In addition to its direct environmental benefit, installing solar energy systems can also have a significant impact on our relationship with energy. At an individual level, this can lead to changes in behaviour such as the purchase of energy-efficient appliances and equipment, process changes, and support for other renewable energy projects. At a community level, the successful installation of one solar system can often give neighbours the confidence to install their own. Similar conclusions were reached by the American National Renewable Energy Laboratory in Colorado with respect to small wind power.[22]

As with any energy source, renewable energy sources have environmental effects, as well as effects on the resources themselves even if they are naturally replenished. The most obvious example is wood which is used for biomass and needs to be carefully harvested and replanted to ensure that long-term supply is greater than consumption. Hydro electricity requires interfering with a river or stream and thus needs careful management and planning to mitigate effects. Large-scale wind installations affect birds and bats, especially during migratory seasons. Large-scale solar has effects on habitat and needs appropriate locations.

Renewable energy is sometimes incorrectly referenced as an energy efficiency technology. It is instead an energy substitution technology — it substitutes a non-renewable energy source with a renewable energy source either on-site or as offered by an energy utility. Renewable energy technologies work in tandem with energy efficiency technologies to reduce and eventually eliminate the consumption of non-renewable energy. See Appendix G for the clarification of additional terms and concepts.

Rapid Changes in Renewable Energy Industries

Renewable energy has been growing rapidly around the world for several decades. Changes in renewable energy markets, investments, industries, and policies have been so rapid in recent years that perceptions of the status of renewable energy can lag years behind the reality.[23] Many organizations are working on the cutting edge and pushing developments forward at the same time.

In 2008 and 2009, the United Nations Environment Program (UNEP) reported for the first time that investments in new electricity generation from renewable sources had outpaced investments in new coal, natural gas and nuclear electricity. This is creating new industries and jobs around the world. [24]

The 2030 Energy Outlook, published by British Petroleum (BP), predicts that over the next 20 years, renewable energy will contribute more to new energy growth than oil.[25]

An increasing number of reputable organizations are taking a serious look at the opportunities for economic development and environmental solutions provided by

[21] Sierra Club Prairie, Greenpeace Canada, Alberta Federation of Labour, "*Green Jobs: It's time to build Alberta's future*", 2009 April, 72 pp.

[22] National Renewable Energy Laboratory, "*Perspectives on an NWCC/NREL Assessment of Distributed Wind*", No. NREL/CP-500-28421, 2000.

[23] Renewable Energy Policy Network for the 21st Century, "*Renewables 2011: Global Status Report*"

[24] The Pembina Institute, "*Reducing Pollution, Creating Jobs: The Employment Effects of Climate Change and Environmental Policies*", 2011 March, pp. 59, **www.pembina.org/pub/2178**

[25] British Petroleum (2011), BP Energy Outlook 2030. **www.bp.com/sectiongenericarticle.do?categoryId=9035979&contentId=7066648**

renewable energy.[26] Some reports being issued suggest that renewable energy will be able to provide most or all of the world's energy consumption by 2050.

A growing number of government and industry leaders are questioning the views of conventional experts on the security and sustainability of the world's energy future and their "business-as-usual" scenarios, embarking instead on a serious search for realistic alternatives.[27]

Though the historic perception of renewable energy is that it is very expensive, the price of renewable energy from various technologies is rapidly improving. Huge investments are being made by private companies in technologies that reduce manufacturing costs, improve efficiencies, reduce material supply costs, improve supply chain logistics, and reduce installation, operating and maintenance costs. Some governments are also assisting. SunShot, for example, is a major US Department of Energy collaborative initiative created to make solar electricity technologies cost-competitive with other forms of electricity by reducing the cost of solar electric systems without incentives by about 75 per cent before 2020.[28]

In response to this, many other cities around the world are facilitating the increased use of renewable energy and gaining from its rapidly expanding economic opportunities. Much can be learned from their example that can be implemented within the Edmonton context.[29]

Renewable Energy in Edmonton

There are many reasons why Edmonton is in a good position now to be a leader among municipalities in harnessing the economic opportunities of renewable energy development:

- State-of-the-art municipal solid waste management system
- Solar energy potential and urban context for solar energy production
- Access to large energy resources from forest biomass
- Strong leadership position in helping drive Alberta as "the Energy Province" of Canada and in its competiveness on the global market[30]
- Formal references to adopting renewable energy in many of its sector plans
- Existing authority to adopt effective policies for this purpose

The Pembina Institute's report to the Task Force, Renewable Energy Potential for the City of Edmonton,[31] evaluated the full spectrum of feasible renewable energy options for the city according to seven key parameters for triple bottom line policy outcomes and appropriateness to the city's social and physical contexts.[32] The sources of renewable energy evaluated included solar, wind, biomass and biogas, and hydro electricity. Ground source heat pumps, which use solar energy stored under the earth's surface, were also evaluated. These resources are strictly confined to what might be available within the current municipal limits of the City of Edmonton. As such, other renewable electricity sources such as from deep geothermal, tidal, wave and large-scale wind are not considered.

The evaluation determined that solar PV and solar domestic and commercial water heating present the most significant strategic opportunities for

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26 See Appendix D, "Renewable Energy Reports from Other Organizations" for a list relevant reports:
United Nations' Intergovernmental Panel on Climate Change, "Special Report on Renewable Energy Sources and Climate Change Mitigation"
World Wildlife Fund, "The Energy Report, A Vision for 100% Renewable Energy by 2050"
Renewable Energy Policy Network for the 21st Century, "Renewables 2011: Global Status Report"
Canadian Solar Industries Association, "Solar Vision 2025: Beyond Market Competitiveness"
Clean Air Strategic Alliance, "Recommendations for a Renewable and Alternative Electrical Energy Framework for Alberta"
The Pembina Institute, "Greening the Grid: Powering Alberta's Future with Renewable Energy"
David Thompson, Sierra Club Prairie, Greenpeace Canada, Alberta Federation of Labour, "Green Jobs: it's time to build Alberta's future"

27 World Wildlife Fund, "The Energy Report, A Vision for 100% Renewable Energy by 2050"

28 American Department of Energy: Sunshot initiative. **www1.eere.energy.gov/solar/sunshot**

29 See Appendix E, "Renewable Energy — Programs in Other Cities"

30 Alberta Senator Elaine McCoy, "Canada needs to take a sober second look at our energy policies and practices. A prosperous, principled and abundant future beckons, but only if we create a national energy consensus that galvanizes our whole nation to become famous world-wide for our expertise in energy productivity and our excellence in both renewable and carbon-based technologies", Article in The Edmonton Journal, 2011 July 21, pg A23.

31 The Pembina Institute, "*Renewable Energy Potential for the City of Edmonton: A Report for the City of Edmonton's Renewable Energy Task Force*", 2011 February, 63 pp.

32 Ibid., pp. 37 – 39.

Edmonton.[33] In particular, for both technologies, "the high number of individual residents … that could implement these technologies raises their technical potential as well as their social and participatory benefits."[34]

Making the Transition

Society's drain on the environment is not an issue to be ignored. Taking concerted action now to transition from high-emission short-term fossil fuel energy to low-emission sustainable renewable energy will reduce the impact that our energy requirements have on the environment. The result will help ensure that Edmonton has an energy supply mix that has less impact on the environment than is currently the case. Energy resiliency — the ability to withstand energy supply and price volatility — will also be a positive consequence of adopting more sustainable renewable energy. Resiliency protects businesses and residents from global issues outside of our influence. The greater our access to renewable energy, the less vulnerable we become.

Policies are needed that will facilitate decision making in order for people, communities, municipalities, not-for-profit organizations, business and industry to install renewable energy systems. A financial framework is necessary to enable organizations to find local, innovative and sustainable solutions to their energy needs.

All businesses need reliable long-term policies in order to develop and implement their business plans — and renewable energy businesses are no exception.

2.2 THE STRATEGIC ROLE OF ENERGY EFFICIENCY

The vital linkage between energy efficiency and renewable energy cannot be overstated. The first focus of any energy transition plan must be on energy efficiency for purely economic reasons.

Energy efficiency:

- is recognised for high environmental and economic value
- is the most affordable way to reduce energy consumption, energy costs and noxious emissions
- can provide a significant reduction in energy consumption in all areas of energy use
- is recognised as the most important method by which society is able to reduce its environmental footprint regardless of the energy source.

But energy efficiency alone cannot address all of our energy needs. Combined with significant improvements in energy efficiency, a steady and multi-fold increase in the use of renewable energy is required for a transition from what is currently seen as a fringe option to becoming a mainstream supply of energy.

Renewable energy technologies, especially those that have a high level of engagement with end-use customers, such as solar domestic water heating and solar electricity, often have a particularly important social value in helping to promote the use of energy efficiency. This is because the renewable energy system personalizes the generation and ownership of energy for customers. The question of "how can I increase the proportion of the energy that I generate?" or "how can I sell more energy to the grid?" can best be answered with the response that everyone must become more energy efficient. Renewable energy systems, therefore, help sell the economic opportunities of energy efficiency. When bundled together on a project, the financial and marketing linkage of renewable energy and energy efficiency technologies can offer projects much more attractive promotional and economic opportunities.

[33] Ibid., pp. 38 – 39.

[34] Ibid., p. 38.

3.0 OPPORTUNITIES FOR RENEWABLE ENERGY

> Alberta's development and use of renewables will help in reducing greenhouse gas emissions, enhance Alberta's diversity of energy supply, stimulate regional activity, and fortify collaboration across industry sectors.[35]
>
> — Alberta Provincial Energy Strategy, 2008 December 11

Natural gas and electricity are the primary sources of energy in Edmonton. The vast majority of the city's space heating and water heating needs are met by on-site natural gas combustion.

Passive solar heating, caused by the sun shining through windows, can provide 10 – 15 per cent of house heating requirements depending on size and type of windows, their placement and the energy consumption of the house.

Alberta's electrical energy consumption in 2010 was generated from the following sources:

- 71% from coal
- 19% from natural gas
- 2.5% from hydro
- 2.5% from wind
- 1% from other
- 4% imported from British Columbia and Saskatchewan.[36]

Due to the proximity of Edmonton to the major electricity generators, the electrical energy entering Edmonton's boundaries is largely from coal.

Table 1 outlines the current energy use and emissions in Edmonton. The total greenhouse gas emissions associated with the energy use is expressed as tonnes of CO_2 equivalent (tCO_2e).

[35] Government of Alberta, "*Launching Alberta's Energy Future: Provincial Energy Strategy*", 2008 December 11, pg. 10. **www.energy.alberta.ca/Initiatives/strategy.asp**

[36] Alberta Electric System Operator, 2010 Annual Electricity Market Data. **www.aeso.ca/market/8856.html**

Table 1: Energy use and emissions in Edmonton (2009)[37]

		ENERGY USE[38]	TOTAL GHG EMISSIONS
Sector		**MWh**	**tCO_2e**
Residential (298,500 sites)			
Electricity		1,895,000	1,550,000
Natural Gas		7,910,000	1,420,000
Total GHG			2,970,000
Non-Residential (34,000 sites)			
Electricity		5,300,000	4,340,000
Natural Gas		28,657,000	5,150,000
Total GHG			9,490,000
	Total Electricity	7,200,000	5,890,000
	Total Natural Gas	36,570,000	6,570,000
	Total GHG		**12,460,000**

Energy consumption in the city:

- Energy used in Edmonton: 16% from electricity, 84% from natural gas
- Energy used by the City of Edmonton: 40% from electricity, 60% from natural gas
- Total electrical energy used in the city: 26% is residential, 74% is non-residential
- The City of Edmonton corporation's total energy consumption is 1.3% of the total used in the city.

Energy consumption and emissions can be reduced in a number of ways:

- Improve the efficiency of Edmonton's residential and commercial buildings
- Adopt energy-efficient vehicles and transportation systems
- Integrate development and transportation planning to minimize need for high-energy and high-emission transportation systems
- Choose cleaner fossil fuel sources
- Employ emissions-removal technologies on fossil fuel electricity generators and natural gas processing plants
- Install renewable energy technology in City operations
- Facilitate the use of renewable energy by Edmonton's citizens and businesses.

3.1 EDMONTON'S RENEWABLE ENERGY RESOURCES AND SUPPLY

The major sources of renewable energy available within the Edmonton's city limits are listed in Table 2.

Though Edmonton and the surrounding region are rich in renewable energy resources, little is currently derived for the energy supply.

[37] Electricity data was provided by EPCOR; natural gas data was from the City of Edmonton.

[38] GJ and MWh are merely different energy units. 1 MWh = 3.6 GJ. Though natural gas consumption is normally presented in GJ, this chart is also intended to compare the amount of energy used from natural gas and electricity.

Table 2. Renewable Energy Technologies Applicable Within the City of Edmonton [39]

Category	Technologies	Energy Service				Potential for Ownership[40]					
		Electricity	District Heating	On-Site Heating	Transportation	Residential	Community	Municipal	Commercial	Industrial	Utility
solar	photovoltaics	X				X	X	X	X	X	X
	passive space heating			X		X	X	X	X	X	
	active liquid[41] heating					X	X	X	X	X	X
	active air heating					X	X	X	X	X	
wind	Typically Edmonton does not have sufficient annual wind energy resource to make it a viable alternative										
geothermal	heat pumps[42]		X	X		X	X	X	X	X	X
biomass	animal & human waste	X	X	X	X			X	X	X	X
	municipal refuse	X	X	X				X		X	X
biogas	animal & human waste	X	X	X	X			X		X	X
	municipal refuse	X	X	X	X			X		X	X
	landfill gas	X	X	X	X			X		X	X

Table 3 is an estimate of the types and number of renewable energy systems in operation in Edmonton today. There are no validated studies on the number of systems of any type used in Edmonton at this time. We know from EPCOR that as of mid-July (2011) there were 60 independent power producers, likely most of them solar PV.

Regardless of the accuracy of the quantities reported in this table, the amount of energy generated by these systems is basically negligible when compared to the amount of energy that Edmonton uses.

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39 As may be regulated by the land-use bylaw.

40 Ownership of the facility that generates the energy or fuel, and not where the energy or fuel is used.

41 "Liquid" refers to systems that use either water or glycol as the heat transfer fluid.

42 Ground-source heat pumps effectively use solar energy stored in the shallow layers of the earth's surface.

Table 3. Estimates of Renewable Energy Technologies Operational in Edmonton in 2011

Energy Source	Renewable Energy Technologies Presently Serving Edmonton	Direct Contribution	Energy Service			Actual System Owners					
			Electricity	Heating	Transportation	Residential	Community	Municipal	Commercial	Industrial	Utility
solar	photovoltaics	– 70 systems, 320 kW total	X			X		X	X		
	passive space heating	– significant in most buildings		X		X	X	X	X	X	
	active water heating	– 30 systems		X		X	X	X	X		
	active space heating										
	– liquid	– 5 systems		X		X					
	– air	– 5 systems		X		X		X			
wind[43]	turbines	one 3.5 kW	X						X		
hydro	run of river	none	X								
	dams	2%	X								X
geothermal	deep well	none	X	X							
	heat pumps	200 systems		X		X	X	X	X	X	X
biomass	crops	none		X							
	wood for electricity	none	X								X
	wood for heat	1%		X		X					
	municipal refuse	none		X							
biogas	crops	none		X							
	animal & human waste	Gold Bar		X				X			
	municipal refuse	none	X	X							
	landfill gas	4.8 MW	X								X
biofuel	from canola	2% biodiesel			X	X					
		5% ethanol									

[43] Realistically none of the electrical energy from these technologies enters the city. The energy is likely all used within ~200 km of the generators.

3.2 OPPORTUNITIES FOR RENEWABLE ENERGY IN EDMONTON

Today, very little of Edmonton's energy is derived from renewable energy. Renewable energy prices are declining. Public interest in renewable energy appears to be growing. These opportunities present an attractive starting point for a transition from relying on fossil fuels to making use of the abundant renewable resources available.

In May, 2010, The Pembina Institute developed a discussion paper, "Greener Energy Opportunities and Priorities for the City of Edmonton" for *The Way We Green*, Edmonton's Environmental Strategic Plan. [44] In February 2011, further investigation on opportunities for Edmonton was completed in order to facilitate the work of the Renewable Energy Task Force. The Pembina Institute assessed the scale of opportunity for select mature renewable energy technologies within the municipal boundaries of the City of Edmonton.[45] This assisted the Task Force in developing priorities and provided a resource for future discussion on renewable energy decisions by the City.

Their report, Renewable Energy Potential for the City of Edmonton, includes information about the availability and accessibility of renewable resources within a 50 km radius of the city, as well as the scale of benefits, such as investment, job creation and emission reductions.

[44] The Pembina Institute, "*Greener Energy Opportunities and Priorities for the City of Edmonton*", Discussion Paper 14 for *The Way We Green*, 2010 May, 16 pp.

[45] The Pembina Institute, "*Renewable Energy Potential for the City of Edmonton: A Report for the City of Edmonton's Renewable Energy Task Force*", 2011 February, 63 pp.

The potential for each technology was described along with the amount of energy from fossil fuel sources that would be displaced for electricity or heat generation, along with the quantity of greenhouse gases that would be reduced annually. The report did not examine the significant potential for energy efficiency to further reduce fossil fuel dependence. Table 4 summarizes the amount of energy that could be generated from each source ten years from now.[45] The table is based on the findings of the Pembina Institute report with adjustments made to the GHG emissions generated by electricity using an emission savings rate 0.65 kg/kWh instead of the grid average of 0.88 kg/kWh as originally used.

Seven key parameters were used to evaluate the city's renewable energy options.[46] The sources of renewable energy evaluated included solar, wind, biomass and biogas, hydro electricity and ground source heat pumps. Distant renewable energy sources such as from forest and agricultural biomass, deep geothermal, ocean thermal, tidal, ocean wave and large-scale wind were not considered since these technologies cannot be sourced within Edmonton's boundaries.

Using an objective scoring methodology, their evaluation determined that solar PV and solar domestic and commercial water heating present the most significant strategic opportunities for Edmonton.[47] In particular, for both technologies, "the high number of individual residents … that could implement these technologies raises their technical potential as well as their social and participatory benefits." [48]

[46] Ibid., pp. 37 – 39.

[47] Ibid., pp. 38 – 39.

[48] Ibid., p. 38.

Table 4. Summary of the Potential for the Supply of Renewable Energy in Edmonton

	TOTAL ENERGY POTENTIAL				GHG SAVINGS	
Energy Source	Residential	Institutional, Commercial, Industrial	Residential	Institutional, Commercial, Industrial	tCO_2e /Year	Portion of Edmonton's electricity and natural gas emissions
Solar PV	420,000 MWh	225,000 MWh	22%	4%	419,250	3.0%
Passive solar space heating	505,000 MWh	n/a	6.4%	n/a	90,870	0.73%
Solar hot water heating	437,000 MWh	77,000 MWh	4.5%	0.2%	92,332	0.74%
Solar air heating	n/a	83,000 MWh	n/a	0.25%	14,970	0.12%
Ground-source heat pump	812,000 MWh	1,961,000 MWh	8.3%	5.8%	null	null
Biogas	1,051,000 MWh (of electricity), or 1,814,000 MWh (of heat)		up to 14.6% (total electricity)		683,150*	5.1%*
Biomass	198,000 MWh (of electricity), or 555,000 MWh (of heat)		2.8% (total electricity)		128,700*	1.04%*
Low-head hydro	6,700 MWh		0.09%		4,355	0.03%
Small wind	n/a	n/a	n/a	n/a	n/a	0.00%

* Assumes resource is used to displace electricity.

This analysis found that using current renewable energy technologies, a conservative estimate indicates that it is possible to generate up to 20 per cent of current electricity consumption in the city, and 10 per cent of the natural gas consumption. Though these are significant opportunities, they highlight the importance of improving energy efficiency as well as efforts to improve the overall sustainability of energy supply in the province. Improving the efficiency by which the city uses energy can dramatically increase the proportion of energy supplied by renewables.

4.0 KEY INITIATIVES

As a result of its work, the Task Force identified a long list of potential initiatives that could be considered for Edmonton. Of these, four were identified as key to laying the groundwork for transition to renewable energy technologies. These four initiatives, along with corresponding opportunities for action, will define a sustained, fundamental adoption of renewable energy into our lives and businesses:

- municipal policies (including regulations, permitting, codes and standards)
- incentives
- training
- partnerships

The opportunities are shown with additional indicators:

Importance:

incremental steps
contributes to the many incremental improvements in market conditions

strategic (window of opportunity)
allows stakeholders to be well-positioned for growth opportunities

foundational
undergirds industry development, essential to developing the markets

critical
renewable energy markets and industries cannot move forward without this

Timeframe:

immediate
today to 2 years

short
2 to 5 years

medium
5 to 15 years

long
15+ years

Complexity:

none
minimal or no barriers

some
some barriers requiring planning and training

much
significant competing barriers from several parties requiring integrated solutions involving many levels of government and/or regulatory changes to resolve

Scale of application:
Residential, community, commercial, learning, institutional, municipal, industrial, utility

Jurisdiction:

- Municipality can act alone
- Municipality can act with citizens
- Municipality can act with another level of government, to advocate or collaborate

4.1 INITIATIVE: ADDRESS MUNICIPAL POLICIES TO ENABLE RENEWABLE ENERGY

Municipal codes, policies and legislation can present barriers to the deployment of renewable energy technologies and can also provide opportunities for enabling them.

Action: Identify elements in municipal codes, policies and legislation that present barriers to renewable energy, then revise them to enable renewable technologies

Benefits:

- Reduces project processing time and effort on the part of the City and the renewable energy developer
- Facilitates increasing the size and scope of new local markets for renewable energy and thus growing local industries and a stronger and more competitive economic environment
- Provides local companies with an advantage that can service the local economy and potentially serve broader markets
- Minimizing these barriers enables economic growth. Renewable energy companies are attracted to municipalities with a positive business climate.
- With each policy change, the City has an opportunity to communicate the progress of its environmental strategic plan.

Context: Policies and regulations are in place for multiple reasons. Their continuing legitimacy in the face of changing technology and any unintentional negative consequences they might cause merit examinination to determine how they can be modernized.

Relationship: Interaction with multiple stakeholders to identify and resolve existing policy issues that detracts from Edmonton's renewable energy investment climate.

Importance: Strategic

Timeframe: Immediate, short

Scale: Residential, Commercial, Municipal, Institutional, Industrial, and Utility

Complexity: Some, much

Jurisdiction: Municipality can act alone

4.1.1 DEMONSTRATE RENEWABLE ENERGY SYSTEMS ON CITY/PUBLIC BUILDINGS

Opportunity: Incorporate renewable energy systems in new and existing City-owned or other public buildings and facilities to demonstrate leadership and generate benefits.

Benefits:

- Opportunity to demonstrate visible and informed City leadership
- Increases the City's ability to deliver its energy and environmental message to its citizens and businesses
- Makes renewable energy technologies visible to citizens, businesses and other municipalities
- Provides City staff experience and training with technologies (purchasing, installation, suppliers, options, operation, maintenance, codes, awareness, and economics), aiding in developing informed City renewable energy policies applicable to residents and industry
- Establishes consideration of these technologies as part of normal City decision-making business.

- With substantial purchasing power, City investment in renewable energies contributes to a stronger foundation in the Edmonton market
- Addresses Edmonton's Sector plans and their references to renewable energy

Examples:
- Solar domestic water heating on facilities with high water heating loads such as vehicle washes as per the City of Red Deer
- Solarwall on bus barns as per the new Edmonton Transit System Centennial bus garage in Ambleside
- Geothermal heating and cooling as per the ATCO Gas building
- Solar heating on municipal swimming pools as in Pincher Creek and Okotoks
- Work with school board to encourage the installation of solar domestic water heating and solar electricity on schools to facilitate unobstructed solar access, local community prominence, and existing community education role.

Relationship: Broad range of potential partners

Importance: Strategic

Timeframe: Immediate, short, long

Complexity: Some, much

Scale: community, commercial, municipal

Jurisdiction: Municipality can act alone, with citizens, with school boards

4.1.2 CHANGE LAND-USE BYLAW TO PERMIT SPECIFIED RENEWABLE ENERGY SYSTEMS

Opportunity: Formalize standards in the land-use bylaw to allow renewable energy systems to be accommodated through discretionary uses and, where necessary, update the bylaw for specific renewable energy configurations.

Example: Modify the land-use bylaw for specific configurations of renewable energy systems (likely solar PV and solar thermal in all zoning areas, perhaps including wind in some industrial areas) from "discretionary" to "permitted". The City of Calgary has developed similar modifications to its land-use bylaw.

Benefits:
- Reduces project processing time and effort on the part of the City and the renewable energy developer
- Provides an opportunity for the City to communicate the sincerity of its environmental strategic plan
- Reduces project development time for solar energy systems by approximately two weeks and approximately $500 in project costs. This may assist ENMAX Energy in their mass solar PV leasing program

Context: In standardizing policy and process, the City enables mass installation by removing uncertainty and reducing the time and cost required to complete a project.

Relationships: Residential, municipal, industry

Importance: Fundamental

Timeframe: Immediate, short

Complexity: Some, much

Scale: Residential, commercial, municipal, institutional, industrial, utility

Jurisdiction: Municipality can act alone

4.1.3 IMPLEMENT HOME ENERGY PERFORMANCE LABELLING

Opportunity: Implement a program to require energy performance and energy-source labelling on all residential building types whenever they are built, sold, leased or rented. In addition, transit and walkability scores could provide a more complete energy picture for homebuyers.

Benefits:
- Increases the visibility of energy performance allowing for informed decisions whenever the homes are built, purchased, sold, leased or rented

- Energy performance would become an element affecting the re-sale value of a building ultimately driving building and retrofit decisions
- Will drive choices for energy efficiency and/or renewable energy during the original construction or retrofit process
- Simplifies the measure and value of both energy efficiency and renewable energy

Explanation: A variation of the standard EnerGuide for Homes label[49] could be used to reflect a home's energy consumption and energy source(s). The passive solar contribution as well as the solar energy potential for a building could be additional factors.

Context:
- Currently, house energy performance isn't a typical part of purchase decision-making despite its effect on the operational costs of a house and corresponding affordability in the long term
- Many homebuilders are already aware of house energy labelling as this is a part of NRCan's R-2000 program, which has been available for 30 years

Relationships: These could be a valuable part of the Edmonton Energy Code. Associations of homebuilders and real-estate agents would be ideal partners in its implementation.

Timeframe: Short

Scale: Residential

Complexity: Some (Training needed for real-estate agents, homeowners, homebuilders. More certified energy auditors will be needed.)

Jurisdiction: Municipality can act with citizens and with another level of government to collaborate.

4.2 INITIATIVE: PROVIDE A STRONG ECONOMIC PLATFORM FOR RENEWABLE ENERGY

Renewable energy requires a strong policy and incentive framework to level an economic playing field that currently favours other energy resources in attracting market share, economic development and investment.

Action: Co-ordinate financial incentives to support and build renewable energy markets and supply-chain capacity until the technologies become mainstream and no longer require rebates or subsidy.

Benefits: In many other parts of the world such as Ontario and Germany, incentives have been shown to be the most significant mechanism in increasing the use of renewable energy.

Explanation: Specific policies allow the City to proceed towards its renewable energy goals, complete with progressive incentives, evolving standards and key performance indicators.

Importance: Fundational, strategic

Timeframe: Imediate, short

Scale: Residential, community, commercial, industrial

Complexity: Some

Jurisdiction: Municipality can act alone

Municipality can advocate and collaborate with other levels of government

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[49] An EnerGuide for Homes label from Natural Resources Canada is a standard label that applies to the energy performance of houses. It focuses on components of the house that the homeowner would not readily change, such as the building envelope, passive solar space heating, heating equipment, solar domestic water heating, solar electricity and ground-source heat pumps.

EnerGuide labels are currently available for houses upon request and are already found on all appliances. A few Certified Energy Auditors and companies already exist in Edmonton in order to provide R-2000 and EnerGuide evaluations.

A Certified Energy Auditor evaluates the home's drawings (or visits the house and takes measurements), conducts an air-pressure test (called a blower-door test), enters the data into NRCan's HOT-2000 modelling software, has it validated by NRCan and prepares the label. The cost depends on the size and complexity of the house and can be in the order of $300 to $500.

Context for Incentives

A strong economic platform is needed for any industry to thrive and to grow its market. This is no different for the renewable energy industry.

The most significant barrier facing the renewable energy industry, however, is the cost difference between renewable and fossil fuel resources arising from an uneven economic playing field. This inequity is created by long standing financial and policy incentives for fossil fuel energy technologies.

A useful starting point to change this context is the development of a long-term economic model that requires all energy sources to accurately reflect their true costs to their owners and to society. Neither Alberta's electricity nor natural gas prices take into account the health, environmental, and resulting economic costs of fossil fuel exploration, extraction, processing and combustion. For this reason, the resulting prices are artificially low and enjoy an unfair advantage to clean renewable energy sources.

In the absence of a carbon tax or similar fee to accurately reflect the true societal costs of fossil energy use, financial incentives are necessary to advance the adoption of renewable energy technologies. The renewable energy industry seeks the same incentives in a form that recognises its low-carbon energy characteristics. Similar economic development incentives have been helping to advance the coal, oil, natural gas and bitumen extraction and processing industries for several decades. For additional historical details on energy industry subsidies, see Appendix F.

The financial support of incentives brings prices of renewable energy into line with existing energy sources. This support can decrease as the prices of renewable energy continue to fall. This has already been the case in Germany and in Ontario.[50]

Incentives have the potential to rapidly increase the demand for renewable energy equipment and services. Increased development of the industry's chain of equipment and service suppliers will be crucial to the successful expansion of the renewable energy market. Incentives will encourage and promote more robust competition, which in turn will help drive costs down while maintaining quality installations. This is evident in several other parts of the world with Ontario being the latest example.

Incentives are an effective way to rapidly and immediately begin the transition to renewable energy in Edmonton. They stimulate the industries necessary to serve the renewable energy markets and accelerate the development of technologies that effectively compete with fossil-feedstock energy. Incentives need to be combined with phasing in of regulations, codes and standards that remain in place to maintain a healthy renewable energy market once the incentives for renewable energy are phased out, having served their purpose.

4.2.1 USE LOCAL IMPROVEMENT CHARGES FOR COMMUNITY-BASED RENEWABLE ENERGY

Opportunity: Apply the Local Improvement Charges (LIC) tool for installation of renewable energy systems on structures owned by community groups. Identifying the residents/businesses responsible for repayment would be determined by LIC regulations. Evaluate this funding design for privately-owned structures (known in other jurisdictions as PACE).

Benefits: Simple, accessible financing of renewable energy projects help remove the barriers of lengthy paybacks, lack of access to capital to improve existing buildings, and resistance within the property development industry. Using the LIC approach, municipalities are able to participate directly in the way energy is used within their jurisdiction. The United Kingdom has recently introduced this

[50] Canadian Solar Industries Association. *"Using findings that show private investment in Ontario is spurring a healthy solar industry, the Canadian Solar Industries Association is supporting the reduction of feed-in-tariff rates this fall"*, media release, 2011 August 09. **www.cansia.ca/news-media-archive/study-shows-ontario's-solar-program-spurs-private-investment---solid-foundation-0**

mechanism nationally.[51] The Pembina Institute completed a study on how such policies could be of benefit in Canada.[52]

Explanation: Use LICs to finance renewable energy and energy efficiency improvements in community-owned buildings for localized benefits and as another tool to promote energy efficiency and renewable energy. Work with the Alberta government to enable a province-wide policy change that would see this funding mechanism become applicable to residential and/or commercial buildings.

Context: Local Improvement Charges have long been used by municipalities to cover the costs of improving community infrastructure, such as roads and sidewalks, to the benefit of a specific neighbourhood. The improvement is financed by the City and repaid through property taxes. The City assesses which landowners will benefit from the improvements and recoups the expenditures through their property taxes each year.

Example: The Toronto Renewable Energy Co-op's SolarShare program[53] is an excellent example of how people and organizations are able to share in the investment and benefits of renewable energy systems once a premuium feed-in tariff is in place that makes it an attractive investment.

Example: Vancouver has adopted a similar approach and Toronto is working to change legislation to make this possible. Another approach being explored by Vancouver is to add the energy upgrades to the property tax in the same way that you pay for paving your back alley through a Local Improvement Tax that people would pay for over 20 or 25 years. This assessment would remain with the property even if ownership changes. The revenue is collected by the City and aggregated into a multimillion dollar bond (secured by the City through its right to tax properties).

Relationships: Facilitate citizen ownership of a renewable energy system on a community building.

Importance: Strategic

Timeframe: Immediate, short

Scale: residential, community, commercial, institutional

Complexity: Some (LICs on community buildings). Much (LICs on private buildings).

Jurisdiction: Municipality can act alone (LICs on community buildings)

Municipality can advocate or collaborate with another level of government (LICs on private buildings)

4.2.2 ESTABLISH A STABLE FUNDING SOURCE FOR RENEWABLE ENERGY INCENTIVES

Opportunity: Establish a stable funding source, such as an increase to the local access fee (electricity) or municipal franchise fee (natural gas). Use this additional fee revenue to provide ongoing funding for renewable energy incentives.

Benefits:
- Can provide a stable funding source
- Uses an existing fund-collection mechanism
- Increase in fee can be accurately projected and managed by capping the amount of incentive funds available each year

Explanation: This is a tax that could be used specifically for incenting the implementation of the City's renewable energy plans. In considering financial incentives the biggest question is, what is the duration

[51] The Guardian, *"Green loans Q&A: How does Pay As You Save finance work?"*, 2010 May 04. **www.guardian.co.uk/environment/2010/mar/02/pay-as-you-save-loans-decc-answers**

[52] Pembina Institute, *"Using Local Improvement Charges to Finance Energy Efficiency Improvements: Applicability Across Canada"*, prepared for the Office of Energy Efficiency, Natural Resources Canada, 2005. **http://re.pembina.org/pub/197**

[53] Toronto Renewable Energy, Co-op SolarShare Community Solar Bonds. **www.trec.on.ca/generation/solarshare**

and value of the funding? Typically the sources of funds for any energy incentives are:

- revenue from various levels of governments funded by the tax base
- revenue from an increase in energy prices and thus funded by the rate payer
- carbon taxes on existing fossil fuel energy resources.

The City charges EPCOR Distribution and Transmission (EPCOR D&T) a fee for access to its customers and the use of City land to provide its services. This is called a "Local Access Fee" (LAF). The City sets the budget requirements for this and EPCOR D&T then determines the rate of the fee. The 2011 LAF price is 0.66 ¢/kWh + GST or $46 per year for an average residential customer who uses 6,600 kWh of electrical energy per year.

The City charges ATCO Gas a fee for access to its customers and the use of City land to provide its services. This is called a "Municipal Franchise Fee" (MFF). For residential bills in 2011, the price of the Municipal Franchise Fee is based on a percentage (32 per cent) of the ATCO Gas bill including its natural gas fuel energy-based charges and its grid-connection (time-based or "fixed") charges and GST. The 2011 MFF price amounts to $59 per year for an average residential customer who uses 120 GJ of natural gas per year plus $104 per year for grid-connection charges.

Business Case: Incentives need to have stable funding for sustained impact. LAF and MFF are funding mechanisms in which funds arise from energy utility bills. These can provide a dual benefit: the revenue funds the incentives and the increased energy price provides an additional economic incentive to reduce energy consumption.

Privately-owned renewable electricity or heat generation will slightly reduce the amount of energy delivered from the grid and thus the amount of City revenue from these fees. This reduction will be gradual and will be reviewed and adjusted according to future priorities.

Importance: Foundational

Timeframe: Medium

Scale: Residential, community, commercial, institutional, industrial

Complexity: Some

Jurisdiction: Municipality can act with citizens

4.2.3 IMPLEMENT A PRODUCTION-BASED FEED-IN TARIFF (CLEAN CONTRACT MECHANISM)

Opportunity: Implement a production-based incentive similar to a feed-in tariff[54], for grid-connected renewable electricity and heat. The rate and timeframe of the incentives would reflect the actual cost of generation plus a reasonable return on investment.

Benefits:

- Incents the generation of renewable electricity and renewable heat by removing all economic barriers[55]
- Incents the development of renewable energy markets and their supporting industries
- City could procure a portion of its electricity requirements from residents who sell electricity to the grid
- Notable for the City because it would be the 2nd municipal feed-in tariff in North America
- Provides a leading-edge role model for other municipalities to consider

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54 As described in the Pembina Institute's report on CLEAN Contracts for Edmonton. CLEAN is the acronym for "clean, local, energy, available, now".

55 British Renewable Heat Incentive. **www.stackyard.com/news/2011/07/environment/06_fg_renewable_heat_incentive.html**

Explanation: A feed-in tariff has proven to be a highly-effective policy mechanism for incenting renewable electricity generation. In this case a CLEAN Contract is proposed as a production incentive for renewable electricity and renewable heat. These contracts are designed as an agreement between the City and the energy producer. Energy producers could include single family homes, multi-family, commercial, industrial buildings and other parties that could support solar PV and/or solar hot water installations.

- In covering the costs of a CLEAN contract program with energy consumption-based fees, the City would harness the economic, environmental and energy price resiliency opportunities provided by energy efficiency technologies. The footprint reduction and economic development potential of energy efficiency is massive.[56] Through this ground-breaking policy innovation, the City can link two key complementary energy forms: renewable energy production and energy efficiency.
- The experience of other jurisdicitions world-wide has contributed to the proposed design of the CLEAN Contract and how best to successfully implement a production-based incentive.
- The CLEAN Contract will be needed until the price of renewable energy becomes comparable with grid energy.

Context: As demonstrated in other jurisdictions, energy-based incentives might well be the single most effective and sustainable way to increase the use and production of renewable energy in Edmonton.

- A key driver for such incentives is to make renewable energy not just an environmentally sound decision, but also a financially attractive one. This support helps drive the uptake of renewable energy now, stimulates the renewable energy industry, encourages further innovation and continues to bring down the price of renewable energy.

[56] Marbek and MK Jaccard & Associates (2006). *Demand side management potential in Canada: Energy Efficiency Study*. www.electricity.ca/media/pdfs/policy_statements/EE-DSM_Final%20Report.pdf; McKinsey & Company (2009). *Unlocking efficiency in the US Economy*. www.mckinsey.com/clientservice/electricpowernaturalgas/us_energy_efficiency

- Production-based incentives such as a feed-in-tariff (FIT) typically include the following key provisions:
  - guaranteed grid access
  - long-term contracts for the electricity produced
  - FIT prices that are reduced over time as renewable energy reaches a price comparable with utility energy
  - renewable energy developers can obtain a reasonable return on renewable generation investments

Relationships: Citizens, businesses, community groups

Importance: Foundational

Timeframe: Immediate

Scale: Residential, community, commercial, municipal, institutional, industrial

Complexity: Some

Jurisdiction: Municipality can act alone or may need the support of the Alberta government

Examples:

- Ontario developed a Green Energy Act in 2008 as an industrial development plan to assist Ontario's small renewable energy industry increase their energy supply to burgeoning world markets. To develop their local industries, The Green Energy Act developed local markets by setting a premium feed-in tariff for the electrical energy from solar PV and wind systems. It also mandated that an increasing portion of equipment needed to be made in Ontario in order to qualify for the tariff. As a result of the Green Energy Act, prominent manufacturers have established operations in Ontario and created 13,000 new jobs in the solar and wind field over three years.
- Production-based incentive program in Indiana called "Rate REP" (Renewable Energy Production)
- Over 40 jurisdictions in the world now have feed-in tariffs
- See the Appendix I for the complete discussion paper and details of the CLEAN contract, including regular assessments of the rate, annual cap and financial modelling
- This is a framework that could be expanded to include other energy technologies (geothermal, wind, combined heat and electricity)

Production based incentives including feed-in-tariffs are not without controversy from various stakeholders and those concerns will need to be addressed.

4.3 INITIATIVE: PROVIDE LEADERSHIP IN RENEWABLE ENERGY

The City's ability to direct the changing reality of renewable energy and its technologies can be demonstrated through policy decisions, purchasing choices and engagement of citizens.

Action: Initiate and support community projects that demonstrate and promote renewable energy.

Benefits:

- Demonstrates highly visible City energy leadership in the community
- Provides community groups and their citizen stakeholders experience in renewable energy
- Engages citizens and supports them in their energy initiatives.
- Helps to change attitudes towards energy and its related environmental issues
- Opens the door for leveraging private community capital in developing renewable energy projects
- Encourages decentralized energy generation as an equitable, reliable and secure source

Explanation: Education, capacity building and demonstration are important in developing a message from the City on the benefits of transitioning to renewable energy.

Context: These projects can provide tangible ways for citizens and businesses to respond to the City's environmental strategic plan.

From *The Way We Green*: "A critical dichotomy exists in that Edmonton citizens recognize the severity of global environmental challenges, but tend to believe that Edmonton (and Alberta) can somehow remain largely immune to these problems or they do not necessarily see the relevance of these issues to the local community and to their own daily life. Concepts of living within limits and action will resonate with the public only when and if they appear relevant to the practical daily life of the population. There is also a clear need to integrate expert knowledge, stakeholder views and public opinion."

Example: A useful example of such a program is the City of Medicine Hat's Hat Smart[57] program which has residential, commercial, and community components and is now in its second phase.

Relationships: Wide range of stakeholder engagement.

Importance: Foundational

Timeframe: Immediate, short

Scale: Residential, community, commercial

Complexity: Minimal or no barriers

Jurisdiction: Municipality can act with citizens

4.3.1 SPEARHEAD DEVELOPMENT OF COMMUNITY-LEVEL RENEWABLE ENERGY GROUPS

Opportunity: Spearhead development of community-level renewable energy groups

- Support access to solar energy where residents could share ownership and benefit from systems on community buildings
- Implement small-scale district heat and electricity co-generation stations for the benefit of the surrounding community
- Solar roof programs have been instrumental in establishing a strong momentum for the growth of the solar PV and solar thermal industries in several countries, most notably Japan, California and Germany. BC is considering one. They are usually marketed as a "100,000 roof program", for example.

[57] City of Medicine Hat HAT Smart II. **www.hatsmart.ca**

Benefits:
- Opens up the opportunity of renewable energy system ownership to more Edmonton residents even if they live in apartment buildings or in areas where trees or buildings limit solar energy production or are outside the area of the co-generation station.
- Leverages private capital in financing these projects
- When tied in with production-based incentives, these programs could financially reward schools, community leagues, and non-profit groups
- Establishes the capacity for remotely-owned and aggregately-owned renewable energy systems, which are commonly called "community solar gardens."[58]

Explanation: Many residences and businesses do not have the physical sites suitable for the installation of a solar system, for example. Building orientation, roof angles, trees or nearby buildings and height restrictions can preclude the installation of a system on site. Additionally, many residents and businesses are renting or are located in high-rise office buildings or condominiums. At the same time, there are numerous buildings and properties that are excellent candidates for solar systems. These include schools, churches, community centres, and large commercial and industrial buildings. The City could aid the establishment of remotely owned and aggregately owned systems by creating sample contracts and then providing a public educational program.

- While district energy systems are more about efficiency than renewable energy generation, they can provide a more energy efficient and low maintenance means of providing heating and cooling for locations with a high density of commercial buildings. A City map delineating potential areas for district heating would be helpful in understanding the opportunities for community-scale systems.

Context: There is evidence of the success of community energy co-operatives in increasing the use of renewable energy. Denmark is a good example of this. Co-ops are now under development in Ontario.

Relationships: The city engaging with resident and business communities to enable broader eligibility for ownership through co-operative models for renewable energy installations.

Importance: Strategic

Timeframe: Short, perpetual

Scale: Community, commercial, municipal, institutional

Complexity: Some (qualification process, permitting, on-going management)

Jurisdiction: Municipality can act with citizens

[58] Community Solar Gardens. **http://solargardens.org, www.ecopolitology.org/2010/04/29/community-solar-gardens-explained**

4.3.2 CONTINUE TO DEVELOP PROGRAMS TO INCREASE RENEWABLE ENERGY AWARENESS

Opportunity: Continue to develop programs to increase renewable energy awareness:

- Through the existing City of Edmonton's Carbon Dioxide Reduction Education (CO_2RE) program, expand the website to include material for schools, the general public and businesses that detail environmental and economic benefits of renewable energy and the process for installing systems
- Provide scholarships and funding to local educational centres to develop renewable energy training programs
- Work with the Edmonton Real Estate Board to certify Realtors on the use and interpretation of home energy performance labels
- Coordinate with agencies to facilitate hiring by businesses of technology students from renewable energy training programs.

Benefits:

- Provides education and capacity building components
- Helps shape citizen focus and create the opportunity for greater awareness
- Assists learning institutions in developing and delivering training programs

Explanation: Capacity-building ensures Edmonton has the human and technical resources needed to undertake this energy transition. Representative careers include trades (electricians, iron and steel workers, metal fabricators, machinists, sheet metal workers, welders), construction, labourers, electrical power line operators, installers and repair, technologists, and engineers (electrical, computer software). Pro-active investments to rapidly build this sector (similar start for fossil fuels in last century) is essential.

Background: A lack of understanding about renewable energy exists. Providing readily-accessible information for people to make informed decisions can make a difference. This would primarily include information on installed costs, energy performance, energy savings, how renewable energy works, and who supplies it.

With the rapid improvements in renewable energy technology, the increasing benefits for renewable energy resources are not widely known. Addressing this with timely information and support programs can move energy options into the mainstream.

Relationships: City with residents, businesses, academic institutions, labour market.

Importance: Foundational

Timeframe: Immediate, ongoing

Scale: Community, commercial, institutional

Complexity: Some (maintaining current and pertinent material)

Jurisdiction: Municipality can act alone

4.4 INITIATIVE: PARTNERSHIPS FOR RENEWABLE ENERGY POLICIES AND PROGRAMS

Alberta is an example of how the development of energy resources is possible when done in collaboration with neighbouring communities and other levels of government.

Action: Challenge and partner with neighbouring communities to co-ordinate requests for a range of progressive renewable energy policies to advance the commercial uptake of renewable energy in Alberta.

Benefits:

- Helps the Province of Alberta understand the economic and job development opportunities of renewable energy
- Helps other municipalities take their own steps towards renewable energy

Relationships: Province of Alberta, municipal governments in Alberta, Alberta Urban Municipalities Association, Alberta Association of Municipal Districts and Counties, Federation of Canadian Municipalities, Government of Canada

Example: Many examples of initiatives exist that could serve as the basis for collaborative partnerships such as the Red Deer County Biogas Project[59] and the City of Medicine Hat solar thermal electricity initiative.[60]

Importance: Strategic

Timeframe: Short

Scale: Community, municipal, provincial

Complexity: Much, (potentially significant competing barriers from several parties requiring integrated solutions and regulatory changes)

Jurisdiction: Municipality can act with other levels of government, to advocate and/ or collaborate

4.4.3 ENGAGE MUNICIPAL PARTNERS TO MAXIMIZE RESOURCES

Opportunity: Engage municipal partners to maximize resources and share successful programs

Benefits:
- Helps other municipalities take steps towards renewable energy
- Engages the funding and advocacy resources of other municipal groups

Explanation: The Task Force acknowledges the importance of Edmonton's regional partners in addressing our sustainability challenges. By developing complementary policies and actions, sustainability will benefit from co-ordinated action across the region.

Example: An economic strategy to cooperate with rural partners in developing renewable industries to supply the balance of renewable energy Edmonton will need to move toward 100%

Example: Mayor's Megawatt Challenge[61] in Toronto challenges municipal governments to pool energy managmenent knowledge and experience to achieve savings of at least one megawatt of electrical demand.

Context: Research shows that up to 20 per cent of Edmonton's electricity and 10 per cent of its heating requirements could be generated through renewables. As a result, Edmonton can act on its own to start its renewable energy initiatives. In order to exceed these values with renewable generation, Edmonton will need to form a variety of partnerships.

Relationships: The cities, towns, villages, municipal districts and Aboriginal reserves in the Edmonton Capital Region

Importance: Strategic

Timeframe: Immediate, short, medium, long

Scale: Community, municipal, provincial

Complexity: Some, much

Jurisdiction: Municipality can act with other governments to advocate or collaborate

[59] Red Deer County Biogas Project. www.ewmce.com/images/stories/PDF_Files/05-01R_November_2007.pdf

[60] Medicine Hat Solar Concentrating Steam Power Plant Project. www.hatsmart.ca/City%20of%20Medicine%20Hat%20Energy%20Projects/Solar%20Concentrating%20Steam%20Power%20Plant%20Project.asp

[61] The Mayors' Megawatt Challenge. http://trca.onlca/understand/programs-of-the-living-city/mayors-megawatt-challenge

4.4.4 ADVOCATE STRATEGIES AND FUNDING FOR RENEWABLE ENERGY DEVELOPMENT

Opportunity: Work with the Government of Alberta to create strategies and funding mechanisms (similar to that done previously for the oil industry) for the rapid development and smooth implementation of Alberta's vast renewable energy resources.

Benefits:

- Moves Alberta toward becoming a clean energy province
- Provides the Province of Alberta the social and political resources to take action on the economic and job development opportunities for renewable energy in Alberta.
- Engages the leadership and funding resources of the Province

Explanation: Alberta, with its wealth from bitumen deposits, has a significant opportunity to participate in the national and world renewable energy resource market. The government has already created a progressive electricitiy market, the structure of which may provide an evolving path to facilitate the increased use of renewable energy.

Examples:

- Develop a comprehensive Energy Efficiency Strategy leading to a suite of regulations, economic instruments, education and outreach, and collaboration with industry
- Provide funds to support public investment in renewable energy:
  - training for trades and technology
  - strategic renewable energy opportunities
  - create a significant "Renewable Energy Fund" from fossil fuel revenues as a public investment in renewable energy
- Alaska is using its fossil fuel revenues to create a quarter billion dollar "Renewable Energy Fund".

Context: Investment in research will drive technologies such as electrical power integration and management and storage. This investment would not only help Alberta clean up the grid electricity, but enable it to export products and skills to the booming global renewable energy industry. Provincial-scale resources can amplify municipal efforts and results.

Relationships: Government of Alberta, municipalities, municipal associations, renewable energy industries

5.0 EMPLOYMENT

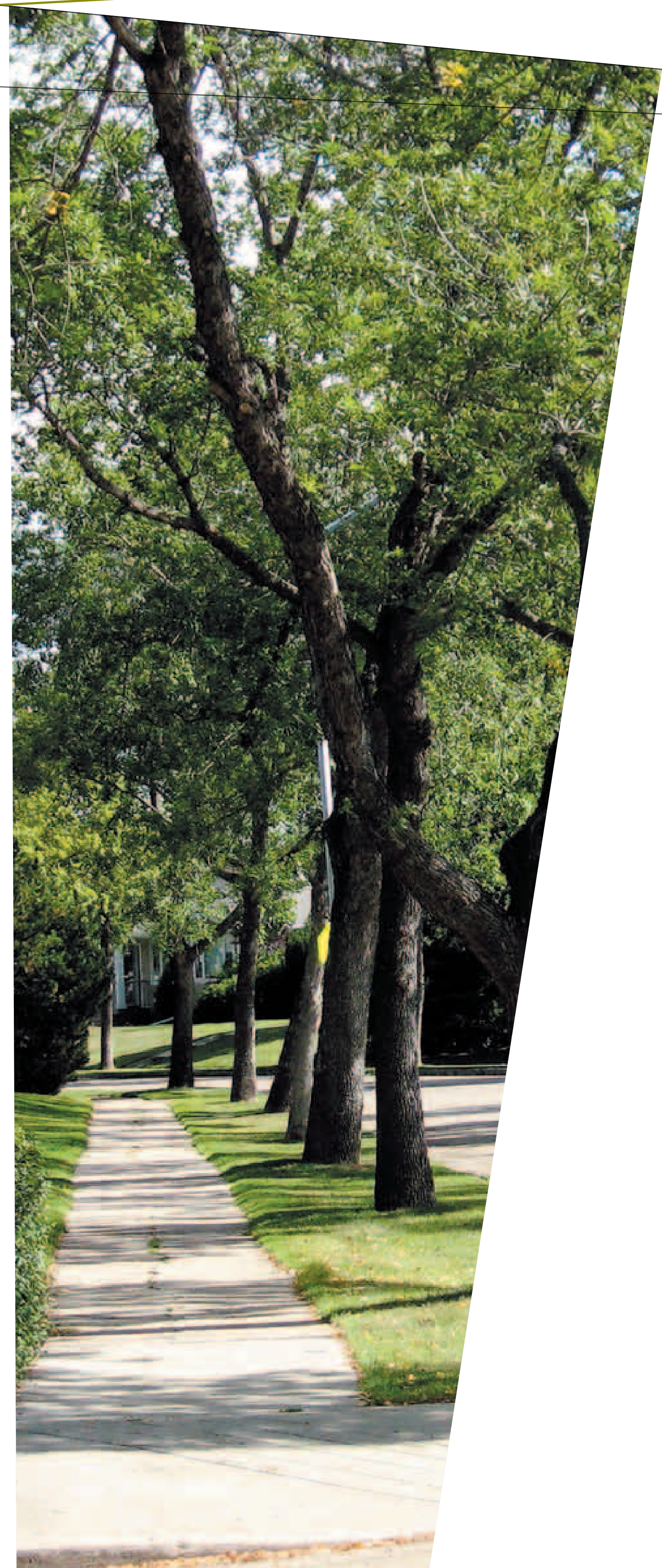
Research has shown that "… the pace of green job creation is likely to accelerate in the years ahead. A global transition to a low-carbon and sustainable economy can create large numbers of green jobs cross many sectors of the economy, and indeed become an engine of development. Current green job creation is taking place in both the rich countries and in some of the major developing economies."[62]

Pertinent for our local economy are studies that indicate a conversion from fossil fuel energy generation to renewable technology provides a net increase in jobs in all sectors of the renewable energy industry

- Research and development
- Manufacturing
- Renewable fuel production and supply
- System design
- Equipment installation
- Maintenance.

These jobs would strengthen and diversify Edmonton's economy.

Table 5 below demonstrates the comparative job creation in the various forms of energy generation.



[62] *Green Jobs: Towards decent work in a sustainable, low-carbon world*, September 2008, United Nations Environment Programme. http://www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf

Table 5. Comparative job creation per dollar of investment[63]

Energy Technology	Total Job-Years Per Gwh of Energy Generated	Job Creation Rank (Where 1 Is Highest)
Solar photovoltaics	0.87	1
Landfill gas	0.72	2
Energy efficiency	0.38	3
Small hydro	0.27	4
Geothermal	0.25	5
Solar thermal	0.23	6
Biomass	0.21	7
Carbon capture and storage	0.18	8
Wind	0.17	9
Nuclear	0.14	10
Coal	0.11	11 (tied)
Natural gas	0.11	11 (tied)

Local Industry & Employment

In 2005, the Canadian Solar Industries Association estimated that the entire solar energy industry could provide 60,000 jobs in the Canadian labour market by 2025.[64] With an as-yet fledgling industry finding its legs in Canada, communities can take measures now to become an early leader in this future energy industry, support post-secondary to provide the curriculum and attract tomorrow's jobs today. By supporting an early market for technologies and installation, cities can establish themselves as hubs for solar energy goods and service provision, exporting products, technical expertise, and labour skill to other municipalities, provinces and countries, generating revenue and business opportunity in the city.

Existing electricity and natural gas consumption sees consumers in Edmonton purchasing energy that is sourced mostly from outside of the city. Solar-electric and solar-domestic hot water systems installed in buildings in the city can each support local industries and jobs. Economically displacing energy consumption with solar electricity and solar domestic hot water means supporting locally-sourced energy, as well as local industries for research and development, manufacturing, construction, installation, operations, and maintenance of solar energy systems. In 2009, Canada's relatively small but developing solar-electric industry, with 95 MW of installed capacity and 62 MW installed in that year, directly employed 2,700 full-time labour place equivalents.[65] Other studies

[63] University of California Berkeley, "*Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?*", 2004, p.28. **http://rael.berkeley.edu/sites/default/files/very-old-site/renewables.jobs.2006.pdf**

[64] Ibid. at p. 8.

[65] Natural Resources Canada. "*National Survey Report of PV Power Applications in Canada*", 2010, pp. 7 – 8, 15. This includes jobs in research and development, manufacturing, distribution, dealing, retailing, installation, and consulting.

accounting for indirect and induced employment effects indicate up to 80 jobs per MW and even higher.[66] These numbers cannot be mapped directly onto the municipal context, as a substantial proportion of this total is manufacturing positions, which may not be created locally. Nevertheless, a significant local market for renewable energy, particularly one with some long-term stability, can encourage more local supply chain, manufacturing, distribution, and research and development activity.

In the absence of manufacturing, significant jobs can still exist for inherently local activities, like retailing, installation, maintenance, and private consulting work. Studies indicate that some subset of these activities employs up to 36 people per MW of installed generating capacity.[67] Again, these exclude indirect and induced employment effects, and include only certain, not all, inherently local industries.

Despite the difficulty pegging precise job creation numbers, it is clear that local renewable electricity will employ more people than conventional electricity — and certainly more people locally. Studies have indicated that, because of the high labour-intensity of solar energy projects and the higher capital-cost-intensity of fossil-fuel electricity generation, electricity generated by solar electricity creates eight times more job-years than the same amount of electricity generated by coal[68], and an investment in solar energy yields twice as many jobs as the same investment in coal energy.[69]

The indirect and induced effects are hard to measure, but important to consider. Indeed, anecdotal evidence from a North American model for the sort of program proposed in this report — Gainesville, Florida's program supporting local solar photovoltaic (PV) installations — points to a broad array of economic benefits. These include direct opportunities like new solar supply and installation companies and increased employment in the industry, but also less obvious indirect results like new professional business for financing and contracts, and solar installation advertising revenue for local media.

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[66] Canadian Solar Industries Association (CanSIA), "*Job Creation Potential of Solar*", 2005, p. 6. **www.cansia.ca/training-employment/archives**

[67] CanSIA, "*Job Creation Potential of Solar*", supra note 66, at p. 6.

[68] Daniel Kammen, Kamal Kapadia, Matthias Fripp, *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?*, 2004, pp. 2 – 3, **http://rael.berkeley.edu/sites/default/files/very-old-site/renewables.jobs.2006.pdf**

[69] Robert Pollin, James Heintz and Heidi Garrett-Peltier, *The Economic Benefits of Investing in Clean Energy: How the Economic Stimulus Program and New Legislation Can Boost U.S. Economic Growth and Employment*, June 2009, pp. 28 – 33.

6.0 IMPLEMENTATION

Edmonton is in the process of developing its long-term vision and progression with renewable energy. *The Way We Green* reports "Edmonton will encourage the growth of its renewable energy industry as an Energy City and leader in studying, testing, and adopting new energy technologies". The key strategy relevant to renewable energy is the creation of a City of Edmonton Energy Strategy.

As with any new paths, transitions, technologies and developments, new insights occur along the journey that may make the original steps seem out of place, but that could not have been gained without the original steps. This is the case with the development of energy strategies on any large scale. We expect that many unforeseen opportunities will open up once implementation of the renewable energy plan is begun.

We would encourage the City to take a "plan, do, learn" approach with such a progressive and major transition to renewable energy. This means:

- Make a plan to start on the transition;
- Get on with implementing the plan;
- Learn from the results of implementing the plan; and
- Modify the plan to get improved results.

Phasing of large changes can be an important strategy in achieving the end goal. Phases avoid deadlines that have a hard pass-fail feel to them, can be less threatening and allow activities to overlap as part of the transition.

Change is always disruptive. The above approach permits an orderly transition to the deep penetration of renewable energy in the City, allowing businesses the time and the policy certainty to develop appropriate business models to adjust to the changes. This provides the strong and appropriate leadership that Edmonton needs in this area. This takes into consideration present policies and ways of doing business, plus our need to change.

Excellent examples of implementation of renewable energy policies can be found in a number of peer municipalities, such as Medicine Hat, Vancouver, Dawson Creek, Halifax, Gainesville, Florida and many more.

All the opportunities cited in this report will require a detailed business case as a basis for approval and adoption by the City. Each business case will be tailored to maximise its benefits for the City of Edmonton.

APPENDIX A: ADDITIONAL OPPORTUNITIES TO INCREASE RENEWABLE ENERGY USE

Many opportunities exist for the implementation of renewable energy within a municipal context. Many more are emerging as municipalities around the world develop plans, strategies and programs that incorporate renewable energy. This appendix contains the balance of the inventory of recommendations identified by the Task Force as having potential for Edmonton. These examples are grouped under the initiative headings shown in Section 4.

A.1 INITIATIVE: PREPARE MUNICIPAL POLICIES FOR RENEWABLE ENERGY

Additional opportunities to prepare municipal policies for renewable energy include:

1. Renewable electricity for City operations
2. Edmonton Energy Code
3. Solar Access Law
4. Solar-ready buildings
5. On-site renewable energy requirement
6. Energy performance labelling of commercial buildings
7. Energy standards for existing commercial buildings
8. Linking renewable energy to energy efficiency
9. Renewable energy for City vehicle fleet

A.1.1 OPPORTUNITY: RENEWABLE ELECTRICITY FOR CITY OPERATIONS

Contract for the provision of up to 100 per cent low-impact renewable electricity for City operations

Benefits:
- Potential to reduce to zero the City's net emissions from its electricity consumption
- Provides leadership on achieving a net zero carbon footprint option by filling the gap for those residents and businesses not able to generate their own clean electricity
- Supports clean electricity generation beyond municipal boundaries
- Engenders civic pride as well as public sector employee pride

Explanation: The City has the ability to contract electricity purchase for government operations from several sources.
- Though this technically goes beyond City boundaries, as well as the scope of technologies considered by the Renewable Energy Task Force, the Task Force is recommending it as an additional way to drive the market as well as reduce net City emissions.
- This is especially important since Edmonton is not able to provide for all of its energy consumption within City boundaries even with the expansion of renewable energy technologies.

Examples:
- Calgary City operations, including its LRT and the well known "Ride the Wind" program, are powered by wind energy.
- The Province sources electricity from a combination of wind and biomass.

Timeframe: Immediate

Scale: Municipal

Complexity: None

Jurisdiction: Municipality can act alone

A.1.2 OPPORTUNITY: EDMONTON ENERGY CODE

Combine a number of codes, standards and programs into an "Edmonton Building Energy Performance Code".

Benefits:
- Becomes an envelope into which any similar codes and standards can be placed
- Provides a flexible, tailor-made Edmonton solution that is adaptable for the future

Examples:
- Britain's Code for Sustainable Homes[70]
- New York City's Energy Conservation Code[71]
- The Edmonton Energy Code could include, for example:
  - Municipal policies that specifically remove regulatory barriers to renewable energy systems
  - Policy that includes renewable energy on municipal buildings
  - Energy performance labelling for houses and commercial buildings
  - Energy and water consumption standard for existing houses
  - Energy consumption standard for existing commercial buildings
  - Solar access law
  - Solar ready buildings
  - On-site renewable energy generation requirements for houses and commercial buildings

Context: A municipality's work to enable desired behaviours is recognised by its citizens and others.

Relationships: Co-ordination with Edmonton's Green Building Strategy for maximum effect.

Timeframe: Immediate, short

Scale: Residential, community, commercial, municipal

Complexity: None

Jurisdiction: Municipality can act alone

A.1.3 OPPORTUNITY: SOLAR ACCESS LAW

Develop a solar access law for houses and buildings that ensures a number of hours of direct solar access per day in each month.

Benefits:
- Ensures the long term viability of existing solar systems by protecting the access to sunlight
- Encourages the consideration of future ramifications by property developers
- Clarifies a potential area of conflict among neighbours such as trees and developments
- Removes any restrictions against the use of solar energy by subdivision property covenants outside of zoning regulations
- Helps to simplify the mass-marketing of solar energy systems

Explanation: Solar access policies are designed to establish a right to install and operate a solar energy system on a property. Solar access laws can also ensure a system owner's access to sunlight. In some jurisdictions, access rights prohibit homeowners' associations, neighbourhood covenants and local ordinances from restricting a homeowner's right to use solar energy. The City can use several policies to prioritize and protect solar access including solar access ordinances, development guidelines requiring proper street orientation, zoning ordinances that contain building height restrictions, and solar permits.

Context: Consider including this in an Edmonton Energy Code.

There are at least 60 solar access laws in place in American states and municipalities. These laws vary in the technologies they cover as well as the breadth of the rights protected. Much legal work has been done in this area with many

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70 British Code for Sustainable Homes **www.communities.gov.uk/planningandbuilding/sustainability/codesustainablehomes**

71 New York City Energy Conservation Code. To meet the City's goal of reducing GHG emissions by 30% by 2030. Sets energy-efficiency standards for new construction and retrofits. **www.nyc.gov/html/dob/html/reference/nycecc_main.shtml**

examples of existing policies. A listing of these solar access laws can be found at the Database of State Incentives for Renewables and Efficiency.[72] Significant potentially useful research has been done by Edmonton lawyer Ronald Kruhlak in his ground-breaking solar access work.[73]

Relationships: Action on this opportunity can be independent of the other recommendations. Existing federal and provincial codes may restrict the ability of the City to establish certain solar access laws. Co-ordinate with Edmonton's Green Building Strategy.

Timeframe: Short

Scale: Residential, community, commercial, municipal

Complexity: Much, but not insurmountable

Jurisdiction: Municipality can act with citizens and businesses

A.1.4 OPPORTUNITY: SOLAR-READY BUILDINGS

Implement a requirement that houses and buildings be constructed to be ready for solar energy systems.

Benefits:
- Reduces barriers to the installation of solar energy systems in the near future
- Opens up the market for solar energy system to be easily installed as prices continue to drop
- Helps the building design, construction and ownership industries better understand what is needed for technically-viable solar energy systems

Explanation: A definition of "solar-ready" will be necessary for a policy to be effective. Reference to passive solar space heating, active solar water heating, process heating and/or electricity could be incorporated. The result could be incorporated into building codes and requirements of municipal permits.

Context: Consider including this in an Edmonton Energy Code.

Relationships: Co-ordinate with Edmonton's Green Building Strategy. This connects to other opportunities such as requiring a specified building energy performance and requiring a specified amount of on-site renewable energy production.

Timeframe: Short

Scale: Residential, community, commercial, municipal, industrial

Complexity: Some

Jurisdiction: Municipality can act alone

A.1.5 OPPORTUNITY: ON-SITE RENEWABLE ENERGY REQUIREMENT

Develop and implement a plan requiring a specified portion of house or building energy to be provided by on-site renewable energy

Benefits:
- Helps create an industry that can respond to the need for affordable renewable energy
- Uses renewable energy as a lever to increase the use of energy efficiency measures

Explanation: This arises from the groundbreaking planning policy developed in 2003 by the Borough of Merton in England[74]. This goes one step further than requiring buildings to be solar ready. It requires any new residential development of more than 10 units or any commercial building over 1000 m^2 to generate a minimum of 10 per cent of its energy consumption through on-site renewable energy technologies. This is the accepted definition by local (and regional) planning

[72] Database of State Incentives for Renewables and Efficiency (DSIRE) **www.dsireusa.org/summarytables/index.cfm?ee=1&RE=1**

[73] **Ronald Kruhlak**, *"A Legal Review of Access to Sunlight in Sunny Alberta"*, submitted to The Alberta Environmental Research Trust, 1981, 73 pp.

[74] The Merton Rule **www.merton.gov.uk/environment/planning/planningpolicy/mertonrule.htm**

authorities, academic institutions, trade and professional bodies, and the development, construction and engineering industries.

Reducing the energy consumption of a building through inexpensive energy efficiency measures also reduces the size of the renewable energy system needed to provide the 10 per cent of its energy consumption. This also bundles the economics of energy efficiency with the economics of renewable energy.

Context: Consider including this in an Edmonton Energy Code.

As houses are built, they are accompanied by new schools, supermarkets, shopping, malls, office buildings and leisure centres. It is essential that these heavy energy users also play their part in contributing to the renewable energy and emission strategies and targets.

Timeframe: Short

Scale: All buildings

Complexity: Some

Jurisdiction: Municipality can act alone

A.1.6 OPPORTUNITY: ENERGY PERFORMANCE LABELLING OF COMMERCIAL BUILDINGS

Review existing labelling standards for commercial buildings, establish a single standard, and apply this to new building construction in the City

Implement energy consumption labelling on all commercial buildings whenever they are built, sold or leased

Benefits:

- Increases the visibility of building energy performance when making business decisions, such as design, selling, leasing and renting
- Establishes a process that facilitates tracking of how building performance is changing
- Can be used to link renewable energy with energy efficiency

Context: Consider including this in an Edmonton Energy Code.

Relationships: BOMA, Natural Resources Canada's Office of Energy Efficiency and others. Co-ordinate through Edmonton's Green Building Strategy.

Timeframe: Immediate, short

Scale: Community, commercial, municipal, industrial

Complexity: Much

Jurisdiction: Municipality can act with businesses

A.1.7 OPPORTUNITY: LINKING RENEWABLE ENERGY TO ENERGY EFFICIENCY

Link the use of renewable energy technologies to the use of energy efficiency technologies

Benefits:

- Bundles the competitive economics of energy efficiency with the attractiveness of renewable energy to drive both strategies for reducing the production of emissions
- Gain additional understanding, interest, favour and buy-in for both energy efficiency and renewable energy
- Can use specific renewable energy policies to further promote the uptake of energy efficiency measures

Explanation: This opportunity shows several examples of where peoples' interest in using renewable energy can be used to incorporate energy efficiency to improve the economics of a project.

It leverages the positive response of citizens to renewable energy technologies to link them with the better economics of energy efficiency. The result is improved economics for renewable energy and improved attractiveness of energy efficiency, thus resulting in a stronger business case for both.

Context: Renewable energy technologies in urban settings hold more interest and intrigue with the general public, however, energy efficiency typically provides the greater economic return.

Consider including this in an Edmonton Energy Code.

For renewable energy technology incentives, incorporate mandatory efficiency actions/investments as part of qualifying criteria. *e.g.* for the Solar Electric Pilot, require applicants to examine their efficiency opportunities first, such as with appliances, lighting and motors

Timeframe: Short/medium

Scale: All scales of applications

Complexity: Some

Jurisdiction: Dependant on the specific policies

A.1.8 OPPORTUNITY: RENEWABLE ENERGY FOR CITY VEHICLE FLEET

To support the City's approach to the use of renewable energy in its fleet as per *The Way We Move* page 91, "Assessing green technology opportunities and using the technology when appropriate."

Benefits:

- Potential to reduce emissions from City fleet
- Support market and industry for renewable fuels in Edmonton

Background: Energy consumption and emissions associated with the City's vehicle fleet presents another angle with which to reduce fossil fuel reliance. The City signed an agreement with Enerkem Green Field Alberta Biofuels to build a facility to produce 36 million litres per year of methanol then ethanol from municipal solid waste. The ethanol could be blended with gasoline to meet Federal and Provincial requirements or used as an unblended fuel. Depending on the route taken to access the blended fuel, additional future investment in fuelling infrastructure could be needed.

Context: Vehicles operating with clean energy include fuel cells using renewable energy, plug-in electric vehicles operating on renewable electricity, ethanol, and bio-synthetic gas (bio-syngas). Renewable electricity is presently available from a number of technologies and sources. Bio-syngas will be available from Enerkem's facility currently under construction.

Relationships: There may be opportunities to work with the Alberta government to increase the standards for renewable fuels and help to grow the market

Timeframe: Phased in as vehicles are changed out and fuel availability and standards develop

Scale: Municipal

Complexity: Much

Jurisdiction: Municipality can act alone

A.2 INITIATIVE: PROVIDE A STRONG ECONOMIC PLATFORM FOR RENEWABLE ENERGY

Several additional opportunities were identified by the Task Force to provide a strong economic platform for renewable energy. As can be seen by many other renewable energy initiatives around the world, these can take many forms, including codes, standards, regulations, recommendations, training, and financial incentives.

These include:

1. Property Taxation
2. Property-Assessed Clean Energy Financing (PACE)

A.2.1 OPPORTUNITY: PROPERTY TAXATION

Reduce or eliminate the additional property taxes that are incurred by a property owner who installs a renewable energy system and faces an increased property valuation.

Benefits:
- Eliminates or reduces an economic disincentive to installing a renewable energy system
- Encourages renewable energy system owners to go through the existing permit processes by which the City can track the development of the systems and obtain accurate information about the growth of renewable energy in the City
- Shows the City's leadership in directing funds to achieve environmental goals

Explanation: Presently a renewable energy system is treated by the City Assessor and Taxation division as a property improvement and taxed as such.

Context: Numerous jurisdictions presently exempt renewable energy systems from property taxes. Thirty-five American states have such policies along with many municipalities. The policies vary in the number of technologies and sectors which are included. Most policies exempt 100 per cent of the value.

Example: California Property Tax Exclusion for Solar Energy Systems [75]

Relationships: May require work with the Municipal Government Act and the manner in which property is assessed and taxed.

Timeframe: Immediate, short

Scale: Residential, commercial

Complexity: Much

Jurisdiction: Municipality can act with another level of government, to advocate or collaborate

A.2.2 OPPORTUNITY: PROPERTY-ASSESSED CLEAN ENERGY FINANCING (PACE)

Establish a property-assessed energy financing mechanism to allow property owners to access low-interest city-backed financing for energy projects involving renewable energy and energy efficiency

Benefits:
- Up-front costs are eliminated and instead spread over the duration of the financing period
- Uses a broad source of private capital, not taxes, utility bills, or government incentives
- Creates either a positive cash flow for system owners or a lower negative cash flow depending on the size and type of project funded
- Lower loan interest rate because it uses the City's borrowing power, which reduces the end-cost to the system owner
- Reduced credit risk
  - financing is secured solely by the property assessment payments through the City's property taxation ability
  - improved cash flow makes it easier for owners to pay loans
- Voluntary participation — building owners opt-in if they decide that benefits warrant it
- Broad applicability — can apply to residential and commercial properties
- The responsibility for loan repayment transfers with the property title upon sale — the new owner benefits from improvements that stay with the property

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[75] California Property Tax Exclusion for Solar Energy Systems
www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA25F&re=1&ee=0

Explanation: Property-assessed clean energy financing, variously using local improvement charges (LIC), Property-Assessed Clean Energy (PACE) bonds,[76 77 78] or Property-Assessed Payments for Energy Retrofits (PAPER)[79] significantly increase the ability of private sustainable energy projects to be financed. The financing is accomplished using lower-interest long-term loans that result from municipal borrowing power. The loan is repaid through an assessment on the owner's property taxes for the duration of the loan.

Using the City's borrowing power and property taxation to facilitate property-assessed energy financing can be justified because the projects that are financed meet a valid public purpose — i.e. the reduction in greenhouse gas emissions and the increase in sustainability and resiliency of energy supplies.

Context: Upfront costs are the primary barrier to investment in renewable energy systems or energy efficiency upgrades. When the savings on energy costs are greater than the loan payments then issues of long payback and low return-on-investment are no longer economic barriers because the investment is self-financing. Low-interest loans such as from property-assessed energy financing programs provide significant advancements in achieving this.

Examples:

- PACE programs have been successfully operating in America for the last three years. A review of 2,500+ PACE projects shows that PACE programmes have reduced default rates, generate significant income and tax revenues, and create negligible exposure for mortgage holders. They have been shown to generate $60,000+ per home in economic activity and tax revenues.
- Sonoma County in California is a good example of a well-crafted, successful PACE program.[80]
- Vancouver is actively working to launch a program.[81]
- Halifax' Solar City program is funded by property-assessed financing.[82]

Relationships: The implementation of this opportunity may be predicated on the adoption of local improvement charges for community and private structures. Work with the Alberta government and other municipalities to permit the use of Property-Assessed Clean Energy bonds to finance renewable energy systems on private buildings.

Timeframe: Immediate, short

Scale: residential, commercial

Complexity: much

Jurisdiction: municipality can act with another level of government, to advocate or collaborate. It is not clear whether there are any provincial regulations that might be that would restrict this.

76 PACE Now **http://pacenow.org/blog**

77 BC Sustainable Energy Association, "PACE Bonds — An Innovative Approach to Energy Efficiency Financing", **www.bcsea.org/get-involved/events/2010/07/07/pace-bonds-innovative-approach-to-energy-efficiency-financing**

78 Renewable Funding's list of documents on PACE programs in America **https://www.renewfund.com/resources/resources**

79 **David Suzuki Foundation**, *"Property-Assessed Payments for Energy Retrofits: Recommendations for Regulatory Change and Optimal Program Features"*, 2011 March, 50 pp.

"Property Assessed Payments for Energy Retrofits and Other Financing Options", 2011 May, 64 pp.

www.davidsuzuki.org/publications/reports/2011/property-assessed-payments-for-energy-retrofits

80 Sonoma County's Energy Independence Program **www.sonomacountyenergy.org**

81 Imagine 2020, Vancouver Green Capital **www.bcsea.org/sites/default/files/PACE_Ramslie.pdf**

82 Halifax Regional Municipality Community Solar Project **www.halifax.ca/solarcity**

A.3 INITIATIVE: PROVIDE LEADERSHIP IN RENEWABLE ENERGY

Several additional opportunities also support the initiative to provide leadership in the use of renewable energy. These include:

1. Technology Demonstration
2. City Centre Redevelopment
3. Edmonton's Renewable Energy Sector Profile

A.3.1 OPPORTUNITY: TECHNOLOGY DEMONSTRATION

Develop a city- or community-owned facility to house an on-going demonstration of several readily-available renewable energy technologies

Benefits:

- Clearly communicate to citizens what the technologies are, what they look like, how they work, how much they cost, what options are available
- Demonstrate leadership and confidence in the technologies to the citizens of Edmonton
- Creates showcase projects for outreach and advocacy
- Provides an opportunity to engage the public's attention over a long period of time
- Provides valuable performance data for technologies within the city
- Provides a location to update technology as it changes

Explanation: Most people's lack of experience with renewable energy technologies is a significant barrier to the successful implementation of using them. Valuable learning is gained with the "touch and feel" approach, in seeing actual equipment, its size and operation.

Examples: Several examples exist for such a facility:

- The City Centre Lands redevelopment
- partnerships in both research and education with post-secondary education institutions such as NAIT, UofA and Grant MacEwan University
- Edmonton Space and Sciences Centre, because it is explicitly set up to attract and educate crowds of people of all ages including school programs

Timeframe: Immediate, short

Scale: Residential, community, commercial

Complexity: None

Jurisdiction: Municipality can act alone

A.3.2 OPPORTUNITY: CITY CENTRE LANDS REDEVELOPMENT

Use the City Centre Lands redevelopment project to pilot, demonstrate and showcase future sustainable technologies and programs (renewable energy, energy efficiency, water efficiency, transportation).

Consider setting up a Centre of Excellence for Sustainable Communities as part of the showcase.

Benefits:

- Provides a strong culture-setting legacy for the City for the next 30+ years, similar to how the waste management centre has firmly established Edmonton's culture regarding recycling and composting
- Increases Edmonton's identity as a bold, innovative, progressive place to live and work
- Places Edmonton on the global renewable map along side Freiburg Germany's Solar City
- Demonstrates exemplary solutions to all Albertans
- Provides valuable performance data for technologies within the city
- Exposes barriers to the deep penetration of renewable energy into a community and provides motivation to find the technologies, methods, processes, and relationships to resolve them

Explanation: Many cities utilize visible public projects to define a municipal identity and inspire replication. The City Centre Lands redevelopment is a highly visible project deeply tied to the image and identity of Edmonton and a significant opportunity to express and influence the core values of city residents. It is an opportunity to fundamentally demonstrate what a 100 per cent renewable energy community could look like. It is the test case for Edmonton in how to make a City sustainable, showcasing all the emerging environmentally-important factors that will make it sustainable.

Examples:

- Toronto erected the first urban-sited wind turbine in Exhibition Place and it has become a feature of its skyline, which has inspired among other things including Ontario's Green Energy Act.
- Freiburg Germany's Solar City.

Relationships: As with all renewable energy technologies and programs, this may be more economically viable if funding sources from a feed-in tariff, financing from PACE bonds, and the opportunities with solar access for community groups as well as incorporating renewable energy on city buildings are implemented.

Timeframe: Short, medium, long

Scale: Residential, community, commercial, municipal

Complexity: Much

Jurisdiction: Municipality can act alone

A.3.3 OPPORTUNITY: EDMONTON'S RENEWABLE ENERGY SECTOR PROFILE

Create a complete information source on renewable energy in Edmonton

Benefits:

- Showcase Edmonton's renewable energy industry and prowess to the world
- Supports the growth of Edmonton's renewable energy industrial cluster
- Provides a tool for citizens similar to Vancouver's advanced energy sector profile[83] and Calgary's[84] sustainable and renewable energy profile
- Dispels mis-information about renewable energy industry and market activities
- Supports innovative companies, projects and research
- Help connect potential customers to providers
- Profile Edmonton as an innovative and sustainable city
- Increases interest in renewable energy in Edmonton
- Strengthens the City's relationship and communication with the local renewable energy industries
- Increases the profile of renewable energy companies midst the ocean of competing energy companies

Examples: The sector profile could contain, for example:

- listing of companies
- case studies showing examples of technologies being used
- market and development opportunities available

[83] Vancouver Economic Development Commission's Green Tech website, including green tech map, green building sector profile, advanced energy sector profile
www.vancouvereconomic.com/page/green-economic-development

[84] Calgary Economic Development's SUstainable and Renewable Energy (SURE) Cluster Directory
www.calgaryeconomicdevelopment.com/key-industries/sustainable-and-renewable-energy/sure-cluster

- statistics showing the growth of the market and industry
- the policies, associations, agencies and programs that support renewable energy
- renewable energy training centres
- Inventory of renewable energy assets and feedstock availability (solar, wind, biomass, biogas, bio-methane)
- could be expanded to include other sustainable energy technologies such as energy efficiency and enabling technologies
- could be expanded to include a wider region around Edmonton

Context: Calgary and Vancouver have their own profiles.

Timeframe: Immediate, short, medium

Scale: All

Complexity: None

Jurisdiction: Municipality can act alone

A.4 INITIATIVE: PARTNERSHIPS FOR RENEWABLE ENERGY POLICIES AND PROGRAMS

Several additional opportunities support the initiative to partner with neighbouring communities and other levels of government for the purpose of developing stronger cases for policies and programs that facilitate the development of the renewable energy sector. These include:

1. Upgraded building code performance
2. Business model for energy efficiency
3. National Database of Municipal Energy Actions
4. Utility billing system energy pricing
5. System installer standards
6. Ultra-low interest green energy loans

A.4.1 OPPORTUNITY: UPGRADED BUILDING CODE PERFORMANCE

Support the Alberta Government in moving the building code to an EnerGuide 80 for new houses in 2012 as a short-term tactical goal.

Support the Alberta Government moving to the next tactical goal of EnerGuide 86 by 2015 and moving to the further tactical goal of net-zero-energy house by a date such as 2020.

Benefits:

- Upgrades the new home building stock to a level that is cost-effective over the life of the house
- Provides a platform where the next justifiable energy additions to the house will be renewable energy systems
- Works with house energy performance labelling to bring the importance of energy performance into house decision-making.

Explanation: Energy performance standards and codes need to have their levels set higher as the industry starts to easily achieve the previous level. In this way the industry is drawn step by step to the end goal.

Though this is initially focussed on energy efficiency, it provides another linkage into renewable energy.

Context: EnerGuide 80 is the approximate rating for an R-2000 energy efficient house. It was a leading-edge energy efficiency standard, but is now common-place and can easily be exceeded. Though renewable energy can be added to houses at any point, EnerGuide 86 is roughly the level at which renewable energy needs to be added in order to obtain higher ratings. A net-zero energy house or building is one that generates all of its own heat and electrical energy on an annual basis.

Some house-building companies in Edmonton are building almost exclusively EnerGuide 86 houses. There are eight net-zero energy houses in Edmonton today. The vision of the Net-Zero Energy

Home Coalition is for all new house construction to meet net-zero energy standard by 2030.

Experience has shown that an EnerGuide 86 house typically costs $15,000 to $25,000 (before incentives) more than standard construction and provides utility energy savings of 65 per cent.

The Alberta government presently has a significant rebate of $1,500 for new homes that achieve EnerGuide 80, $3,000 for EnerGuide 82 and $10,000 for EnerGuide 86. The City of Medicine Hat provides matching incentives through their innovative Hat Smart program (www.hatsmart.ca).

Relationships: This opportunity works well with the home energy labelling

Timeframe: Immediate, short

Scale: Residential

Complexity: Much

Jurisdiction: Municipality can act with another levels of government to advocate or collaborate

A.4.2 OPPORTUNITY: BUSINESS MODEL FOR ENERGY EFFICIENCY

Work with utility companies and the Alberta government to develop and facilitate a business model in which electric and natural gas utility companies profit on selling less grid energy through the use of renewable energy and energy efficiency measures

Benefits:
- Includes all the benefits of energy efficiency
- Includes all the benefits of on-site renewable energy
- Maintains competitive business models
- Increases sustainability of energy utility companies
- Reduces the risk of lost utility revenue due to renewable energy and energy efficiency programs, and to changing customer priorities
- Eases pressure on governments for incentives to clean up existing grid-energy resources
- Provides Alberta with a broad sustainable renewable energy and energy efficiency policy

Explanation: The profits from energy utility companies are currently derived from selling more energy rather than less. There is no profit-based incentive for energy utility companies to assist their customers in using less energy. A new collaborative business model is needed, crafted by all stakeholders — government, energy production industries, energy consumption industries and municipalities — whereby the reduction of energy consumption and the substitution to clean renewable energy becomes the business model.

Context: The need to reduce the emission of greenhouse gases and other pollutants plus the interest in reducing exposure to volatile energy prices and energy supply issues is putting some energy companies into a difficult position, much like tobacco-product manufacturers, where there emerges pressure for them to sell less of their product rather than more. As a result, it can appear that the companies are generally resistant (not officially of course) to customer-owned renewable energy and to energy efficiency because these technologies compete with their ability to sell their energy products. The consequence is that in jurisdictions without strong government leadership, energy efficiency and demand-side management programs have not flourished.

Relationships: Alberta government, municipal government, energy production industries, energy consumption industries, environmental groups, media

Business case: Enabling long-term sustainable energy development and transitioning to it using our present fossil fuel energy as the springboard and lever

Timeframe: Medium, long

Scale: All

Complexity: Much

Jurisdiction: Municipality can act with another level of government, to advocate or collaborate

A.4.3 OPPORTUNITY: NATIONAL DATABASE OF MUNICIPAL ENERGY ACTIONS

Advocate to the Federation of Canadian Municipalities that a national on-line database of municipal actions on renewable energy be developed

Benefits:

- Easily permit municipal leadership, administration staff and the public to be inspired by the innovation of other municipalities so as to more strongly develop their own actions
- More clearly appreciate what actions work and what don't for municipalities that are of a similar size and scope
- Improve upon what other municipalities are doing
- Share the ideas that are arising within many municipalities
- Strengthen confidence in adopting actions
- Provide solid leadership and additional justification for municipalities as they seek to develop their own actions

Explanation: A central database, such as hosted by the Federation of Canadian Municipalities with its strong advocacy and funding role, is needed to show the actions that municipalities are taking across Canada regarding the development and implementation of plans, policies, strategies and programs focussing on renewable energy, sustainability, resiliency, energy efficiency and greenhouse gas emission reductions. This could be based on a self-editing structure in order for municipalities in Canada to easily add and up-to-date information, details, documents, case studies, outcomes, performance information, photos, and recommendations about these actions. The American Database of State Incentives for Renewables and Efficiency [85](DSIRE) is an example of this.

Timeframe: Immediate

Scale: All

Complexity: None

Jurisdiction: Municipality can act with other organizations

A.4.4 OPPORTUNITY: ENERGY PRICING ON UTILITY BILLS

Work with the electric and natural gas utility companies, the Alberta government and the Alberta Utilities Commission to develop a utility bill tariff based solely on energy consumption and not on fixed charges

Benefits:

- Provides a 40 – 60 per cent higher energy price signal to residential customers
- Makes utility energy bills very easy to understand
- Helps consumers recognize the full benefit out of their actions in reducing the consumption of grid energy — either by using renewable energy, by being energy-efficient or through any combination of both
- Average-consumption customers will not see a change to their bill. Customers that use less than average will see their energy bill reduced and thus rewarded; customers that use more than the average will see their bill increase and thus incented to change.

[85] Database of State Incentives for Renewables and Efficiency (DSIRE), 1400 pages summarising American initiatives for renewable energy, **www.dsireusa.org**

- Permits people to reduce their bills to zero based on their use of renewable energy and energy efficiency
- Improves the economic return on investment and reduces payback times for renewable energy and/or energy efficiency by 41 per cent (electricity) and 63 per cent (natural gas) (e.g. from a 20-year payback to a 6-year payback)
- Significantly reduces the price gap between grid-energy and renewable energy using an existing characteristic of utility bills
- This is only a change in price; there is no change required in the metering, meter data management or billing processes.
- There is no change in revenue to the Energy Retailers or the energy delivery companies. Any future change in revenue is a function of peoples' responses to the energy pricing, not the conversion process.
- The conversion to the new process can be easily implemented in stages in the same way that the Alberta government implemented the conversion, over five years, of Regulated-Rate-Option electrical energy pricing to 100 per cent based on the spot market price.
- Helps utility companies show that through their billing process, they are contributing to helping people make positive changes in their energy consumption and thus emission reductions.
- Helps link renewable energy to energy efficiency as a combined message for customers

Explanation: The "fixed" fees (which are based on the amount of time connected to the grid) are converted into an equivalent "variable" price (which is based on the amount of energy consumed) and based on the average consumption in each rate class so that the utility bills are based strictly on energy consumption. The fixed fee is eliminated and the energy price increases. For residential customers the energy price will be 41 per cent (for electricity) and 63 per cent (for natural gas) higher than at present. The conversion is applied internal to each rate class so that rate classes are handled independently from other rate classes.

Context: A significant portion of residential electricity and natural gas bills are "fixed" and do not reflect the amount of energy that a customer uses. The present configuration of our electricity and natural gas bills is a reasonable way to charge for both fixed and consumption-based expenses incurred by utility companies based on past policies of economic development.

Consumers receive no reduction to the fixed fees by reducing their grid-energy consumption through energy efficiency or renewable energy.

Relationships: All consumers of electricity and natural gas and all energy retailers and energy delivery utilities. This may have more of an effect on homeowners than businesses due to relative amounts of bills that are based on the fixed vs. energy costs.

Timeframe: Immediate, short

Scale: Can apply to all, but would likely have the most effect on residential and community

Complexity: Complex

Jurisdiction: municipality can act with another levels of government to advocate or collaborate

A.4.5 OPPORTUNITY: SYSTEM INSTALLER STANDARDS

Work with the trades-training industry to strengthen the training, certification and enforcement of qualified trades

Benefits:
- Higher quality project installations
- Stronger training courses, trades certification standards and better inspection of installed systems

- Greater consumer and business confidence in the performance of renewable energy systems
- Ability to offer trades training online and around the world to support the renewable energy industry's growth
- Inspires training in design and marketing sectors

Results: The opportunity is for the City's goals with renewable energy to act as motivation to work with groups such as Alberta Municipal Affairs, NAIT, the Canadian Standards Association and industry and trade associations to ensure that training and certification standards are in place for trades and inspectors in the renewable energy technologies.

Context: An owner's experience with a renewable energy system is a function of the quality of the equipment, the design, the installation and the promotion. Quality installations are a significant aspect of this varies widely across companies and regions and is strongly needed as the industry rapidly grows, which attracts many unqualified people.

Example: Canadian Standards Association is developing a solar-electric standard for construction-electricians.

Timeframe: Immediate

Scale: All

Complexity: Some

Jurisdiction: Municipality can act with other organisations and the Alberta government, to advocate or collaborate

A.4.6 OPPORTUNITY: ULTRA-LOW-INTEREST GREEN ENERGY LOANS

Work with the Federation of Canadian Municipalities, Canada and Alberta governments, and banks and credit unions to develop deep-discount loan programs for renewable energy systems

Benefits:

- Removes a significant barrier to expansion in the renewable energy market and its supplying industries
- When coupled with the rapidly falling prices of renewable energy, this has the potential to remove any issue with payback times because then the energy savings can pay back the loan.
- Potential to be a strategic national policy to enable all people and businesses to cost-effectively reduce their energy emissions with a combination of leveraged private money and bank capital

Explanation: The key is to reduce the cost of investment in renewable energy technologies. Bank capital has the ability of setting its loan amounts as a multiple of the amount on deposit. This multiple has the potential of being increased in order to facilitate the development of ultra-low interest green loans.

Context: Financing of renewable energy systems is a significant barrier. Interest rates can easily block important renewable energy projects because they cause the economics to not be sufficiently attractive.

Deep-discount loan interest rates of less then two per cent have the potential to rapidly expand the use of renewable energy because the dropping prices of renewable energy systems are approaching the point where the energy savings can pay off the loan. This reduces the issue with payback times.

Business case: Accelerate enabling the benefits of renewable energy and of energy efficiency

Timeframe: Short

Scale: All

Complexity: Much, based on how people understand loans to be created

Jurisdiction: Municipality can act with another level of government, to advocate or collaborate

APPENDIX B: TERMS OF REFERENCE OF THE RENEWABLE ENERGY TASK FORCE

1. MANDATE

The Edmonton Renewable Energy Task Force will undertake the research, preparation and delivery of a report to the City of Edmonton examining key opportunities and the technical, economic, resource and policy barriers to renewable energy generation and use. The report will make recommendations for action in the short, medium and long term to advance the adoption of renewable energy technologies.

The initial scope of renewable energies to be considered will not be limited; however the Task Force should, early in the process, make general recommendations on renewable energies that have potential in the longer term and focus efforts on technologies that have technical and economic feasibility for implementation in short to medium term.

Recommendations should be made to the appropriate authority, government order or other organization.

2. GOAL AND APPROACH

The goal of the Task Force is to increase awareness and adoption of renewable energy generation, use and purchase in the City of Edmonton by all its citizens, its businesses and by the City municipality. Underlying the research and discussion is an understanding of the potential gains from efficiency improvements in all areas of energy use.

Supporting activities to achieve the goal could include:

- Create a comprehensive and comparative list of viable renewable energy technologies that shows their relative impacts, costs, return on investment, and timelines for implementation in Edmonton;
- Establish criteria for selecting technologies that can be adopted in Edmonton in the short to medium term;
- Identify technologies that match these criteria and focus on those;

- Identify current activity, additional opportunities and barriers to the pursuit of these selected renewable energies in the educational, commercial, industrial and residential sectors within Edmonton;
- Prepare recommendations for action that can take advantage of the opportunities and remove these barriers;
- Be mindful of immediate (within one year) short (one to ten years), medium (ten to 30 years) and long term (beyond 30 years) solution options, potentially establishing transition steps to address an issue immediately and for conditions in future;
- Utilize the local, national and international work and expertise of municipalities, academic institutions and industry for the broadest inventory of options;
- Establish baselines for elements to be measured and targets for improvement;
- Organize recommendations based on target owner. Where jurisdiction lies outside of the City of Edmonton, employ appropriate advocacy. Potential recommendations might include:
    - i. Create a "user friendly" microgeneration approval application and implementation process;
    - ii. Ensure the economic stories are told such as building skills locally and generating wealth for municipalities;
    - iii. Bylaw revisions would be addressed to City Administration;
    - iv. Legal clarification on solar access, wind and geothermal would be addressed to the appropriate level of government;
    - v. Loan program for retrofitting homes and businesses (various levels of government and financial institutions);
    - vi. Training program to increase the number of certified tradespeople for renewable technologies (NAIT), and upgrading courses for design professionals (BOMA, University of Alberta);
    - vii. Develop facilities to demonstrate renewable energy technologies in conjunction with energy efficiency technologies, and
    - viii. Develop highly-visible opportunities for well-known leaders in society to show leadership to people.
- Prioritize programs considering effectiveness, timeliness, aesthetics, return on investment, benefits to air, land and water, sustainable development, employment and other economic development, effect on social change, energy security and climate change mitigation;
- Recommend approaches to advocacy for issues identified that require authority from other orders of government or commercial action.

3. DELIVERABLES

The Edmonton Renewable Energy Task Force will deliver the following:

- A comprehensive report to the City of Edmonton on issues and possible solutions to advance the success of Renewable Energy generation;
- A list of benchmarks against which progress can be tracked, some examples could include:
    - i. % of total heat met with renewable energy broken down by residential and commercial;
    - ii. % of electricity met with renewable electricity;
    - iii. total of roofs with solar energy systems;
    - iv. renewable electricity generation per capita;
    - v. value of investments in renewable energy companies;
    - vi. total renewable energy captured, and
    - vii. Include recommendations to positively impact the engagement of citizens in programs and practices.
- Identify and quantify the benefits and risks of each recommendation;
- Provide detail for the structure of potential programs including options, baseline, mapping requirements and target success measures;
- Commentary that broaches issues and solutions in the mandated areas for residential, commercial, municipal, education and industrial;
- Author position papers that clarify and promote the stance of the City of Edmonton on various elements of renewable energy and micro-generation, and
- Provide input and advice on the City of Edmonton Renewable Energy Pilot Program.

4. PROCESS

An inventory of concerns already exists within the City's administration related to land use planning, regulations, finance, and qualified labour. These, and additional issues will be researched by the Task Force to generate an overall understanding of challenges for consideration.

Based on a series of criteria to be established by the Task Force, each issue and potential solution(s) will be evaluated to establish potential and priority. These criteria could include but are not limited to:

- Opportunities;
- Jurisdiction;
- Cost of the barrier in all relevant impact types (financial, reputation, carbon footprint, etc.);
- Nature of possible solutions;
- Sustainability and the triple bottom line: economic, environmental and social;
- Opportunities for other cleaner (than status quo) options that exist within Edmonton city limits (eg. gas fired cogeneration, gas fired district energy) and ensure that recommendations do not work counter to promoting these options;
- Potential timeline progress through pilot, short-, mid- and long-term;
- Potential for wealth generation;
- Solution cost estimates scaled (pilot to mass implementation), and
- Estimated benefit, scaled and including all relevant impact types.

The Task Force must test all recommendations against this definition

Renewable Energy relevant in an urban setting is energy generated from natural resources including direct solar radiation, wind, flowing water, biomass, biogas, geothermal heat and waste heat/waste energy all of which are naturally replenished within a person's typical lifetime.

5. SCOPE / JURISDICTION

This task force will limit itself to issues, process, law and bylaw, tools and information specifically involving renewable energy as it does or will pertain to geographical and political boundaries. Where issues move beyond jurisdictional boundaries, advocacy may be the recommendation.

6. MEMBERS AND MEETINGS

The Task force members have been identified through referrals, recommendations and within the staff of the City of Edmonton.

- A group of no less than eight and no more than sixteen members (as volunteers) will make up the task force at any one time. No fewer than three City of Edmonton staff will be among these members.
- Task Members represent at least one of the following categories: City of Edmonton Administration, Commercial interests, Residential Interests, Academic/Research, Related Industry, Legal, Engineering, Environment, Economics, Renewable Energy, and the utility sector.
- Task members are appointed for the entire assignment period of the Task force of twelve months beginning with the inaugural meeting on June 23, 2010
- Following the completion of the mandate, the Task Force will dissolve. Potentially, a new Task Force would emerge with a unique focus.
- Meetings will occur monthly at a minimum, and more frequently as necessary.
- Minutes will be made available upon request by Administration.
- Public engagement will be included in the schedule of events for the Task Force.
- A Communication Strategy will seek opportunity for providing transparency, influence and leadership to Task Force activities.

7. STRATEGIC ALIGNMENT

All recommendations advanced will align with City's Strategic Plan, The Way Ahead.

Goals:

a. Preserve and Sustain Edmonton's Environment
b. Improve Edmonton's Livability
c. Transform Edmonton's Urban Form
d. Shift Edmonton's Transportation Modes
e. Diversify Edmonton's Economy
f. Ensure Edmonton's Financial Sustainability

Principles:

a. Integration of planning with energy solutions
b. Sustainability
c. Liveability
d. Innovation

8. MEMBERS — SEE APPENDIX C FOR NAMES AND PROFILES

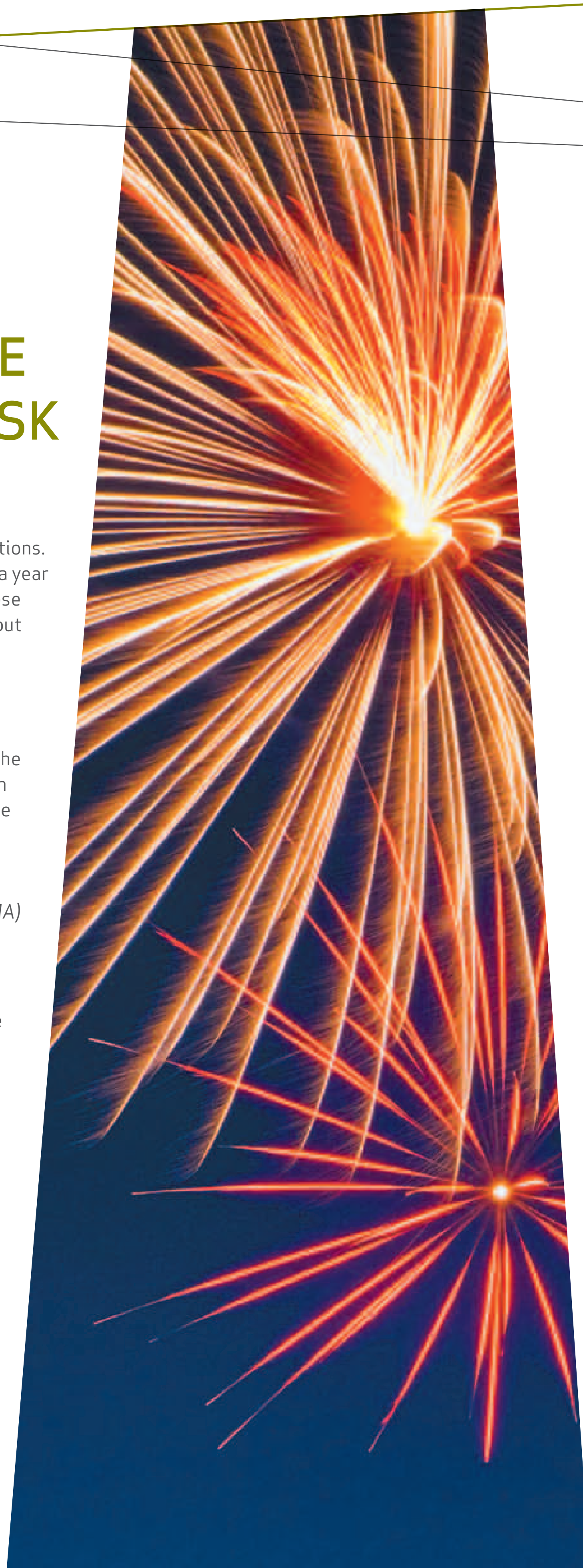
9. COMMITTEE RESOURCES

a. Committee facilitation, administration and support will be provided by the Office of Environment, Urban Planning and Environment branch
b. Expertise for other areas of the City Administration will be accessed as necessary to support research and discussion.

10. GOVERNANCE

a. The Task force will report to the City of Edmonton Administration
b. Corporate Leadership Team (CLT) will review and approve Task Force
c. A final report will be provided to City of Edmonton CLT
d. CLT will provide the final report to City of Edmonton Executive Committee with an accompanying report which will:
    i. Provide a review of the Task Force recommendations
    ii. Options for implementing recommendations provided to the City of Edmonton
    iii. A plan for conveying Task Force recommendations directed at other orders of government, institutions or organizations.

APPENDIX C: MEMBERS OF THE RENEWABLE ENERGY TASK FORCE



The Task Force members represented a range of stakeholder organizations. The recommendations for this report were generated from more than a year of monthly meetings, discussion papers and guest speaker events. These solutions for the City of Edmonton would not have been possible without the effort, creativity and wisdom of these professionals.

Bassil Bassil

Manager, Commercial Credit, TD Commercial Banking.

Bassil Bassil is a proud Edmontonian who was raised and educated in the City of Champions. He earned an MBA from the University of Alberta in 2006 and completed the CMA program in 2011. He works in the finance industry with TD Commercial Banking.

Rachel Bocock

Senior Policy Analyst, Alberta Urban Municipalities Association (AUMA)

Rachel Bocock serves as the Secretariat Coordinator for the AUMA's Sustainability and Environment Committee. She is also member of the Municipal Climate Change Action Centre and Welcoming and Inclusive Communities Steering Committees. Prior to working with the Association, Rachel was an Associate with the public policy consulting firm, Cambridge Strategies Inc. She also worked with the Wild Rose Agricultural Producers during and after completing her BA (Hons) in Political Science at the University of Alberta.

Mark Brostrom

Director, Office of Environment, Urban Planning and Environment, Sustainable Development, City of Edmonton

John Byron

Senior Advisor, EPCOR Distribution and Transmission

John Byron, P.Eng., B.Sc (Alberta, Electrical Engineering, 1975) is retired from EPCOR but presently working at EPCOR as a temporary employee undertaking various transmission and distribution projects and assignments. Mr. Byron served in many positions throughout his 34 years with EPCOR and prior to that Edmonton Power. In his final years with EPCOR Mr. Byron served as the General Manager of EPCOR Distribution and Transmission Inc. He is a Member of the Institute of Electrical and Electronic Engineers.

David Dodge

Director, Edmonton Federation of Community Leagues

David Dodge is Senior Advisor, Communications at the Pembina Institute. He spent seven years as an award winning photojournalist and columnist with the St. Albert Gazette. He served as the first executive director of the Canadian Parks and Wilderness Society in Alberta, the founding editor of Borealis Magazine and the host and producer of more than 350 CKUA Radio programs on sustainability and the environment. David was the production manager for Lone Pine Publishing and he also served as the project manager for GreenLearning.ca, phase I. In his spare time, David coached basketball and soccer for 10 years, has served as the president of the Evansdale Community League and he is currently the president of the Edmonton Federation of Community Leagues.

Bill Dushenko

Dean, School of Sustainable Building and Environmental Management, Northern Alberta Institute of Technology

Dr. William (Bill) Dushenko obtained his PhD in biology at Queen's University, Kingston. He has worked in the academic sector for over 20 years, authoring numerous scientific reports and scientific papers in the environmental and sustainability fields. Bill has also provided leadership in sustainable development at the institutional and educational program level, including a new program in Alternative Energy Technology to provide workforce training in renewable energy.

Rob Harlan

Executive Director, Solar Energy Society of Alberta

Rob Harlan is the Executive Director of the Solar Energy Society of Alberta. He has taught workshops and classes in solar technologies in North America including a course in Renewable Energy at Grant MacEwan University. Mr. Harlan is a Solar Contractor, Electrical Contractor and General Building Contractor with 12 years experience designing and installing over 150 solar electric and solar hot water installations, primarily in the United States.

Bob Hawkesworth

Co-ordinator, Municipal Climate Change Action Centre (MCCAC), Alberta Urban Municipalities Association (AUMA)

Bob Hawkesworth joined the MCCAC in January 2011. He served 10 terms as a Calgary Alderman and as an Alberta MLA for Calgary Mountain View. In 1999 he received the AUMA Award of Excellence for outstanding service to municipal government and in 2008, a special Life Membership. His leadership on environmental sustainability has been acknowledged by his Provincial appointment since 2000 as a Founding Director of Climate Change Central. He served from 2004 to 2007 as President of the AUMA. He has a BA degree from the UofA and a MA Degree in Resources and the Environment from the UofC.

Gordon Howell

Managing Principal, Howell-Mayhew Engineering, ghowell@hme.ca

Gordon Howell, P.Eng., B.Sc (Alberta, Electrical Engineering, 1975) has 28 years of experience with grid-connected solar-electric systems and 21 years on international, national and provincial solar standards committees. His solar-electric house was the first grid-connected home west of Toronto in 1995 and the 12th in Canada. Since 1995 he has worked on the development of simple uniform steps to connect all micro-generators to Alberta's grid. His priority is to work with governments, electric regulators and utilities to resolve and remove barriers to solar electricity so we can be ready for solar-grid parity. His most recent work is with developing cost-effective net-zero-energy houses.

Linda Keyes

Economic Development Officer, Edmonton Economic Development Corporation, lkeyes@edmonton.com

Linda Keyes works in economic development, focusing on diversifying and growing the energy, alternative energy and environmental services sectors in Edmonton. She is a Registered Professional Forester in Alberta and British Columbia, with experience in the oil and gas industry.

Simon Knight

President and Chief Executive Officer, Climate Change Central

Simon Knight's passion for sustainable building design has kept him active in the residential and commercial building sector for many years. Most recently, he served as the president of the Alberta Chapter of the Canada Green Building Council and was president of the Net Zero Energy Home Coalition. He also served as the Alberta representative on the National Advisory Council on Energy Efficiency and was a board member for the Canadian Energy Efficiency Alliance. His commitment to sustainable design is more personally evident in C3's office space where eco-friendly and energy-efficient design elements are beautifully displayed.

Vik Maraj

Human Relations Specialist, Vik Maraj Consulting

Vik Maraj is the co-creator of Unstoppable Conversations Inc. which deals with people's invisible patterns of thinking that limit innovation, fulfillment, and performance. For 12 years he has caused explosive results in organizations by revealing the hidden constraint that past successes and failures have placed on the future. He has permanently dismantled the proverbial "box" that has suppressed the performance of thousands of people in the realms of business, family, and personal accomplishment. He is a Dean's List graduate and holds a Masters in Science from the University of Alberta. He is the co-founder of the multi-million dollar Castle Rock Research Corp, is a high-stakes conflict resolution specialist, and has extensively trained with Landmark Education. The clients with whom he has made a lasting difference include National and International Governments, Multinational Corporations, Universities, the UN, National Not-For-Profits, School Boards, and Communities. He has facilitated world congresses, instigated dramatic shifts in corporate cultures, and unlocked historically intractable relationships with billions of dollars and lives at stake.

Mike Melross

Project Manager, Urban Planning and Environment, Sustainable Development, City of Edmonton

Simon O'Byrne

Managing Principal, Stantec

Simon O'Byrne is a professional urban planner with experience in a wide range of current and long-range planning projects. He has provided strategic input and has led multi-disciplinary teams in the planning and successful delivery of large, complex and politically-charged projects. Simon's experience ranges from regional land use and economic development studies to detailed design, public consultation and transit oriented development planning. Notable projects have included intensive urban revitalization in the Bronx, New York, the Downtown Arena and Entertainment District in Edmonton, the Capital Region Land Use Plan and the Government of Alberta's Lower Athabasca Regional Plan. In addition, Simon has been the principal planner on many new communities throughout the Capital Region. Simon's unique background and experience give him considerable knowledge in the areas of sustainable development, regional planning, economic development, transit oriented development, and innovative private/public partnerships. Well recognized as an urban planning expert, he is frequently quoted in the media and is a sought after speaker to professional, community and leadership groups.

Peter Odinga

Chief Development Planner, Current Planning, Sustainable Development, City of Edmonton

Klaas Rodenburg

Design Coordinator, Buildings Engineering, Stantec

Klaas Rodenburg has been in the building design industry for more than 30 years and currently serves as the Sustainable design Coordinator for Stantec. He is a Certified Engineering Technician (CET) in Alberta and has an Arts Degree from the University of Alberta with a specialization in Industrial Design. He received his LEED® Accredited Professional designation in 2003 and is the past Chair of the Alberta Chapter of the CaGBC and past Chair of the CaGBC Leaders Forum. Klaas currently serves as a director for the Alberta Council of Technologies (ABCTech) and is a founding director of the Alberta Clean Technology Industry Alliance (ACTia).

Paul Specht
Director, Building and Landscape Services, Infrastructure Services m City of Edmonton

Chris Vilcsak
President and CEO, Solution 105 Consulting

Chris Vilcsak has been active in the energy industry for more than 25 years. In 1999, he started Solution 105 focusing on energy consumers in deregulated environments. Today, Solution 105 is a leading and award-winning North American provider of complete utility management solutions. Chris graduated with a mechanical engineering degree from the University of Alberta in 1985 and completed an MBA on a part-time basis from the U of A in 1997. He is active in the community on a professional and personal level.

Tim Weis
Director, Renewable Energy and Efficiency, The Pembina Institute

Dr. Tim Weis is a professional engineer and specializes in clean energy policy design, research and strategic decision making. He has written extensively on sustainable energy technical and policy issues at national, provincial and municipal levels, as well as opportunities specific to First Nations' and northern communities. He has assisted more than 20 communities at various stages of development of renewable energy projects and has also worked as a renewable energy consultant examining wind energy challenges in Northern communities. Tim holds a PhD (Université du Québec à Rimouski) in Environmental Sciences (sciences de l'environnement), where he studied wind energy development in remote communities. He also has an M.Sc. (University of Alberta) and a B.A.Sc. (University of Waterloo) in mechanical engineering.

City Support Staff:

Barbara Daly
Project Manager, Urban Planning and Environment, Sustainable Development, City of Edmonton

Mary-Ann Thurber
Communication Officer, Urban Planning and Environment, Sustainable Development, City of Edmonton

APPENDIX D: RENEWABLE ENERGY REPORTS FROM OTHER ORGANIZATIONS

This appendix lists other relevant reports about renewable energy.

1. United Nations' Intergovernmental Panel on Climate Change:
   Special Report on Renewable Energy Sources and Climate Change Mitigation
   900 pages. 2011 May. http://ssren.ipcc-wg3.de
2. World Wildlife Federation:
   The Energy Report, 100% Renewable Energy by 2050. 256 pages. 2011 February.
   www.worldwildlife.org/climate/energy-report.html
3. REN21: Rene3wable Energy Policy Network for the 21st Century
   Renewables 2011 Global Status Report. 116 pages. 2011, July
   www.ren21.net/REN21Activities/Publications/GlobalStatusReport/GSR2011/tabid/56142/Default.aspx
4. Canadian Solar Industries Association:
   Solar Vision 2025: Beyond Market Competitiveness 41 pages. 2010 December
   www.cansia.ca/node/6512
5. Clean Air Strategic Alliance
   Recommendations for a Renewable and Alternative Electrical Energy Framework for Alberta 2007 March 36 pages
   www.casahome.org/projects/completed Projects/RenewableAlternativeEnergy.aspx
6. The Pembina Institute
   Greening the Grid: Powering Alberta's Future with Renewable Energy 2009 January. 109 pages.
   www.pembina.org/pub/1764
7. Sierra Club Prairie, Greenpeace Canada, Alberta federation of Labour (new) Green Jobs: It's time to build Alberta's Future 72 pages. 2009 April. www.afl.org/index.php/View-document/114-Green-Jobs-It-s-time-to-build-Alberta-s-future.html
8. Clear Sky Advisors, "*Economic impacts of the solar PV sector in Ontario 2008 – 2018, 2011 July 26*" prepared for Canadian Solar Industries Association. 2011 July 38 pages.

APPENDIX E: RENEWABLE ENERGY — PROGRAMS IN OTHER CITIES

The following chart briefly notes a selection of renewable energy policy approaches and precedents for municipalities around the world:

Municipality	Renewable Energy Program
Dawson Creek	All new houses must be built "solar ready"
Medicine Hat	Land sale conditional on solar installation Municipal R&D funding Hat Smart incentive program, **www.hatsmart.ca** Development of a 1 MW solar thermal-electric generating plant
Halifax	Finances solar domestic water heating systems and home owner pays it off through their taxes. **www.halifax.ca/solarcity**
Okotoks	Sustainable Okotoks **www.okotoks.ca/default.aspx?cid=46&lang=1**
Vancouver	Imagine 2020, Vancouver will be the greenest city in the world. **www.talkgreenvancouver.ca, http://vancouver.ca/greenestcity, http://vancouver.ca/sustainability/building_green.htm** Vancouver Green Capital **http://vancouver.ca/greencapital**
North Vancouver	Map of potential heat generated from solar domestic water heating systems
Richmond	District Energy Utility **www.richmond.ca/news/city/districtenergy.htm** New position of District Energy Manager Strategic Climate Change Program target: reduce GHG emissions by 33% by 2020 and 80% by 2050 from 2007 levels
Colwood, View Royal, Metchosin Esquimalt — 36 BC communities in total	**www.housing.gov.bc.ca/building/consultation/shwr/index.htm** Adopt new building regulation as of June 21, 2011 that requires all new single family homes to be solar hot water ready. Additional cost will be $200 to $500. Reduction of natural gas greenhouse gas emissions by one to two tonnes per year.
Colwood, BC	Solar Colwood, **www.solarcolwood.ca** Demonstration of whole community energy conservation and renewable energy. Focus on solar thermal hot water heating and energy-efficient retrofits. Also includes ductless split heat pumps, Smart Home/Smart Grid technologies, energy-efficient/smart appliances, solar PV, ground-source heat pump, district energy, and electric vehicle charging infrastructure.
Sunshine Coast, BC along with 32 other communities	2011 Solar Readiness Policy **www.scrd.ca/files/File/Community/Building/Solar-Readiness-2011.pdf**

Municipality	Renewable Energy Program
Guelph	Community Energy Initiative (2007 – 2031) **http://guelph.ca/living.cfm?subCatID=1831&smocid=2407** 50% less energy use per capita, 60% less GHG emissions per capita, decouple energy consumption from population growth 25% renewable energy in 15 years 10% biomass for base load heat (2031) 20% solar for electricity demand (2031) 30% electricity associated with combined heat & power (2031) 25% reduction transportation-related energy costs (2031) Efficiency Investment in the green economy and green jobs **Prioritization of Community Energy Initiative** 1. Energy Efficiency — If you don't need it, don't use it 2. Heat Recovery — If it's already there, use it 3. Cogeneration — Why waste fuel at the generating plant? 4. Renewable Energy — If it makes sense, go carbon free 5. Partner with utilities — Maximize use of grid as a resource to optimize and ensure reliability Mayor's Megawatt Challenge on City facilities New City positions: • Energy Conservation Coordinator • Community Energy Plan Program Manager (Building Efficiency, City Policies and By-laws, Energy Zoning, Planning and Permitting, Transportation Guidelines, Energy Mapping)
Victoria	Victoria's Green Initiatives **www.victoria.ca/cityhall/departments_plnsrv_green.shtml**
Toronto	Live Green Toronto **www.toronto.ca/livegreen**
Calgary	imagineCALGARY Plan for Long Range Urban Sustainability **www.calgary.ca/portal/server.pt/gateway/PTARGS_0_2_820582_0_0_18/imagineCALGARY.htm** mandate city government electricity purchases to come from renewable sources. Expects to be largest proportional consumer of green electricity in North America by 2012, downtown district energy project to provide co-generation heating for downtown municipal buildings, pilot projects for solar water heating and electricity for municipal buildings.
Austin, Texas	Property tax exemptions/credits, low interest loans, underwriting loans, need to consider solar orientation when siting buildings on lots
Chicago, Illinois	Bulk purchasing, grants/donation of solar energy systems to specific projects, procurement conditional on local manufacturing

Municipality	Renewable Energy Program
Gainesville Florida	America's only municipal feed-in tariff for solar electricity, now facilitating the installation of 3.5 MW per year
Madison, Wisconsin	Need to consider solar orientation when building streets and communities
Minneapolis, Minnesota	Renewable energy development fund
San Francisco, California	Solar@Work, solar PV leasing program **www.wri.org/project/technology/renewable-energy-and-efficiency/solar-at-work**
Freiburg, Germany	Freiburg Solar City. Concerted policies to reduce environmental burden. Goal to create sustainable regional development. 1996 City resolution to reduce CO_2 emissions to 25% below 1992 level by 2010. Innovative energy policy: efficiency, combined heat and power and solar. New eco-village of 2000 houses being built on an abandoned military base. Solar Village with 50 net-surplus energy houses. Car-free zones. Low-cost bus service. **www.solarregion.freiburg.de/solarregion/freiburg_solar_city.php**
Adelaide, South Australia	Leasing opportunities giving priority to tenants who invest in solar
Barcelona Spain	Bylaw that requires solar

APPENDIX F: PRECEDENCE FOR GOVERNMENT RENEWABLE ENERGY INITIATIVES

Some question the need for government to play a role in the development of renewable energy industries in Alberta. A brief comparison between renewable energy resources today and Alberta's renowned bitumen deposits in 1970s is useful and can clarify the precedence and value of government partnership and policy initiatives in renewable energy developments.

The initiatives described in this report take direction from the world-class leadership that the Government of Alberta has been providing in working with industry to develop Alberta's bountiful coal, oil, natural gas and bitumen resources over the last 80 years. To achieve Alberta's economic development goals for these resources, government initiatives have included various facilitating policies, tax holidays, reduced royalties and direct investments, without which, the province would likely not be in today's enviable position of a highly employed and skilled workforce, vast wealth, low taxes, generous budgets and international prominence.

As with any industry, the renewable energy industry needs stable regimes of tax, incentive and regulatory policies in order to attract investment and enable it to provide its energy services. Such policies should not pick winners or losers, but instead provide a level playing field on which all energy technologies, fossil-based and renewable, can compete squarely in the long-standing and widely-preferred models of capitalism and free-enterprise.

	Bitumen deposits in the 1970s	Renewable energy in 2011
Wealth of resource in Alberta	2nd richest deposits of oil in the world	300+ times more energy resource potential per year than all the coal, oil, natural gas and bitumen extracted per year in Alberta
Availability of resources	primarily to large industrial corporations due to size of investments needed	available to many: homeowners, community, agricultural, commercial, municipal, industrial, utility due to ability to scale the size of the technologies
Resources reserves	100+ years depending on extraction rate	tens of millions of years
Location	concentrated over 1/3 of Alberta's surface area	diffuse and spread over much of Alberta's surface area, with higher concentrations in particular locations (rivers and areas of wind, sun, forests, geothermal hot spots)
Cost	~3 to 5 times more than the world price of oil	~1.5 to 5 times more than the production price of new utility energy and the present consumer price of energy

	Bitumen deposits in the 1970s	Renewable energy in 2011
Level of experience	not a lot of experience in Alberta: 2 small oil companies and the Alberta Research Council	not a lot of experience, 30 tiny companies, a few larger companies, 2 electric utilities, several companies developing plans, processing and generating plants
State of technology	needing higher efficiency, lower costs, greater reliability, lower environmental footprint	some technologies are shovel ready and growing rapidly, some are in pilot stage, huge amount of investment world-wide
Barriers	many, typical with start-up industry and new technology cost, technical	many, typical with small industry, cost, technical in some areas, awareness, education, workforce development, resistance to change
Opportunities	highly skilled jobs during construction and operation, energy products to serve energy markets around the world, technical expertise to develop bitumen deposits elsewhere	highly skilled jobs during construction and operation, energy products to serve energy markets in Alberta and nearby, technical expertise to develop renewable energy projects elsewhere
Competition	from conventional oil: significant; from other bitumen deposits: none	from coal and natural gas: significant
Benefits to province	some royalties now, more in the future, jobs, taxation from jobs and supply companies	no royalties at this time, jobs, taxation from jobs, energy companies and supply companies
What is needed?	government policies and incentives to facilitate its development in order to attract industries and investment	government policies and incentives to facilitate its development in order to attract industries and investment

APPENDIX G: CLARIFICATION OF SOME TERMS, DEFINITIONS AND CONCEPTS

The terms and concepts included here are sometimes a source of confusion. These descriptions provide clarification.

a. Sustainability

Ability of human society to endure over a prolonged period as an integral part of Earth's natural systems; achieved through the practice of sustainable living

b. Resiliency

- capacity of a system to withstand and bounce back intact from environmental disturbances
- the ability to continue with only minor issues in the face of major environmental, social or financial challenges

c. Renewable energy

As used in the Task Force Terms of Reference:
energy generated from natural resources as direct solar radiation, wind, flowing water, biomass, biogas, geothermal heat and waste heat and waste energy, all of which are naturally replenished within a person's typical lifetime

As used in the Task Force:
renewable energy is energy that is replenished within the typical lifetime of a person

Renewable energy is sometimes incorrectly referenced as an energy efficiency technology. However, renewable energy is instead an energy substitution technology — it substitutes a non-renewable energy source with a renewable energy source. It works in tandem with energy efficiency to reduce the consumption of non-renewable energy and the production of its emissions.

Alternate energy, as differentiated from renewable energy, refers to energy from technologies that are not mainstream and includes most renewable energy (except large hydro dams) as well as some fossil fuel energy (such as from combined heat and power).

d. Energy

The ability to do work (which means "to move a mass over a distance")

Standard units of measuring energy:

- Joules (J)
- kWh (particularly used with electrical energy)
- BTU
- calorie
- HP-h
- tonnes (of ice)

e. Power

- the rate at which energy flows
- the amount of energy used at a moment in time

Standby power: the ability to turn on a switch and have immediate access to energy

Standard units of measuring energy

- joule per second (J/s) = watt (W)
- kW
- MJ/h
- BTU/h
- HP
- Tonnes (of ice)/h

Unfortunately, the common use of the term "power" to refer to electricity in general causes confusion in the understanding of energy and power concepts.

f. Energy efficiency

Ratio of the amount of usable energy recovered from an energy conversion process divided by the amount energy that was fed into the process

Units: % or dimensionless

Some people suggest that energy efficiency can be considered as a "negative energy source" which has conceptual merit, but not technical merit.

g. Biomass

Living and recently living biological material that can be used as fuel or for industrial production

Commonly refers to plant matter grown for use as bio-fuel

Also includes plant or animal matter used as inputs into the bio-based economy

Biomass is generally available from two categories of sources: one that is left over from other processes and one that is purpose-grown.

Biomass that is left over from other processes includes agricultural straw and corn stover and woody material resulting from insect and disease attacks, major forest fires, timber harvesting and wood processing.

Biomass from purpose-grown sources includes switch grass, hybrid poplar, or willow plantations.

h. Bio-based economy

An economy derived from applying the advances in science and innovation to the biology of plants, animals and micro-organisms to develop new bio-products

Bio-products can be generated from a variety of renewable resources

Sustainable sources of electricity and heat, transportation fuels, chemicals and materials are possible. Bio-products support the rural economy by providing employment opportunities to grow and harvest biomass feedstock, as well as refining the feedstock into bio-products.

i. Electricity

Free electrons that are available to do work

Units: coulombs (C) of charge Other units: Ah

j. Electricity bills

Periodic statement of the amount of electric energy imported and delivered from the grid or exported and delivered to the grid and the charges arising from this transaction, plus the peak demand of electric power charged during the period

The energy is measured in kWh. The energy is purchased from electrical energy retailers (EPCOR Energy and others). The delivery of the energy is provided by Edmonton's Wires Service Provider (EPCOR Distribution and Transmission). Commercial customers over 150 kVA of electric power demand are billed monthly for peak electric power (called "demand") and measured in kW.

All charges seen on electricity bills (including energy purchase, distribution, transmission and rate riders) are either based on the amount of time connected to the electricity grid (# of days and priced in ¢/day), based on energy consumption (the amount of energy in kWh, and priced in ¢/kWh) or based on both time and energy. EPCOR Distribution and Transmission's tariffs describe the delivery prices.

The energy purchased and the energy delivered is separately priced in ¢/kWh. Both the energy purchased and its delivery also have separate charges based on the amount of time that the customer is connected to the electric grid (called "fixed" charges), and which are separately priced in ¢/day.

Many people consider electricity bills to be confusing. Describing all the charges on electricity bills as aggregated ¢/day and ¢/kWh prices (including GST) thus helps to clarify how the bills are determined and what is the real price of energy on the bills.

k. Local Access Fee

Fee charged to the electricity delivery company by the local municipality for access to customers and the use of municipal land to conduct its business

In Edmonton, the City of Edmonton determines the revenue it wants from EPCOR Distribution and Transmission. EPCOR then determines the amount of energy that it will deliver in meeting this expense and sets an energy price (¢/kWh) to meet the City's revenue requirement.

For Edmonton, this fee does not need to be approved by the Alberta Utilities Commission because EPCOR is owned by the City.

l. Natural gas bills

Periodic statement of the amount of natural gas fuel imported from the grid and the charges arising from this transaction

The natural gas fuel is measured in its energy equivalent, in GJ. The fuel is purchased from natural gas retailers (Direct Energy and others). The delivery of the fuel is provided by Edmonton's Natural Gas Service Provider (ATCO Gas).

All charges seen on natural gas bills (including energy purchase and distribution) are either based on the amount of time connected to the natural gas grid (# of days and priced in ¢/day), based on energy consumption (the amount of energy in GJ, and priced in $/GJ) or based on both time and energy. ATCO Gas' tariffs describe the delivery prices and methods.

The fuel purchased and the fuel delivered are separately priced in $/GJ. Both the fuel purchased and its delivery also have separate charges based on the amount of time that the customer is connected to the natural gas grid (called "fixed" charges), and which are separately priced in ¢/day. The delivery of natural gas fuel consists of several individual charges including fixed (time-based), variable (energy-based) and various rate riders (which are can be based on time or energy) — all of which are either based grid-connect time, based on energy consumption or based on both.

Many people consider natural gas bills to be confusing. Describing all the charges on natural gas bills as aggregated ¢/day and $/GJ prices (including GST) thus helps to clarify how the bills are determined and what is the real price of energy on the bills.

Some commercial customers also are billed monthly for peak natural gas consumption (called "demand") and measured in GJ/day.

m. Municipal Franchise Fee

Fee charged to the natural gas delivery company by the local municipality for access to customers, the use of municipal land to conduct its business, and to cover its property tax

In Edmonton, the City of Edmonton determines the revenue it wants from ATCO Gas. ATCO Gas then determines the amount of energy that it will deliver in meeting this expense and then sets a percentage rate that is applied to all the distribution prices (time-based and energy-based) to meet the City's revenue requirement. In 2011, the percentage rate is 37 per cent. The rate is approved by the Alberta Utilities Commission.

APPENDIX H: REFERENCES

1. Paul Kralovic and Dinara Mutysheva. 2006 November. "*The Role of Renewable Energy in Alberta's Energy Future*". **The Institute for Sustainable Energy, Environment and Economy**, University of Calgary.
2. **Renewable Energy Deployment Initiative**. "*Priming the Green Heating and Cooling Market for Take-Off*" Strategic Business Plan. 9 – 51. 2004 – 2007. Natural Resources Canada.
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    e. **Natural Gas Supply Association,** "*Natural Gas and the Environment*", Washington, America. www.naturalgas.org/environment/naturalgas.asp#industrial
    f. **Ontario Public Health Association,** "Beyond Coal: Power, Public Health and the Environment", 2002, 60 pp.
    g. **Physicians For Social Responsibility,** "*Coal's Assault on Human Health*", Washington, America, 2009, 64 pp. www.psr.org/resources/coals-assault-on-human-health.html
    h. **Union of Concerned Scientists,** "*A Risky Proposition — The Financial Hazards of New Investments in Coal Plants*", pg. 25, Cambridge, America, 2011, 74 pp. www.ucsusa.org/clean_energy/technology_and_impacts/impacts/financial-hazards-of-coal-plant-investments.html
    i. Paul R. Epstein from the Center for Health and the Global Environment at the Harvard Medical School, et. al. "*Full cost accounting for the life cycle of coal*" in "*Ecological Economics Reviews*." Annals of the New York Academy of Sciences. 1219: 73–98. 2011. http://solar.gwu.edu/index_files/Resources_files/epstein_full%20cost%20of%20coal.pdf
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APPENDIX I: CLEANING EDMONTON — A MODEL CLEAN CONTRACT PROGRAM FOR SOLAR ENERGY DEVELOPMENT

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The Pembina Foundation for Environmental Research and Education is a national registered charitable organization that enters into contractual agreements with environmental research and education experts, such as the Pembina Institute, to deliver on its work.

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About the Pembina Institute

The Pembina Institute is a national non-profit think tank that advances sustainable energy solutions through research, education, consulting and advocacy. It promotes environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance. For more information about the Pembina Institute, visit www.pembina.org or contact info@pembina.org. Our engaging monthly newsletter offers insights into the Pembina Institute's projects and activities, and highlights recent news and publications. Subscribe to Pembina eNews: http://www.pembina.org/enews/subscribe.

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CLEANing Edmonton

A Model CLEAN Contract Program for Solar Energy Development

Contents

1. Introduction

Edmonton sits at the confluence of parameters necessary for positioning itself as a leader among municipalities on harnessing the coming economic opportunities from renewable energy development. It has a very good solar resource and urban context for solar energy production. It has the visionary desire among City leadership for taking active steps toward developing as a centre for green technologies and for reducing greenhouse gas emissions and other environmental impact. It has the interest in taking early policy action to grasp the early mover benefits of quickly establishing a market for solar energy technology. And it has the capacity to adopt the most effective policy for this purpose.

Chapter 2 describes the context within which Edmonton is considering its renewable energy policy options. It notes the opportunities available to Edmonton, particularly from the city's substantial solar energy potential, and looks to both economic and environmental benefits available from early action to support local solar energy development. It also identifies the provincial and federal policy void around Edmonton's ensuing efforts and explains the immediate need for supportive policy in advance of wider commercial development of renewable energy technologies. It explains the basics of the most effective policy for this purpose, contracts to guarantee a reasonable rate to energy producers, or "CLEAN contracts", a policy first among municipalities in Canada.

Chapter 3 describes the jurisdictional authority that Edmonton has to implement such a program. Alberta's regulatory regime for maintaining a competitive power pool is a somewhat complicating context for a municipality to implement such a program. However, by innovatively employing powers within municipal competence under Alberta law, Edmonton can pioneer a broadly replicable policy innovation for visionary cities wanting to promote local renewable energy within a deregulated market. It can also recover the costs of the program appropriately from energy consumers, using its power to impose franchise fees.

Chapter 4 details a model CLEAN contract program for the City of Edmonton. It makes certain assumptions and decisions regarding important inputs such as program size, project size, to whom the program is available, and energy prices. It presents the costs of such a program, the impact on energy consumers if the costs are recovered from franchise fees, and some of the economic and environmental benefits attainable through the program. It is not presenting a take-it-or-leave-it policy design. Rather, it offers an ambitious but realistic policy framework and plays the presets through economic models. It intends to initiate discussions around the possible designs appropriate to Edmonton for taking advantage of this powerful policy template and pioneering visionary policy innovation for North America.

2. Background & Context

2.1 Renewable Energy Opportunities & Policies

In 2008, the United Nations Environment Programme (UNEP) reported for the first time that investments in new electricity generation from renewable sources had outpaced investments in new coal, natural gas and nuclear electricity. This is creating new industries and jobs around the world.[1]

While Edmonton is a city that is currently heavily dependent on fossil fuel development, it is also looking for ways to diversify its economic base and increase its long-term sustainability and resiliency, including developing as a "knowledge and innovation centre for value-added and green technologies and products".[2]

2.1.1 Focus on Solar

The CLEAN (Clean, Local, Energy, Available Now) contract policy is a flexible template that can accommodate specific and appropriate support for any of a number of different renewable energy technologies. Here, however, we focus on solar photovoltaic (PV) and solar domestic hot water (SDHW) technologies, for a few reasons.

Solar energy in particular offers some unique opportunities, as it is almost universally applicable and is predicted to have exponential growth over coming decades. The IEA predicts that solar energy may provide up to 1/5th of the world's electricity within the next 40 years. Jurisdictions that take the lead in developing the know-how for such technologies will have enormous opportunities as this market continues to expand rapidly.

The Pembina Institute's report to the Task Force, *Renewable Energy Potential for the City of Edmonton*,[3] evaluated the full spectrum of feasible renewable energy options for the city according to seven key parameters for triple-bottom-line policy outcomes and appropriateness to the city's social and physical contexts.[4] Using an objective scoring methodology, the evaluation determined that solar PV and SDHW present the most significant strategic opportunities for Edmonton.[5] In particular, for both technologies, "the high number of individual residents … that

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[1] See Clare Demerse, *Reducting Pollution, Creating Jobs: The Employment Effects of Climate Change and Environmental Policies*, March 2011 (The Pembina Institute), p. 40, available at: http://pubs.pembina.org/reports/reducing-pollution-creating-jobs.pdf.
[2] City of Edmonton, *The Way We Grow: Municipal Development Plan*, May 26, 2010, pp. 5, 169, available at http://www.edmonton.ca/city_government/documents/MDP_Bylaw_15100.pdf [hereinafter "*The Way We Grow*"].
[3] Tim Weis, Paul Cobb, Erin Welk, Dave Lovekin, and Kristin Anderson, *Renewable Energy Potential for the City of Edmonton: A Report for the City of Edmonton's Renewable Energy Task Force*, February 2011 [hereinafter "*Renewable Energy Potential*"].
[4] Ibid., pp. 37-39.
[5] Ibid., pp. 38-39.

could implement these technologies raise their technical potential as well as their social and participatory benefits."[6]

As a first step into the nascent realm of municipal CLEAN contracts, Edmonton would do well to focus on a priority area of renewable energy generation. Targeting resources in this way can ensure substantial outcomes for a particular technology and facilitate administration. It allows the City to concentrate its pioneering efforts on a technology that is particularly amenable to Edmonton's urban characteristics, natural renewable energy endowment, and vision for a participatory local energy movement of tomorrow.

2.1.2 Opportunity

Solar PV and SDHW technologies both offer substantial opportunity to transform Edmonton's future relationship with energy consumption. The city's energy consumption is, like Alberta's, pollution-intensive and adverse to human and environmental health. It is also less than optimal for supporting the city's local economy, fails to promote community resiliency against global energy price volatility, and perpetuates a non-sustainable energy relationship. Generating energy with solar PV and SDHW technologies displaces conventional, fossil-fuel-fired energy generation. This engenders a number of different benefits. The key objective, however, is to position Edmonton as an early regional leader in solar energy technologies, enabling it to harness quickly developing energy opportunities.

Consuming electricity from the Alberta electricity grid, the city's electricity consumption effectively matches the province's electricity generation profile: 95% from fossil fuels, including 82% from coal.[7] The vast majority of the city's water heating needs is met by on-site natural gas combustion, with some electrical water heating.[8] Solar PV and SDHW provide means of displacing portions of this fossil-fuel-based energy consumption with renewable energy generation from the local solar resource, with higher job-intensity and much lower pollution-intensity.

<u>Local Industry & Employment</u>

Economically, displacing energy consumption with solar PV and SDHW means supporting locally sourced energy, as well as local industries for research and development, manufacturing, construction, installation, operations, and maintenance of solar energy systems. Existing electricity and natural gas consumption sees consumers in the City of Edmonton purchasing energy that is sourced mostly from outside of the city. Solar PV and SDHW units installed in buildings in the city can each support local industries and jobs.

In 2009, Canada's relatively small but developing solar PV industry, with 95 MW of installed capacity and 62 MW installed in that year, directly employed 2700 full-time labour place equivalents: 28 jobs/MW of total installed capacity and 44 jobs/MW of newly installed capacity

[6] Ibid., p. 38.
[7] Statistics are from 2008. Ibid. at p. 4.
[8] Ibid.

in that year.[9] Other studies accounting for indirect and induced employment effects indicate up to 80 jobs per MW and even higher.[10] These numbers cannot be mapped directly onto the municipal context, because a substantial proportion of this total is manufacturing positions, which may not be created near market. Nevertheless, a significant local market for renewable energy, particularly one with some longer-term stability, can encourage more local supply chain, manufacturing, distribution, and research and development activity, though it is very difficult to predict a threshold that will attract industries to these opportunities.

Moreover, significant jobs exist also for inherently local activities, like retailing, installation, maintenance, and private consulting work. As solar technology costs decrease, the proportion of these costs to the overall installed solar system costs increases, meaning solar system installation becomes proportionally more local per dollar invested and this is happening already.[11] Studies indicate that some subset of these activities employs up to 36 people per MW of installed generating capacity.[12] Again, these exclude indirect and induced employment effects, and include only certain, not all, inherently local industries.

Despite the difficulty pegging precise job creation numbers, it is clear that local renewable electricity will employ more people than conventional electricity—and certainly more people locally. Studies have indicated that, because of the high labour-intensity of solar energy projects and the higher capital-cost-intensity of fossil-fuel electricity generation: electricity generated by solar PV creates eight times more job-years than the same amount of electricity generated by coal;[13] and an investment in solar energy yields twice as many jobs as the same investment in coal energy.[14]

Investment in SDHW also offers significant employment opportunities, relative to coal. One estimate indicates that a $1 million investment (private, public, or joint) in the solar thermal industry could create as many as 28 jobs, accounting for direct, indirect, and induced effects in all other relevant industries.[15] Again, activities such as manufacturing are not necessarily local, though manufacturing is commonly nearby for many components of SDHW systems and strong local markets can attract manufacturing and distribution to create a hub.

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[9] Josef Ayoub, Lisa Dignard-Bailey and Yves Poissant, *National Survey Report of PV Power Applications in Canada*, June 2010 (prepared for Natural Resources Canada and the International Energy Agency), pp. 7-8, 15. This includes jobs in research and development, manufacturing, distribution, dealing, retailing, installation, and consulting.

[10] Canadian Solar Industries Association (CanSIA), *Job Creation Potential of Solar*, January 2005, p. 6 available at: http://www.cansia.ca/training-employment/archives.

[11] Renewables Internaitonal, *Cost of turnkey PV in Germany drops*, January 14, 2011, http://www.renewablesinternational.net/cost-of-turnkey-pv-in-germany-drops/150/510/29911/.

[12] CanSIA, *Job Creation Potential of Solar*, *supra* note 10, at p. 6.

[13] Daniel Kammen, Kamal Kapadia, Matthias Fripp, *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?*, 2004, pp. 2-3, available at: http://rael.berkeley.edu/sites/default/files/very-old-site/renewables.jobs.2006.pdf.

[14] Robert Pollin, James Heintz and Heidi Garrett-Peltier, *The Economic Benefits of Investing in Clean Energy: How the Economic Stimulus Program and New Legislation Can Boost U.S. Economic Growth and Employment*, June 2009, pp. 28-33.

[15] SouthGrow Regional Initiative, *Solar Energy Opportunity Profile,* available online at: http://southgrow.com/sites/southgrow.com/files/SolarEnergyProfile_1.pdf.

Moreover, SDHW is more local-employment-intensive, with proportionally more installation work. An industry-based Alberta estimate that considers only direct employment by installation companies alone indicates that for every 1000 2-collector systems, 27 full-time equivalent job years are needed.[16] Another study confirms this range by indicating that installation and sales employ as many as five or more people per 1000m^2, or 30 per 1000 systems.[17] Once more, these do not take account of indirect or induced employment effects.

The indirect and induced effects are hard to measure, but important to consider. Indeed, anecdotal evidence from a North American model for the sort of program proposed in this report, Gainesville, Florida's program supporting local solar PV installations, points to a broad array of economic benefits. These include direct opportunities like new solar supply and installation companies and increased employment in the industry, but also less obvious indirect results like new professional business for financing and contracts, and solar installation advertising revenue for local media.

In 2005, the Canadian Solar Industries Association estimated that the entire solar energy industry could provide 60,000 jobs in the Canadian labour market by 2025.[18] With an as yet fledgling industry finding its legs in Canada, communities can take measures now to become an early leader in this future energy industry and attract tomorrow's jobs today. By supporting an early market for technologies and installation, cities can establish themselves as hubs for solar energy goods and service provision, exporting products, technical expertise, and labour skill to other municipalities, provinces, and countries, generating revenue and business opportunity in the city.

Environment & Health

Both technologies, but particularly solar PV, offer important means for attaining the City's ambitious greenhouse gas emission reduction targets in its draft environmental strategic plan, calling for a reduction of "approximately 17-20 per cent of 2008 levels by 2020, with carbon neutrality being the ultimate long-term goal."[19] Solar PV can also help to reduce other pollutants that impact human health.

Because Alberta's provincial grid electricity is very greenhouse gas (GHG) intensive, displacing electricity from the existing electricity profile with solar PV electricity produces significant results for greenhouse gas reduction. With an electrical grid with a greenhouse gas intensity of 0.82 kg CO_2e/kWh for electricity consumption,[20] a common household 3 kW (20 m^2) PV system would offset 2755 kg CO_2e every year. The city's current rooftops give Edmonton the potential to avoid almost 500,000 tonnes of CO_2e each year, a 4% reduction in Edmonton's greenhouse gas emissions from electricity and natural gas consumption. Displacing electricity consumption from coal-fired plants would also substantially decrease emissions that are harmful to human health, including NO_x, SO_x, particulates, and mercury.

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[16] Estimate of David Kelly, President, Sedmek Inc. Estimate is based on two-person crew able to install 3 SDHW installations per week, with one support staff at the installation company for each employed two-person crew.
[17] CanSIA, *Job Creation Potential of Solar*, *supra* note 10, at p. 5.
[18] Ibid. at p. 8.
[19] City of Edmonton, *The Way We Green: The City of Edmonton's Environmental Strategic Plan*, 2011, p. 50, available at: http://www.edmonton.ca/city_government/city_wide_initiatives/environmental-strategic-plan.aspx.
[20] Tim Weis et al., *Renewable Energy Potential*, *supra* note 3, at p. 2.

SDHW offers less impact, because of the predominant use of less GHG-intensive natural gas for domestic water heating. Displacing residential natural gas consumption, with a GHG intensity of 50 kg CO_2e/GJ (0.18 kg CO_2e/kWh), a common two-collector (6 m^2) residential system producing 12 GJ per year can save about 600 kg CO_2e every year, so that Edmonton's current overall potential for SDHW installation could save 92,332 tonnes of CO_2e per year.[21]

2.1.3 Policy Needed: A Bridge to Economic Development

At present, solar energy cannot compete with conventional energy in commercial terms. However, rising conventional energy prices and quickly decreasing solar energy technologies mean that solar energy will become increasingly competitive in coming decades, ultimately reaching "grid parity". To ensure that Edmonton can effectively take advantage of the new commercially feasible solar energy industries at that time, policy must provide a bridge to support the fledgling industry, to hit the ground running. Existing policies, however, are inadequate for this purpose. Effective and appropriate policies to support the industry to gain local technical understanding and capacity can position the community to harness the solar energy opportunities in the coming decade and beyond.

Existing Policy

The only current policy in Alberta for supporting solar energy is the province's *Micro-generation Regulation*. The *Regulation* allows micro-generation generating units with under 1 MW of rated generating capacity to export excess site electrical energy to the grid and receive credit against their electricity bill for this energy.[22] To qualify for the *Regulation*'s exemptions, generating units must be designed only to meet the customer's anticipated electricity consumption.[23] Small units, defined as those under 150 kW capacity, allow their owner to receive credit at their electricity retailer's retail rate.[24]

The *Regulation* is a good start for allowing interconnection with the electricity grid, but does not address the practical market barriers to immediate solar electricity development. Retail and pool electricity prices in Alberta are too low for solar PV to be a commercially feasible investment option. The inadequacy for encouraging renewable energy development in Alberta is demonstrated by the fact that, as of May 31, 2011, after 29 months with the *Regulation*, there is only 910 kW of installed capacity across the entire province (0.006% of total installed generating capacity).[25] Similarly, there is no policy supporting SDHW, so system owners receive the benefit of displacing some portion of their natural gas usage. With such low natural gas prices, SDHW is similarly disadvantaged and not presently competitive in commercial terms. Of course, neither electricity nor natural gas prices take account of the health, environmental, and economic costs of the fossil-fuel combustion, so the prices are, in this sense, artificially low and unfairly disadvantageous to alternative, clean energy sources.

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[21] Ibid. at pp. 14-15.
[22] Alberta Government, *Micro-generation Regulation*, A.B. Reg. 27/2008.
[23] Ibid. at s. 1(1)(h).
[24] Ibid. at s. 7(5)(a). Large units, between 150 kW and 1 MW capacity, receive credit at the hourly pool price instead. Ibid. at s. 7(5)(b).
[25] Alberta Utilities Commission, *Micro-Generation Reporting*, March 31, 2011, available at: http://www.auc.ab.ca/rule-development/micro-generation/Pages/default.aspx.

Early Mover Dividends

Rising fossil-fuel energy prices and decreasing solar energy technology prices indicate a brighter future for solar energy. The pool price of electricity in Alberta is expected to rise between 88 and 124% over the next seven years,[26] which does not take account of potential cost increases from transmission infrastructure that might be passed to consumers. The price of natural gas in Alberta is projected to rise 58% over the next decade.[27] Solar technology, meanwhile, has shown stunning decreases in price per installed capacity. In Canada, solar PV prices have decreased by an average of 10% annually for the past ten years,[28] and are likely to continue to do so as PV technology and installers gain efficiency. With these trends, solar energy will become increasingly competitive in the short-to-mid-term and develop as a significant component of the energy industry. Indeed, energy experts foresee solar PV becoming cost competitive with grid electricity in some markets within the next decade. [29]

Again, it is hard to foresee the precise economic and employment effects of renewable energy development within a community. But it is clear that communities with experience in solar energy technology installation, operation and maintenance will be best able to harness the economic, social, and environmental opportunities of that viable solar energy industry. Early movers attract manufacturing industries, which invest both infrastructure and human resource capital in the community, which often leads them to stay and expand once the industry is viable.[30] Solar systems offer manufacturing opportunities not only with respect to PV module and thermal collector technologies, but also installation components such as racking structures. This means that more parts making, an employment-intensive aspect of solar energy, is done locally instead of imported. Once a hub or cluster develops in a community, exporting opportunities also become available.[31]

To position itself as an industry leader, centre for sector knowledge and innovation, and hub for technology distribution and technical know-how, a visionary community must build a policy bridge between today's reality and the future's opportunity. This policy bridge must allow potential solar energy generating system owners to obtain a reasonable return on their investment, creating the conditions for the free market to finance solar energy systems and to signal to supply chains, distributors, retailers, installers, and other relevant industries to prepare their capacities for meeting demand. Indeed, the jurisdictions in the world that have most of the manufacturing industries for renewable energy are those that have provided significant government support for renewable energy.[32] This is how a community can "hit the ground running" when the point of technology viability arrives. CLEAN contract programs are the best policy mechanisms for this purpose.

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[26] EDCA Associates, *Quarterly Forecast Update: First Quarter 2011*, March 14, 2011, p. 117
[27] Ibid. at p. 102
[28] Canadian Solar Industry Association, *Canadian Solar PV Market*, http://www.cansia.ca/market-intelligence/market-research/canadian-solar-pv-market.
[29] International Energy Agency. 2010. *Current and Projected Costs.* http://www.iea-pvps.org/pv/snapshot/costs.htm.
[30] Clare Demerse, *supra* note 1, at p. 40.
[31] Ibid. at p. 36.
[32] Ibid. at p. 37.

2.2 CLEAN Contracts

2.2.1 Basics

CLEAN contract programs provide guaranteed revenue sources to participating renewable energy generators through long-term contracts. Because of the revenue security of a contract with a guaranteed rate, this category of policy instruments is widely recognized as the most successful mechanism for rapidly developing renewable energy. They are not specific to solar energy, but we focus on solar energy here. Though the details of a CLEAN contract program vary widely according to many parameters, there are two key features.

First, successful CLEAN contract programs set a guaranteed payment tor energy produced based on the actual cost of the energy generation plus a reasonable profit. The program secures this rate with the energy producers through long-term contracts. When a government properly sets the rates and program details, constituting an effective and appropriate program, it:

- Ensures cost recovery and a reasonable return, which develops economic interest in solar energy and drives free-market attention to the industry.
- Ties monetary support for system development to energy production, ensuring owner responsibility for maintaining efficient operation of the system throughout the contract term.
- Provides developers with long-term certainty, overcoming the risk of price volatility that is a major obstacle to renewable energy development.
- Permits diffuse, small owners who cannot absorb substantial investment risk to overcome risk and financing challenges, allowing broader society to participate practically in solar energy development.
- Facilitates access to financing, thanks to simple, clear, transparent, long-term contracts for guaranteed rates that cover payments.
- Provides market predictability for the program's availability, sending a clear signal to manufacturers and installers to hire and train crews and make long-term infrastructure and human resource investments.
- Overall, provides the best way of overcoming the major obstacles to near-term solar energy development, and ensuring quick uptake within the community.[33]

Second, the best form of CLEAN contract programs obtains the funds for their incentives from energy users. Though the specific source of funds is not essential to the goal of encouraging quick and effective solar energy uptake, it is, however, key for obtaining the following additional benefits:

[33] See Roger Peters and Tim Weis, *Feeding the Grid Renewably: Using Feed-in Tariffs to Capitalize on Renewable Energy*, February 2008 (The Pembina Institute), available at: http://pubs.pembina.org/reports/FITariffs_Primer.pdf.

- From a fairness perspective, it ensures that energy users pay for the cost of developing energy options that are sustainable and locally sourced, according to their energy use.
- It provides incentive for energy efficiency, driving free-market forces to implement energy efficiency measures, with substantial greenhouse gas emission reduction and job creation potential.

2.2.2 Opportunity for Edmonton

Edmonton has an opportunity to claim a leadership position in municipal energy policy.

The most effective European renewable energy policies, with the same core structures as the CLEAN contract program proposed here, grew out of municipal action in Germany.[34] Municipalities are capable of substantial innovation, which can later lead to adoption by other municipal governments and other levels of government.

Edmonton can be the first city in Canada to deploy the unparalleled potential of CLEAN contract programs municipally. Such a program would mark the city as a trailblazer in renewable energy policy innovation, a centre for visionary and ambitious renewable energy aspirations, and an early mover in taking actual, effective action to position itself as a renewable energy leader. By using the municipal authority to collect franchise fees, as we propose here, Edmonton could set a precedent for similarly placed municipalities across North America and lead a municipal renewable energy tide.

[34] See Tim Weis and Kristi Anderson, *Renewable Energy: FIT for Cities*, Dec. 9, 2010 (The Pembina Institute), available at: http://pubs.pembina.org/reports/fit-cities-fact-sheet.pdf.

3. Municipal Authority & Franchise Fees

3.1 Background: Challenge & Opportunity

Provincial law governing the electricity market and limiting municipal government authority poses some obstacles to implementing a municipal CLEAN contract program in Alberta. These obstacles are not insurmountable, however, as provincial law grants a revenue-generating authority that permits innovative municipal policies for implementing an effective and appropriate CLEAN contract program.

As noted above, the best form of CLEAN contract programs recovers the costs of the program incentives through ratepayer-based charges on energy usage. This is easy enough where a government body sets regulated rates to recover the costs of generation that the government either directly owns and controls or approves through regulatory oversight.[35] Provincial governments, with constitutional jurisdiction, have direct authority to legislate and implement such programs, either within a regulated market or with a guaranteed-rate offshoot of a deregulated market.

Municipalities, however, are creations of provincial statute and derive their legal competencies therefrom.[36] Provincial law delimits the powers and responsibilities of municipalities: enabling provisions establish authority to act, while other provisions restrict municipal actions. As such, provincial law governs the capacity of municipalities to implement a program of CLEAN contracts.

As just described, CLEAN contract programs are relatively intricate policy mechanisms—indeed, their effectiveness is owed, in part, to their nuance. For proper functioning, a set of precise details must be set appropriately to ensure an efficient, effective, and properly functioning policy that is simple for citizens to participate in. At their core, however, CLEAN contract programs require that a municipality possess two basic, discrete authorities, working in concert:

1) the authority to enter contracts with owners of renewable energy installations to pay them set rates for the energy they generate over a contract period; and

2) the authority to recover the costs of those payments from energy users, based on their usage of energy.

[35] As the government body is already setting rates through regulation to recover generation costs, a CLEAN Contract policy is simply a program for more dispersed renewable energy whose higher generation costs are recovered through proportionally higher regulated rates.
[36] See *Municipal Government Act*, R.S.A. 2000 Ch. M-26, s. 5.

By possessing and linking these two authorities, a municipality can implement an effective and appropriate CLEAN contract program.

However, there are certain obstacles to municipalities supporting local energy in Alberta. For electricity, our deregulated market system restricts municipal authority by, for example: precluding direct ownership of electricity generation;[37] and requiring that all electricity generated and retailed be exchanged through the provincial power pool,[38] precluding municipalities from controlling sources of electricity consumed in their limits or directly instituting a premium rate for clean local electricity. Only Medicine Hat is exempted from these limitations.[39] For domestic water heating, legal restrictions on municipal authority to support local renewable energy is less significant, but municipalities are still hindered in recovering program costs from fossil fuel energy users based on usage because of the open retail natural gas market.[40]

Nevertheless, with policy innovation, municipalities can clear these obstacles with alternative mechanisms within their legal competence.

3.2 Authority to Enter and Perform CLEAN Contracts

Nothing explicitly precludes a municipality from supporting local renewable energy through a variety of supportive mechanisms, including CLEAN contract programs. Municipal councils have broad discretion to support local business activities through expenditures, so long as programs meet the *Municipal Government Act*'s procedural requirements for budgeting.[41] Moreover, nothing in the *Electric Utilities Act* or the *Gas Utilities Act* explicitly prohibits a municipality, or any other organization, from supporting local renewable energy generation. Edmonton's recent Solar-Electric Pilot Program exemplifies an Alberta municipality's capacity to help local renewable energy generation within the open market system established by the *Electric Utilities Act*.

CLEAN contract programs equally do not offend provincial law. In fact, CLEAN contracts require little additional municipal authority, only the power to contract with owners of renewable energy systems for guaranteed rates over a contract term. Municipalities have this authority: the *Municipal Government Act* endows Alberta municipalities with "natural person powers", which

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[37] Municipalities in Alberta are precluded from holding an interest in an electricity generating unit that it did not hold as of May 1, 1995, except under ownership structures that prevent tax, subsidy, and financing advantages or "any other direct or indirect benefit as a result of association with the municipality or subsidiary". *Electric Utilities Act*, S.A. 2003 Ch. E-5.1, ss. 95(1)-(3). Small-scale exceptions are where the unit is on municipal property and either the electric energy produced is incidental to the main purpose of another process or the municipality will use a "majority" of the electric energy produced. Ibid. at ss. 95(8), (9).

[38] Ibid. at s. 18(2).

[39] Section 2(1)(a) of the *Electric Utilities Act* exempts the City of Medicine Hat from the Act's application. Other provisions exempt the City from particular restrictions: s. 95(4) allows the City to own generating units; s. 100 precludes application of the Act's governance of distribution systems to the City; s. 1(1)(z) exempts the City's transmission and distribution system from the definition of "interconnected electric system", into which all electricity, with limited exceptions, must be exchanged through the power pool under s. 18(2); and s. 109 exempts the City from the market participation of retailers and customers' rights to purchase from retailers.

[40] Alberta Utilities Commission, *Alberta's Natural Gas Market: Deregulated Since 1985*, http://www.auc.ab.ca/market-oversight/albertas-energy-market/Pages/default.aspx#gasmarket.

[41] *Municipal Government Act*, R.S.A. 2000 Ch. M-26, ss. 242-43.

includes the power to enter contracts that are binding under private law.[42] As such, municipalities are not restricted to the upfront rebates for installed electrical capacity that have been piloted thus far in Alberta. Instead, they can support local renewable energy through production-based payments to renewable energy system owners for any length of contract term.

Of course, municipalities also need renewable energy system owners with whom to contract—and provincial law allows such systems. For electricity, as noted above, the *Micro-generation Regulation* allows electricity customers to set up small renewable electricity systems and to export excess electricity to the grid, without having to exchange this energy through the power pool, a costly administrative process that would otherwise be prohibitive for small generators. For the provision of renewable heat, nothing prohibits utility customers from providing their heating needs with solar heating systems.

As a consequence, Alberta municipalities can support solar PV systems that qualify as micro-generation generating units under provincial law, as well as any SDHW system. They can do so with long-term guaranteed rates for electricity and/or heat generated.

3.3 Authority to Recover Costs from Energy Users

By making appropriate use of its power to levy usage-based franchise fees, municipalities also possess the second key capacity for implementing an appropriate and effective CLEAN contract program: recovering the costs of the program from energy consumers.

Section 360 of the *Municipal Government Act* empowers municipalities to make "tax agreements" with public utilities, including owners of electric and gas distribution systems, establishing annual payments that the utility makes to the municipality in lieu of property taxes and "any other fees or charges payable to the municipality."[43] The "other fees" that the *Act* contemplates include fees for "the use of municipal land upon which an electric distribution system is located" and for "the exclusive right to provide distribution access service within a municipality."[44] These fees are variously called "local access fees" on electricity bills and "municipal franchise fees" on natural gas bills.[45]

The *Municipal Government Act* does not prescribe the method of calculating the franchise fee payments.[46] According to Alberta Energy, the municipality can "charge what it believes is fair considering the local situation."[47] However, the *Act* provides that any agreement for franchise fees must be approved by the Alberta Utilities Commission.[48] Moreover, where the municipality does not own its distribution utility, the franchise fee payment calculation forms part of a broader

[42] Ibid. at ss. 1(1)(t), 6.
[43] Ibid. at ss. 360(1), (2).
[44] Alberta Energy, *Talk about Electricity*, August 2006, http://www.assembly.ab.ca/lao/library/egovdocs/2006/aleo/157581.pdf. These are fees that municipalities can charge to utilities for using their property under s. 61(2) of the *Municipal Government Act*, R.S.A. 2000 Ch. M-26.
[45] In this report they will be termed "franchise fees" as a generic term for both electricity and natural gas bills.
[46] *Municipal Government Act*, R.S.A. 2000 Ch. M-26, s. 360(2) ("the tax agreement may provide for an annual payment to the municipality by the operator calculated as provided in the agreement.")
[47] Alberta Energy, *Talk about Electricity*, *supra* note 44.
[48] *Municipal Government Act*, R.S.A. 2000 Ch. M-26, ss. 360(5).

"franchise agreement" that includes the grant to the utility of the exclusive right to provide the utility service, and this agreement must be approved by the Alberta Utilities Commission (AUC).[49] However, where the utility is a subsidiary of the municipality, the AUC need not approve the agreement.[50]

As a result, municipalities vary in the methods by which they calculate the franchise fees. In all cases, the franchise agreement uses a calculation based on each customer's electricity bill. The utility recovers fees from consumers based on the detailed formulae in the franchise agreements,[51] which vary widely between municipalities.

With respect to electricity, most franchise agreements provide for collecting a percentage of the distribution charges on an electricity bill—according to Alberta energy, this is the "approved method" in franchise agreements "for the approximately 235 municipalities served by ATCO and Fortis Alberta", at least as of 2006.[52] These percentages, again, varied very widely. Edmonton, instead, has directed EPCOR Distribution & Transmission Inc. (EDTI), its electric utility subsidiary, to collect a set rate based on electrical energy consumption,[53] which more precisely aligns the fee cost to energy usage than does basing it on distribution charges. Calgary joined the two methods by directing ENMAX to collect the aggregate of a percentage of distribution charges and a consumption-based rate.[54]

With respect to natural gas, some franchise agreements provide for franchise fees based on a percentage of the total charges on a natural gas bill, whereas others charge a percentage of the delivery charges alone.[55] The range of percentages within each method is also very large. However, because municipalities (except Medicine Hat) do not control their own gas distribution utility subsidiary, franchise fees for natural gas form part of franchise agreements that must be approved by the AUC.

In this way, municipalities in Alberta have the power to implement fees on natural gas and electricity bills, allowing municipalities to recover the costs of a CLEAN contract program from utility energy users. Moreover, the municipalities can base the fees on actual energy use, linking the costs of local renewable energy development to energy consumption. Some cities with their own electric utility subsidiary, that need not submit their franchise agreement to the AUC for

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[49] Ibid. at s. 139(1).
[50] Ibid. at s. 45(5); *Electric Utilities Act*, S.A. 2003 Ch. E-5.1, s 139(1)(b). A utility is a subsidiary of the municipality if the municipality controls the utility in the sense of Alberta corporate law. See *Municipal Government Act*, R.S.A. 2000 Ch. M-26, s. 45(5); *Electric Utilities Act*, S.A. 2003 Ch. E-5.1, s. 1(3); *Business Corporations Act*, R.S.A. 2000 Ch. B-9, ss. 2(2), (4).
[51] Alberta Energy, *Talk about Electricity*, *supra* note 44.
[52] Ibid. Note that "distribution charges" always include a time-based or "fixed" charge (priced in ¢/day of time connected to the electricity grid) and an energy-based delivery charge (priced in ¢/kWh of electrical energy delivered).
[53] Ibid.
[54] Ibid.
[55] Brett Gartner, *Municipal Franchise and Local Access Fees*, November 2005, p. 2, http://www.cfib-fcei.ca/cfib-documents/ab5274.pdf. Note that, like for electricity, "delivery charges" always include a time-based or "fixed" charge (priced in ¢/day of time connected to the natural gas grid) and an energy-based delivery charge (priced in $/GJ of natural gas energy delivered).

approval, including Edmonton, are already using this consumption-based calculation.[56] To our knowledge, no municipality has done this with natural gas franchise fees, but there is no apparent legal prohibition on this type of calculation.

3.4 Edmonton's Franchise Fee Regime

The City of Edmonton has franchise agreements with both EPCOR Distribution & Transmission Inc. (EDTI), the City's subsidiary electricity delivery utility, and ATCO Gas and Pipelines Ltd., the City's non-municipal natural gas delivery utility.

3.4.1 Electricity Franchise Agreement

The City's current electrical franchise agreement with EDTI is for a 20-year term that began January 1, 2004.[57] The agreement provides for a franchise fee payable by EDTI to the City in monthly installments, and calculated according to a schedule to the agreement.[58] The schedule stipulates only the calculation for 2004: it states the total fee for the calendar year and stipulates that this will be collected by EDTI from customers based on electric energy distributed to them each month, as a $ per kWh rate, that the City sets to meet the overall payment.[59] Without action by the City, the schedule provides that the fee for each subsequent year would rise at a percentage rate of inflation plus 1.5%.[60]

Importantly, however, the schedule allows the City to set a different calculation or rate for each calendar year upon notice to EDTI by the preceding October 1.[61] In this way, the franchise agreement affords the City discretion to determine franchise fees for each year.[62]

3.4.2 Natural Gas Franchise Agreement

In mid-2010, the City of Edmonton entered a new 20-year franchise agreement with ATCO Gas and Pipelines Ltd., providing that ATCO must pay a franchise fee.[63] The agreement is modelled from a standard agreement that the Alberta Urban Municipalities Association had developed with

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[56] For municipalities that own their own electric utility, the *Electric Utilities Act* also allows these municipalities to impose fees over-and-above the electric distribution tariffs approved by the Alberta Utilities Commission, and the act is silent on how the municipality might calculate the charge. *Electric Utilities Act*, S.A. 2003 Ch. E-5.1, s. 138(3). However, to our knowledge, no such city, which includes Calgary, Edmonton, Lethbridge, and Red Deer, has made use of this provision.
[57] Franchise Agreement between the City of Edmonton and EPCOR Distribution Inc., January 1, 2004, pp. 11-12.
[58] Ibid. at pp. 4-5. The fee is in consideration of the exclusive rights granted in the franchise agreement and the use of City lands only. Ibid.
[59] Ibid. at Schedule A.
[60] Ibid.
[61] Ibid. Interestingly, the agreement also provides that the City can set a new fee for each five-year period of the agreement. Ibid. at p. 12.
[62] City of Edmonton Finance and Treasury Department, *Franchise Fees Rate Increases: 2011 Operating Budget*, 2010FTF051, tabled and approved at agenda item 5.7 of the November 9, 2010, meeting of Edmonton City Council, p. 1 [hereinafter "*Franchise Fees Rate Increases*"].
[63] Franchise Agreement between the City of Edmonton and ATCO Gas and Pipelines Ltd., June 8, 2010. The fee is in consideration for the exclusive grant of franchise to ATCO and use of municipal rights-of-way. Ibid. at p. 6.

ATCO and that the Alberta Utilities Commission's predecessor had reviewed and approved in 2003.[64] It stipulates that the franchise fee "will be calculated as a percentage of [ATCO's] actual total revenue derived from the Delivery Tariff" that ATCO submits to the Alberta Utilities Commission for approval, under the regulated natural gas delivery process.[65]

Initially, the agreement set the franchise fee percentage at 28.5% but allows the City to amend the percentage for each year, with notice by the prior November 15. However, the percentage cannot exceed 35% "unless there has been prior Commission approval." The agreement also allows the City to amend the method of calculating the franchise fee, "provided that any such amendment is approved by the Commission where such approval is required."[66] City administration has noted that the agreement provides the City "flexibility to change the franchise fee rate and methodology during the term of the agreement"[67], but it is not clear whether the Commission approval required would be forthcoming.[68]

3.4.3 Current Rates & Best Franchise Fee Uses

In November 2010, City Council approved a planned increase to the rates for 2011, 2012, and 2013.[69] It did so based on Administration's recommendation that the fee rate increases would "provide a source of funding for priority areas" while containing proposed tax levy increases.[70] It is important to note in the case of electricity that part of the year-over-year increase in annual revenue from the rate increases has already been budgeted by the City based on the default (inflation +1.5%) rate increase provided in the franchise agreement – what the City refers to as the "base change".[71] Similarly, with respect to natural gas, the City had budgeted with projections for revenue from the natural gas franchise fees, but the distribution tariffs expected by ATCO have since fallen, so part of the rate increases are covering that shortfall in projected revenues. Therefore, it appears that only the amount of revenue over-and-above prior projected revenues has been budgeted as part of the "revenue strategy" to help fund the City's strategic initiatives. The two tables excerpted below represent the City's rate increase and revenue strategy plans.

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[64] Alberta Utilities Commission, *City of Edmonton: Franchise Agreement with ATCO Gas and Pipelines Ltd.*, Decision 2010-261, June 8, 2010, p. 1 [hereinafter "AUC, *Franchise Agreement with ATCO*"]; City of Edmonton Finance and Treasury Department, *ATCO Franchise Fee Agreement: Additional Information*, 2010FTF003, January 4, 2010, p. 1 [hereinafter "*ATCO: Additional Information*"].

[65] Franchise Agreement between the City of Edmonton and ATCO Gas and Pipelines Ltd., June 8, 2010, p. 6. The "Delivery Tariff" includes "the fixed charge, base energy charge, [and] demand charge", but excludes the cost of gas. Moreover, ATCO is to charge the rate to consumers and pass the revenue to the City and helps the City to estimate the delivery tariff revenues from consumers for subsequent years. Ibid., pp. 6-7.

[66] Franchise Agreement between the City of Edmonton and ATCO Gas and Pipelines Ltd., June 8, 2010, p. 7.

[67] City of Edmonton, *ATCO Additional Information*, *supra* note 64, at p. 2.

[68] The AUC approved the agreement on June 8, 2010, "subject to the terms and conditions in the Franchise Agreement." AUC, *Franchise Agreement with ATCO*, *supra* note 64, at p. 1; City of Edmonton, *ATCO: Additional Information*, *supra* note 64, at p. 1.

[69] City of Edmonton Finance and Treasury Department, *Franchise Fees Rate Increases*, at p. 1.

[70] Ibid. at p. 3.

[71] Ibid. at p. 1.

Table 2 - Rates	2010 Budget	2011 Proposed	2012 Proposed	2013 Proposed
Electricity Franchise Fee Rates				
Rate ($ per kWh)	$0.0057	$0.0066	$0.0068	$0.0073
Rate Increase		$0.0009	$0.0002	$0.0005
Percent Increase		16%	3%	7%
Gas Franchise Fee Rates				
Rate (% of delivery charges)	28.50%	32.90%	34.30%	35.00%
Rate Increase		4.40%	1.40%	0.70%
Percent Increase		15%	4%	2%

Figure 1. Electricity and natural gas franchise fee rate increases approved by Edmonton City Council in November 2010. (Source: City of Edmonton)[72]

Table 1 - Revenue	2010 Budget	Base Change	2011 Proposed	Base Change	2012 Proposed	Base Change	2013 Proposed
Electricity Franchise Fee Revenue ($Mil)							
Base Revenue	40.924	1.432	42.356	1.482	43.838	1.534	45.372
Revenue Strategy (Cumulative)			5.707		6.794		9.530
Total Proposed Revenue			**48.063**		**50.632**		**54.902**
Gas Franchise Fee Revenue ($Mil)							
Base Revenue	44.380	(2.055)	42.325	0.543	42.868	0.402	43.270
Offset 2011 Base Revenue Reduction			2.055		2.055		2.055
Revenue Strategy (Cumulative)			4.524		6.729		7.814
Total Proposed Revenue			**48.904**		**51.652**		**53.139**
Total Gas and Electricity Franchise Fee Revenue ($Mil)							
Total Base Revenue	85.304	(0.623)	84.681	2.025	86.706	1.936	88.642
Offset 2011 Base Revenue Reduction			2.055		2.055		2.055
Revenue Strategy (Cumulative)			10.231		13.523		17.344
Total Proposed Revenue			**96.967**		**102.284**		**108.041**

Figure 2. Revenue from franchise fee rate increases that is additional to previously budgeted franchise fee revenue and indicated for City revenue strategy. (Source: City of Edmonton)[73]

The City is planning to continue to increase the electricity franchise fee rates over the 2012-2013 period. These rates can still be modified and, according to the City's franchise agreement with EDTI, these rates can increase more or rates in subsequent years can continue to increase, with great discretion and flexibility for the City.

For natural gas, the City has also set the franchise fee rates to increase. However, the City ultimately makes full use up to the 35% cap by 2013. Any increase beyond the 35%, or any

[72] Ibid. at Attachment 1.
[73] Ibid. at Attachment 1.

change to the method of calculation, would require approval of the Alberta Utilities Commission.[74]

It is not clear whether the Alberta Utilities Commission would be open to a rate increase beyond the 35% cap, but there is no clear rule, standard, or instruction to foreclose such an increase. In any case, there may still be budget room in the 2012 and 2013 budgets to direct the revenue from franchise fees toward a CLEAN contract program. In proposing the franchise fee increases that City Council approved, Finance and Treasury suggested that Council "may wish to consider for upcoming budget cycles in 2012 and 2013 … to direct franchise fee increases in those years to fund initiatives which will advance the City's strategic priorities."

3.5 Renewable Energy Uses for Franchise Fee Revenue

A particularly appropriate strategic priority, linked to the source of the revenue, would be Edmonton's strategic goal to increase its sustainability and reduce its greenhouse gas emissions,[75] particularly its environmental strategic goal, currently under development, to have a "significant and increasing proportion of [its] energy come[] from renewable sources, with as much as reasonably possible produced locally."[76]

Tying franchise fees, ultimately a cost to energy consumers, to renewable energy development is a particularly appropriate use for this revenue source. It is energy consumption that creates the city's demand for energy supply with the substantial attendant GHG emissions. In endeavouring to increase its reliance on and production of locally produced energy, the City should place the costs of a "policy bridge" to a less volatile and more sustainable local energy future on current energy consumption. This is fair and adheres to the "user pay" principle.

Moreover, in covering the costs of a CLEAN contract program with energy consumption-based fees, the City would harness another major opportunity for substantial greenhouse gas reduction and resilience to energy price volatility: energy efficiency. The footprint reduction and economic development potential of energy efficiency is massive.[77] Efficiency is sometimes referenced as a form of "renewable energy supply" as it frees up already available sources, or limits the need for new ones. Through groundbreaking policy innovation, the City of Edmonton can link two key energy sustainability planks: renewable energy production and energy efficiency.

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[74] Ibid. at pp. 1-2.
[75] City of Edmonton, *The Way Ahead: City of Edmonton Strategic Plan 2009-2018*, p. 11 available at: http://www.edmonton.ca/city_government/documents/COE_strategicbook-FINAL.pdf.
[76] City of Edmonton, *The Way We Green: The City of Edmonton's Environmental Strategic Plan*, 2011, p. 52, available at: http://www.edmonton.ca/city_government/city_wide_initiatives/environmental-strategic-plan.aspx.
[77] Marbek and MK Jaccard & Associates (2006). *Demand side management potential in Canada: Energy Efficiency Study*. Available online at: http://www.electricity.ca/media/pdfs/policy_statements/EE-DSM_Final%20Report.pdf; McKinsey & Company (2009). *Unlocking efficiency in the US Economy,* available online at: http://www.mckinsey.com/clientservice/electricpowernaturalgas/us_energy_efficiency.

4. Model CLEAN Contract Program for Edmonton

CLEAN contract programs involve many design criteria and a series of detailed decisions. As a category of policy mechanisms, it is amenable to a variety of social and economic goals. Here, we propose a solar energy incentive program for the City of Edmonton that is both visionary and realistic.

The framework we describe represents the application of a method — a series of equations — to certain key judgments, assumptions, and projections — "inputs" — that produces the guaranteed rates, overall program costs, and triple-bottom-line impacts that result — "outputs". With this method, we can enter different inputs to build an appropriate program and observe the resulting outputs.

In this chapter, we make certain key decisions in designing an appropriate CLEAN contract program. Though we explain and justify our policy choices, this is not presented as a final analysis or a take-it-or-leave-it option. It is a framework for how an appropriate and visionary program could work in actual practice in Edmonton, to facilitate discussion toward this end.

4.1 Appropriate Annual Installation Targets & Project Categories

At the first step, a CLEAN contract program can choose annual installation targets that can also function as program caps for some cost certainty for the program and to facilitate budget planning. Program caps are not necessary elements of a CLEAN contract program. Indeed, they place a countervailing upper-limit on a program whose main purpose is to galvanize quick renewable energy deployment. However, program caps can be justified for a few reasons if chosen appropriately and reviewed in subsequent years.

First, as mentioned, the caps provide an upper-limit to program costs and thus facilitate budget planning. With a maximum amount of annual renewable energy capacity to be installed under the program, the amount of resulting renewable energy production that will receive the guaranteed rate can be predicted with some accuracy. In the framework presented here, it is safely assumed that the program will be fully subscribed to the modest program cap.

Second, there is some risk that accelerating the deployment of renewable energy systems too quickly will lead to under-qualified new entrants to the installation industry. Without caps, or with caps that are too high, interest in the program could well exceed the capacity for necessary quality training within the local industry. Appropriate caps, along with requirements for appropriate installer certifications, can ensure ambitious, but resilient and robust industry growth.

These considerations have determined the caps that have been chosen for the model CLEAN contract program. Based on discussions with industry participants, looking to existing installation industry capacity and its ability to grow, modest initial caps are appropriate with acceleration to more ambitious caps in subsequent years based on industry's well known ability to respond when there is some certainty in a developing market. For this reason, we have sketched a plan for a five-year program, allowing sufficient forward outlook for existing industries and new entrants to form reasonable expectations and plan investment in labour training and overall business development. The steady growth in caps allows for an ultimately ambitious rate of installations with measured industry growth.

Since CLEAN contract programs set guaranteed rates to ensure a reasonable return on costs and since installed costs of renewable energy systems decrease for larger systems, it is appropriate to subcategorize projects by size for the purpose of rate setting. These categories depend, in large part, on the type of ownership that policy setters want to prioritize. Here, the model program's framework focuses on smaller residential systems. This ensures that economically sensible renewable energy development is widely available to many people, democratizing energy production and exposing more residents and their networks of peers and relationships to renewable energy technologies. This helps to meet one of the goals of the Renewable Energy Task Force: to increase the awareness of people to renewable energy and its potential and technologies. As such, the model program ensures a fair rate for small systems that are typical for single-household residences.

Solar PV

Because the *Micro-generation Regulation* allows only for energy generating systems related to the site consumption, we set the maximum rating in the smallest category at about 10% above what may likely be the size for an average household consumer: 6 kW. This is somewhat above the usual practical size of a single household system, as limited by appropriate south-facing roof area. To accommodate larger residential buildings, we have also created a category and set aside program capacity for 6-10 kW systems, though we have assigned most of the program capacity to the first category. Table 4.1 shows the caps for each of the five years of the framework program, which are referred to as "cohorts": the group of systems that are installed in that calendar year.

Table 4.1. Solar PV Program Categories and Caps

Cohort		2012	2013	2014	2015	2016	Total
6 kW or less	kW	350	700	1500	2750	3750	9050
6-10 kW	kW	150	300	500	750	1250	2950
Whole Program	kW	500	1000	2000	3500	5000	12000
Energy generation	MWh/year	560	1120	2240	3940	5600	13440

The overall program cap grows to installing 5 MW of capacity per year by the fifth year of the program. This is ambitious: the 2010 City of Edmonton pilot program provided support for 66 kW of total capacity for both residential and commercial programs combined. The speed with which this program was subscribed, however, indicates substantial interest to fill the total, particularly with the opportunity of guaranteed rates ensuring a return on investment. The pioneering municipal program for guaranteed rates for solar PV in Gainesville, Florida, with a municipal population around 120,000, started with a 4 MW per year program and each year has easily fully subscribed. Gainesville's existing rate of solar PV installations, however, was much higher and permitted faster deployment.

SDHW

For the SDHW program, we have designed the program to accommodate one type of system: the standard residential two-collector system typical on households with 3-4 people. The program is relatively small, so that limiting the program to such systems is a reasonable option for this first installment of a longer-term series of CLEAN contract programs. The City could establish subsequent or coinciding programs for larger residential complexes and commercial buildings, or the first program could allocate capacity to these separate systems. Table 4.2 shows the annual caps for the SDHW program.

Table 4.2. SDHW Program Caps

Cohort		2012	2013	2014	2015	2016	Total
# of Systems		100	200	400	700	1000	2400
Area	m^2	600	1200	2400	4200	6000	14400
Energy Production	GJ/year	1190	2380	4750	8320	11900	28500

4.2 Appropriate Guaranteed Rates

Setting a fair and appropriate guaranteed rate for renewable energy production is key to implementing an effective CLEAN contract program. In the simplest sense, it must allow for system owners to experience reasonable economics on their system: recovery of its capital cost and a reasonable return. This ensures program uptake. The greater the return on investment, the broader the interest in the program and the greater the exposure to renewable energy systems across the community. Striking a reasonable balance, though, is important for a cost-effective program and for avoiding unfair windfalls for program subscribers.

Methods for setting appropriate rates vary. The most refined methods include sophisticated finance considerations. For modeling the proposed program, we employed the Chabot Profitability Index Method (Chabot PIM), lauded and used extensively by Paul Gipe.[78]

The major inputs using this method include the return on equity and interest on debt invested in the project by the consumer. From these inputs, we can determine the Weighted Average Cost of Capital (WACC), which is the annual cost to the project owner of making their investment, whether in terms of interest on debt that they assume or lost opportunity to invest their assets elsewhere (opportunity costs). When an energy customer makes an investment in a renewable energy system and we develop a program to allow them to recover their costs based on energy

[78] See Paul Gipe, *Chabot Articles Previously Published on Wind-Works*, http://www.wind-works.org/FeedLaws/France/ChabotonWind-Works/ChabotArticlesPreviouslyPublishedonWind-Works.html; Paul Gipe, *Documents by Bernard Chabot*, http://www.wind-works.org/FeedLaws/France/ChabotonWind-Works/DocumentsbyBernardChabot.html; Paul Gipe, *Background on the Cost of Generation and the Chabot Profitability Index Method*, http://www.wind-works.org/PricingWorksheets/BackgroundontheCostofGenerationandtheChabotPIMethod.html.

produced over time, we need to account for the costs of their tied-up debt or assets over this time. The WACC allows us to account for these costs. With the WACC, combined with the number of payments and the length of time these payments are made (the term of the contract), we can determine the Capital Recovery Factor (CRF). By multiplying the CRF by cost of the installed system, we can determine how much the program needs to pay the system owner each year to allow the owner to recover their real investment costs.

Contract term: For the modelled program, we set a term of 20 years of payments for energy produced. Setting a relatively long contract term like 20 years reduces the amount of payments necessary in each year (or for each unit of energy) to ensure that the system owner ultimately recovers their costs. However, it extends these payments over a longer time. The major advantage is that it ensures that system owners will maintain their systems to ensure efficient energy production for this longer period.

Interest on debt & return on equity: It is difficult to set a debt interest level given that rates vary between prospective system owners. For modeling our proposed program, we employed a 6.5% interest on debt, based on conversations with solar installers who estimated rates from observations of prior clients. Policy designers should employ a broader survey of the financial market when setting the final policy. We then set the return on equity at the same rate, which is both: expedient – it makes the proportion of a project financed through debt versus equity irrelevant, so that we do not have to make an assumption about this proportion; and fair – a reasonable interest on debt provides a good measure for setting a return on equity that takes proper account of the opportunity costs of the investment.

CRF: The result is a CRF of 0.0908/yr. This gives a "simple payback" of 10-11 years, depending on the cost of operations and maintenance. The simple payback is a measure of how long it takes for the system owner to recover the simple upfront cost of their system from the program payments, but does not account for the cost over time of their investment (interest and opportunity costs).

It is important to note that this provides only recovery of the cost of capital invested. To ensure a profit, a profitability index (PI) would need to be applied. The PI is the ratio of payoff to investment for a proposed project based on the present value of future revenue to the initial investment. The modelled program uses a profitability index of 1.00, meaning the program provides for recovery of a participant's WACC. The proposed program is relatively small and anecdotal evidence indicates substantial "pent up" interest in solar energy installations. It is likely that allowing full recovery of the cost of their capital with a relatively generous 6.5% real return on the customer's investment will elicit enough interest to fully subscribe the program. Moreover, at the end of the 20-year term, the system continues to supply free energy to the customers if they continue to maintain their systems.

Using both the CRF and the annual cost of operation and maintenance (O&M),[79] along with the installed cost of a system, the annual revenue necessary for the customers to recover their real costs over the 20-year term can be calculated. Then, the necessary revenue per energy produced,

[79] Operation and maintenance (O&M) costs for PV systems consist of an inverter replacement approximately every 15-20 years at $0.40/W of installed capacity. O&M costs for solar thermal systems include a glycol exchange every three years at approximately $165 for the standard 6 m^2, two-converter system.

the "guaranteed effective revenue rates", can be determined based on the amount of projected energy produced in a year from the system.

Based on a small survey of locally and regionally based installation companies, we have estimated the installation costs per capacity for both solar PV project categories and the SDHW projects, as well as changes in installed capacity costs over the five years of the program based on a rough approximation of historic cost changes. Table 4.3 and 4.4, for solar PV and SDHW respectively, show these inputs and resulting outputs, the guaranteed rates for each cohort.

Table 4.3. Calculating Guaranteed Effective Revenue Rates for Solar PV Program

Category		6 kW or less	6-10 kW
Installed System Price	$/W	$7	$6
Projected Annual Change	%	-10%	-10%
Annual O&M Expenses	$/kW	$20.00	$20.00
Guaranteed Rates 2012	(¢/kWh)	59¢	50¢
Guaranteed Rates 2013	(¢/kWh)	53¢	45¢
Guaranteed Rates 2014	(¢/kWh)	47¢	41¢
Guaranteed Rates 2015	(¢/kWh)	43¢	37¢
Guaranteed Rates 2016	(¢/kWh)	38¢	33¢

Table 4.4. Calculating Guaranteed Effective Revenue Rates for SDHW

Category		6 m^2 system	
Installed Cost	($/$m^2$)	$1,420	
Projected Annual Change	%	2%	
Annual O&M Expenses	($/$m^2$)	$9.17	
Guaranteed Rates 2012	($/GJ)	$69.56	= 25.0 ¢/kWh
Guaranteed Rates 2013	($/GJ)	$70.96	= 25.5 ¢/kWh
Guaranteed Rates 2014	($/GJ)	$72.38	= 26.1 ¢/kWh
Guaranteed Rates 2015	($/GJ)	$73.82	= 26.6 ¢/kWh
Guaranteed Rates 2016	($/GJ)	$75.30	= 27.1 ¢/kWh

Again, these are modelled numbers, based on an ambitious but measured program to put substance to the program framework. Different inputs might be used to strike a different balance. Moreover, the actual program would reassess system costs, and other inputs, annually to ensure that changes are reflected in designing the optimal program for each cohort.

4.3 Program Administration & Cost

In order to ensure that system owners receive the guaranteed effective revenue rates for their solar energy production, the CLEAN contract program will need to "top up" other sources of what is, effectively, revenue: the costs of displaced energy. This creates some difficulty in projecting the program costs, due to volatile and difficult to project energy prices, but we can employ conservative estimates for a safe approximation of program costs.

4.3.1 Contribution of CLEAN Contract to Energy Cost Savings

For solar PV, the micro-generation units supply electricity to the electricity consumer's domestic load and only export electricity to the grid when there is a surplus. Electricity that they supply for their domestic load offsets the cost of electricity that they would otherwise import from the grid, which is calculated from the retail electricity price, the energy-based delivery prices (distribution, transmission, and rate riders), and the franchise fee, all including associated GST. For the electricity that is exported to the grid, the micro-generator receives a credit at only the retail electricity price.

Therefore, we need to know how much of their electricity is used for their domestic consumption and how much is exported. Fortunately, we can derive these using two pieces of information that are automatically installed on all solar PV systems: 1) a data display at the inverter on the solar PV system itself measures the total electrical energy generated by the solar PV system; and 2) the meter required by the *Micro-generation Regulation* that measures the electricity both exported to and imported from the grid. The program administrator, therefore, only needs the three data points (total, import and export) plus the retail electricity price (the "exported price") and the price of delivered electricity ("total imported price") to determine the appropriate CLEAN contract program contribution rate, which can be termed a "top up".

Figure 4.1 shows these relationships in a diagram. The total payment represented by both green and blue blocks shows the total revenue that is sufficient to make the system investment economic, which is determined in this report using the Chabot-PIM method. When a solar energy system produces energy, the homeowner obtains some benefit directly from the energy generation, a sort of "effective revenue": in the case of solar PV, the system's owner reduces their net cost of importing electrical energy from the grid either by displacing the electricity that they would otherwise purchase from the grid; or by selling their excess energy to their electricity retailer. This makes up the green block. The CLEAN contract program supplies a top up, the blue block, to meet the overall guaranteed rate. In this way, the CLEAN contract program does not cover the full cost of the guaranteed rate, only the top up necessary to bring the system owner's effective revenue up to the guaranteed rate. This controls program costs while still providing for viable solar installations.

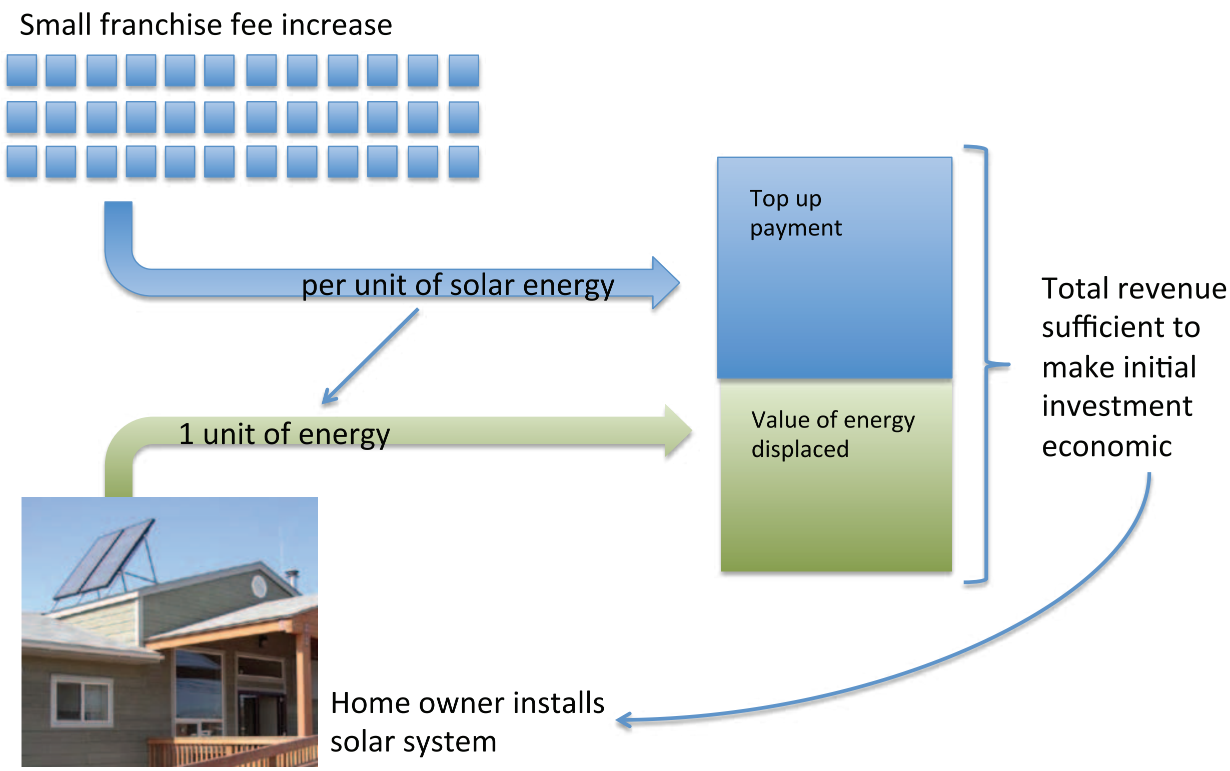

Figure 4.1. Schematic showing the CLEAN contract program contribution to a guaranteed rate sufficient to make investment in solar energy installations economic

SDHW is similar, but simpler, and Figure 4.1 still applies. Energy produced from the solar heating system offsets the use of imported natural gas. The program administrator needs only to determine the amount of energy produced by the solar thermal system, with a standard off-the-shelf revenue-grade heat meter [80]. This energy then directly offsets energy imported in the form of natural gas. The CLEAN contract program's contribution (blue block) is based on the guaranteed rate minus the price of delivered natural gas (green block), which includes the retail price and the energy-based transmission and distribution prices, rate riders and associated GST.

4.3.2 Program Cost and Fund Administration

Budget projections, however, are difficult due to the volatility of energy prices and the need to forecast for the length of the program. For the purposes of modeling this proposed program, we determined current energy prices and increased them annually only by inflation. This is very conservative, such that there is a high likelihood that actual program costs will be lower than our forecasts.

For retail energy prices for both electricity and natural gas, we averaged the monthly regulated rates available in the City of Edmonton over the prior year, to average out the annual cycle of weather-related energy fluctuations. We then simply applied a 2% annual inflation increase to both this derived annual average retail rate and the current price for delivery charges. For the

[80] Revenue-grade heat meters are readily and commercially available in Canada. They are widely used in Europe to measure heat. They consist of two thermocouples and a fluid volume meter.

overall delivered energy rate, we also projected franchise fees. For 2012 and 2013, we used the City's current plan for franchise fee rates. For subsequent years, we used the "base change" for electricity franchise fees (increasing by 1.5% + annual inflation, which we estimated at 2%) and kept the natural gas franchise fees at 35% of delivery costs. Finally, to project the costs of the solar PV CLEAN contract program, we assumed that half of the electricity generated by each PV system will go to domestic load, while the other half would be exported to the grid.

From these assumptions and calculations, we were able to derive the necessary payments from the CLEAN contract programs out to 2035. Using a 3.5% discount rate, comparable to the interest rate on a long-term GIC, we calculated the net present value of these annual program costs. We think this is a conservative estimate, based on the long-term GIC return that should be available for a very large upfront fund.

A number of options for administering the funding are available. The City could directly pay the program costs of each year from revenue in that year's budget, such as franchise fees. However, because the City binds itself to the program costs upfront, it is appropriate to establish funding for the program at that time. The City could either set up funding each year to satisfy the projected costs of the contracts made in that year; or the City could average the costs of the program over the five years. For modelling purposes, the report adopts the latter, averaging the net present value cost of the entire program over the five years of the program, then applying the same discounting rate to project the necessary funding for years 2013-2016. We did this for both the solar PV and SDHW programs.

Finally, the City may chose to establish the program, set aside the necessary funding, and source the administration of the program funding out to some other organization. Accounting for the costs of doing so, as well as the financial fees for properly investing the upfront funding, we have added a 5% administration cost to the whole project.

Tables 4.5 and 4.6 show the funding costs for each of the five years of the respective programs.

4.3.3 Franchise Fees & Consumer Impact

Again, the City has a number of options for paying for the program. For the reasons described earlier — fairness, user-pay principle, and providing incentives for energy efficiency — this report models franchise fees as the revenue source for program funding. In this way, the portion that the CLEAN contract program contributes toward the guaranteed rate is recovered in a dispersed fashion from energy consumers, as illustrated in Figure 4.1.

Tables 4.5 and 4.6 show the costs of paying for the entire solar PV and SDHW CLEAN contract program commitments (20-year contracts) upfront, averaged over the five years of where the program signs contracts for new systems. Tables 4.5 and 4.6 also show the franchise fee impacts for each program based on this upfront financing mechanism. These are estimates based on citywide electrical energy and natural gas consumption and projected natural gas delivery prices. The franchise fee prices necessary and the impacts on residential energy consumers are cumulative, not year-over-year changes.

Table 4.5. Annual Solar PV Program Funding Costs & Franchise Fee Impacts

Year	Annual Cost for 5-year Program (Future Value)	Franchise Fee Necessary (¢/kWh)	Average Annual Cost of Program per Residential Household
2012	$11.1 Million	0.15¢	$9.41
2013	$11.4 Million	0.15¢	$9.53
2014	$11.8 Million	0.16¢	$9.76
2015	$12.3 Million	0.16¢	$10.11
2016	$12.7 Million	0.17¢	$10.46

Table 4.6. Annual SDHW Program Funding Costs & Franchise Fee Impacts

Year	Annual Cost for 5-year Program (Future Value)	Franchise Fee Necessary	Average Annual Cost of Program per Residential Household
2012	$5.28 Million	2.58%	$5.15
2013	$5.46 Million	2.62%	$5.33
2014	$5.65 Million	2.66%	$5.52
2015	$5.85 Million	2.70%	$5.71
2016	$6.05 Million	2.74%	$5.91

The Franchise Fee Necessary columns represent only the funding amounts reflected in terms of the methods in which franchise fee rates are currently calculated from energy bills. These are not necessarily additions to current or planned franchise fee rates. Whether the program costs will be taken out of existing franchise fees levels or from increased fee levels is a different decision point, which would need to be considered at the political level. There are good reasons to raise the fees for the CLEAN contract program, since this is the only way of ensuring that the cost to energy consumers to implement this program avoids conflicts with other demands on general City revenue and ensures that efficiency is promoted in proportion to the costs of supporting solar energy.

Note, again, that this is based on a funding arrangement that pays for the 20 years of payments upfront, in the five years when systems are actually installed. This frees up franchise fee revenue (or other sources of revenue) for subsequent years, allowing the City to follow up with another program.

Electricity franchise fees would thereby have to increase from the currently planned 0.68 ¢/kWh to 0.83 ¢/kWh in 2012 and from the planned 0.73 ¢/kWh to 0.88 ¢/kWh in 2013. Thereafter, the fees would only need to increase by the base change (projected to be 3.5% per year) plus another 0.01 ¢/kWh in 2014, then the same increase again in 2016.

Because the City already plans to increase its natural gas franchise fees to the 35% cap in 2013, further increases require Alberta Utilities Commission approval. The rates would have to rise to 36.88% of natural gas delivery costs in 2012, then gradually to 37.74% by 2016, for the program to recover costs from additional franchise fee increases. Again, the City could, instead, apply currently planned franchise fee revenue to the program.

The last column in each table shows the annual cost of these franchise fee increases to an average residential consumer in Edmonton based on average residential energy consumption.[81] Energy prices fluctuate, so we can only estimate what percentage increase this represents over an average residential customer's annual bill. Based on current delivery charges and the average retail price under Edmonton's regulated rate options (RROs) over the last year, however, these increases represent an estimated 1.10%-1.25% increase on an estimated average $840/year ($70/month) electricity bill and 0.45%-0.55% increase on an estimated average $1070/year (around $89/month) natural gas bill.

4.4 Triple-Bottom-Line Impacts

As discussed previously, it is not easy to project the effects on jobs from the support of renewable energy deployment in a municipality, as opposed to a broader region, because it is very difficult to predict where some of the industries that grow with renewable energy development would expand. However, we can very conservatively estimate the direct employment impacts on more inherently local industries like sales and installation. Table 4.7 and 4.8 represent these estimates, with the total indicating the number of job years over the five-year program. It is vital to remember, however, that these do not account for manufacturing industries that are not inherently local but that may develop in proximity to an early market, nor do they take account of indirect and induced jobs within the city, as noted in Part 2.1.2.

Table 4.7. Triple-Bottom-Line Impacts of Solar PV Program

	Cohort	2012	2013	2014	2015	2016	Total
Direct, Local Jobs Created		18	36	72	126	180	432
Greenhouse Gases Offset	(tonnes CO_2e)	460	920	1840	3210	4590	11020
Investment in Local Systems	($ million)	3.3	6.0	10.9	17.3	22.1	59.8

Table 4.8. Triple-Bottom-Line Impacts of SDHW Program

	Cohort	2012	2013	2014	2015	2016	Total
Direct, Local Jobs Created		3	6	12	21	30	72
Greenhouse Gases Offset	(tonnes CO_2e)	60	120	240	415	590	1430
Investment in Local Systems	($ million)	0.8	1.7	3.5	6.3	9.2	21.6

Tables 4.7 and 4.8 also represent greenhouse gases offset per year by each cohort of the program. Again, a cohort is comprised of all of the systems installed in that year of the program. Each cohort, of course, will have greenhouse gas impacts for each subsequent year that systems are operational. These offsets are realized annually for the life of the systems within the program. The total indicates the offsets realized each year once all five cohorts are operational.

Finally, both tables also represent the future value of direct investment to deploy solar systems locally in each year, derived from the number of systems supported by the program and the cost of each system. The sums reflect the amount of money spent privately directly for the solar

[81] Note that these are calculations relate to average residential consumers only and do not reflect the costs to higher energy consumers like commercial and industrial utility customers.

systems, creating the solar energy infrastructure established and present for the life of the systems.

It is interesting to note that although the CLEAN contract program ensures a guaranteed return on investment for these upfront investments, the total value of local private investment is actually higher than the net present value of the cost of the program to the City. This is because of the non-program contributions to the revenue necessary to meet the guaranteed rates: the value of the displaced utility energy costs and the revenue provided by exporting electric energy to the retailer. In this way, the program helps residents to take advantage of these external revenue (or cost displacement) sources in order to help them to make their local investment economical. In other words, the program would leverage already available utility savings to help bring capital investment to Edmonton.

5. Conclusion

As Edmonton looks to diversify its economy and establish itself as a “knowledge and innovation centre for value-added and green technologies and products”,[82] it has an opportunity to initiate efforts to grasp these opportunities now with pioneering policy innovation. Edmonton has the authority to establish and implement the most powerful and effective policy mechanism for quickly developing renewable energy systems. With novel uses of authorities available to municipalities in Alberta, Edmonton can implement the first municipal program of this type in Canada, setting itself apart as a community with impressive policy vision and out-of-the-box thinking for leading in harnessing the green economy of tomorrow.

Around the world, various jurisdictions of governments are not waiting for the viability of green technologies to establish leadership with the solar industries. Increasingly, communities are recognizing the early mover benefits of developing local technology expertise and creating an early local market for technology manufacturing, distribution and sales. Looking to energy price trends and renewable energy technology price trends, it is clear that renewable energy will be central to tomorrow’s economy. Action today can ensure that a municipality positions itself strategically to compete successfully for attracting the local centre or hub for the renewable energy industry.

Edmonton’s solar resource and urban context provide the prodigious ingredients for substantial solar energy production. With effective policy at the City’s disposal, Edmonton can realize these natural endowments and position itself as a clear regional leader in solar industry development and a visionary policy innovator.

[82] City of Edmonton, *The Way We Grow*, *supra* note 2, at pp. 5, 169.

APPENDIX J: RENEWABLE POTENTIAL FOR THE CITY OF EDMONTON

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Renewable Energy Potential for the City of Edmonton

A Report for the City of Edmonton's Renewable Energy Task Force

Contents

Executive Summary

In 2010, Edmonton's city council established a renewable energy task force that was charged with examining what opportunities the City had to take advantage of renewable energy opportunities.

This research was completed in order to determine the scale of the renewable energy resources that are available within the city's municipal boundaries. This data is intended to assist the task force in determining priorities for policy recommendations.

The research examined the following renewable energy technologies:

- Solar photovoltaic,
- Passive solar space heating,
- Solar domestic hot water heating,
- Ground-source heat pumps,
- Biogas,
- Biomass,
- Low-head hydro, and
- Small wind electricity.

Each technology was evaluated in terms of the quality of its local resource, the potential energy the technology could generate if deployed to its maximum realistic potential given current technology efficiencies, as well as the greenhouse gas reductions that would result from such deployment. Data gaps and areas for further research are also highlighted.

The purpose of this research was to quantify the technical potential for each renewable energy system, not to determine what is realizable over a given period of time. The latter is highly dependent on the policy framework that is in place.

In order to assist in comparing the various renewable energy systems, once the potential for each was evaluated, preliminary ranking criteria were applied to each in order to assist in identifying priorities. It is important to note that each of the ranking criteria was given equal weighting. Depending on city priorities, the relative merits of each technology might vary.

It is also important to note, that this report does not identify or rank the relative ease at which the maximum potential could be achieved for each technology. Finally, it is important to note that on a per unit basis, electricity in Alberta is significantly more polluting and expensive than natural gas and as such, where possible, there is increased benefit to displacing electricity today, although that may not be the case in the long-term.

This analysis found that using current technologies, it is technically possible to generate on the order of 20% of current levels of electricity consumption in the city, and 10% of the natural gas consumption. These are significant opportunities, but they also highlight the importance of improving energy efficiency as well as efforts to improve the overall sustainability of energy supply in the province.

1. Introduction

In 2010, the City of Edmonton established a Renewable Energy Task Force (RETF) with the mandate to: "undertake the research, preparation and delivery of a report to the City of Edmonton examining key opportunities and the technical, economic, and policy barriers to renewable energy generation and use. The report will make recommendations for action in the short, medium and long term to advance the adoption of renewable energy initiatives."

In order to facilitate the work of the RETF, this study assesses the scale of opportunity for select mature renewable energy technologies within the municipal boundaries of the City of Edmonton. This will help inform the RETF in developing priorities and provide a resource for future discussion on renewable energy policy decisions in the City. The analysis in this paper includes information about the availability and accessibility of renewable resources within the city, as well as the scale of benefits, such as investment, job creation and emission reductions.

One-quarter of Alberta's greenhouse gas emissions come from electricity generation – close to current levels resulting from oil sands development.

Electricity generation produces 80 per cent of Alberta's airborne mercury and 30 per cent of its acid rain–causing sulphur oxide emissions.

Source: Weis, T and Bell J. Greening the Grid, The Pembina Institute.

1.1 Energy Consumption in Edmonton

Natural gas and electricity are the primary energy sources in the City of Edmonton for residential buildings, and the commercial, institutional and industrial sectors. The analysis in this report focuses on the opportunities to address emissions from these sources.

The electricity grid in Alberta has one of the highest greenhouse gas emission factors in Canada; this means that in Alberta each unit of electricity used produces more greenhouse gases than in other provinces. In Alberta, on average kWh of electricity that is consumed produces 0.82 kg of CO_2e (coal, which is the majority of generation and emissions is more, while natural gas is less and renewables such as wind and hydro have no emissions). Using natural gas by comparison has significantly lower emissions, producing between 0.45-0.65 kg of CO2e for each kWh of energy that is generated, but is still a longer way from being emissionless.

Table 1: Comparison between coal and natural gas for electricity generation[1]

	Pulverized coal	Natural gas combined cycle
Conversion efficiency	40–43%	50–53%
CO_2 emissions (kg/MWh)	722–941	344–364
SO_2 emissions (ng/J)	198–1,462	0–0.7
NO_x emissions (ng/J)	219–258	5
PM_{10} and $PM_{2.5}$ emissions (ng/J)	15–30	2

[1] Rich Wong and Ed Whittingham, *A Comparison of Combustion Technologies for Electricity Generation* (Drayton Valley, AB: The Pembina Institute, 2006), 7–8. Available online at http://www.pembina.org/pub/1345.

The table below outlines the current energy use and emissions in the city of Edmonton. Note that the columns 'GJ' and 'GWh' are simply the same amount of energy but expressed in different units of measure. The total greenhouse gas emissions associated with the energy use is expressed as Tonnes of CO_2 equivalent (tCO_2e).

Table 2: Energy use and emissions in Edmonton (2009)[2]

	Energy Use		GHG Emissions
	GJ	**GWh**	**tCO_2e**
Residential (298,533 sites)			
Electricity	6,823,117	1,895	1,554,155
Natural Gas	28,478,982	7,911	1,422,127
Total Energy	35,302,099	9,806	2,976,281
Non-Residential (34,051 sites)			
Electricity	19,072,923	5,298	4,344,388
Natural Gas	103,165,970	28,657	5,151,697
Total Energy	122,238,893	33,955	9,496,085
Total	**157,540,992**	**43,761**	**12,472,367**

[2] Electricity data provided by EPCOR, natural gas data from Gary Woloshyniuk, City of Edmonton

1.2 Renewable Energy Opportunities

Renewable energy has been growing rapidly around the world for several decades. In 2008 and in 2009, the United Nations reported that global investments in renewable sources of electricity outpaced investments in new fossil and nuclear based electricity generation combined. The 2030 Energy Outlook, published by British Petroleum (BP) predicts that over the next 20 years, renewable energy will contribute more to new energy growth than oil[3].

In addition to the direct environmental benefit, installing solar energy systems can also have a significant impact on that individual or community's relationship with energy. At an individual level, this can lead to changes in behaviour such as the purchase of energy efficient appliances and equipment, process changes, and support for other renewable energy projects. At a community level, the successful installation of one solar system can often give neighbours the confidence to install their own. Similar conclusions were reached by the National Renewable Energy Laboratory in Colorado with respect to small wind power.[4]

The common definition for renewable energy includes energy from resources that are no depleted as a result of their usage to produce usable energy. Renewable resources are thus naturally regenerated within a reasonable period of time. For example, plants and animals reproduce and re-grow, and water is constantly being cycled and the sun provides continuing energy and generates solar radiation and wind energy. Gravity is also continuous and generates tidal and wave energy and hydropower. Harvesting renewable energy sources does have environmental impacts, as well as impacts on the resources themselves even if they are naturally replenished. The most obvious example is wood that is used for biomass, which needs to be carefully harvested and replanted to ensure its supply is sustainable in the long-term. Hydro power also requires interfering with a river or stream and thus needs careful management and planning to ensure any impacts are minimized. The sources of renewable energy that are reviewed in this report include solar, wind, biomass and biogas, and hydropower. Ground source heat pumps, which use stored solar energy in the earth's surface, are also evaluated. These resources are strictly confined to what might be availability within the current municipal limits of the City of Edmonton. As such other renewable energy sources such as geothermal electricity, tidal, wave and large-scale wind power are not considered.

This report provides technological options to replace fossil-fuelled water and space heating and electricity generation with renewable energy generation. In 2008, 95% of Alberta's electricity was generated using fossil fuels (coal 82%, natural gas 12%, and refined petroleum products 0.03%). The majority of heating needs in Alberta are provided by natural gas. Opportunities exist in Edmonton today for transitioning from relying on fossil fuels to making use of the abundant renewable resources available. The potential for each technology is described along with the amount of energy from fossil fuel sources that would be displaced for electricity or heat generation, along with the quantity of greenhouse gases that would be reduced annually. This

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[3] British Petroleum (2011), *BP Energy Outlook 2030,* available online at: http://www.bp.com/sectiongenericarticle.do?categoryId=9035979&contentId=7066648

[4] National Renewable Energy Laboratory (2000). *Perspectives on an NWCC/NREL Assessment of Distributed Wind* (No. NREL/CP-500-28421)..

report does not examine the significant potential for energy efficiency to further reduce fossil fuel dependence. It is well known that the potentially for energy efficiency is massive[5,6] while still growing the economy. For this reason efficiency is sometimes considered a form of renewable supply as it frees up already available sources, or limits the need for new ones. Furthermore, many efficiency upgrades are cost effectively today, and have immediate impacts on energy savings and greenhouse gas reductions. As important as efficiency is, there is still a need for clean energy generation and that is the focus of this report.

[5] Marbek and MK Jaccard & Associates (2006). *Demand side management potential in Canada: Energy Efficiency Study*. Available online at: http://www.electricity.ca/media/pdfs/policy_statements/EE-DSM_Final%20Report.pdf

[6] McKinsey & Company (2009). *Unlocking efficiency in the US Economy,* available online at: http://www.mckinsey.com/clientservice/electricpowernaturalgas/us_energy_efficiency/

2. Technology Summaries

Each technology that is examined in this report is described in this section. The summaries briefly describe the various technologies, each technology's achievable annual energy production within the city limits and the potential benefits of realizing that potential. The details of the calculations and assumptions that were made to obtain these figures can be found in the appendix.

2.1 Solar PV

Evaluation Criteria	
Technology description	**Basic description of the technology** • Solar photovoltaic (PV) systems convert energy from solar radiation into electrical energy. PV systems typically consist of roof-top mounted solar PV arrays (although they can be mounted on the sides of buildings, on many types of building architectural and structural features, on non-building structures, and on the ground), inverters (converting direct current electricity from the solar cells into alternating current electricity that is used on the grid), and charge controllers and sometimes batteries when electrical storage capacity is needed (typically only in off-grid situations). **Current market penetration (commercially available)** • PV systems are a rapidly growing industry with annual global installed growth rates on the order of 45 world-wide over the past 15 years. The technology is mature and has been proven in extreme conditions including the Arctic and space. Nonetheless, manufacturers are still rapidly improving the technology to increase efficiency, reduce capital costs and increase ease of installation. The NRCan, CETC-Varennes 2006 PV market survey found that the cost of solar PV dropped by over 50% from 1999-2005. Government programs have encouraged significant solar PV growth globally, notably in Germany, Spain, California, Japan and most recently Ontario. Germany, the global leader, installed 3,500 MW (see www.iea-pvps.org) in 2009 alone, and at the time of researching this report was on pace to have installed over 8,000 MW in 2010. These countries are also the major global suppliers of the technology and have been largely responsible for the continuing price decreases. In 2010, the International Energy Agency (IEA) published a solar roadmap which

	"envisions that by 2050, PV will provide 11% of global electricity production (4,500 TWh per year), corresponding to 3,000 gigawatts of cumulative installed PV capacity."[7]
Application	✓ Residential electricity consumption ✓ Commercial / Industrial electricity consumption
Energy potential	**Total Energy Production – Electrical** **Current Potential - Total** • Residential buildings (single detached houses, multi-unit buildings, row houses) – 362,200 MWh / year based on a 3 kW PV system (3,360 kWh/ year / residential dwelling) • ICI buildings – 204,306 MWh / year, based on a 10 kW PV system (12,000 kWh / year / ICI building) **10-year Potential - Total** • Residential buildings (single detached houses, multi-unit buildings, row houses): 419,830 MWh / year based on a 3 kW PV system. • ICI buildings: 224,737 MWh / year, based on a 10 kW PV system **Potential contribution to city's energy supply / demand** **Current Potential** • Residential buildings: 19% of Edmonton's annual residential electricity demand from residential rooftop PV • ICI buildings: 4% of Edmonton's annual non-residential electricity demand could be supplied from rooftop PV mounted on ICI buildings • Rooftop PV could supply 8% of overall electricity demand in City **10-year Potential** • Residential buildings - 22% of Edmonton's current annual demand generation from residential buildings • ICI buildings – 4% of Edmonton's current annual non-residential electricity demand could be supplied from solar PV installed on ICI buildings • Rooftop PV could supply 9% of current total electricity demand in City **Potential impact on energy use of building (% of building energy supply) or sector** • Residential – a well designed and maintained 3 kW solar PV system will provide approximately 55% of the annual electricity consumption for a typical Edmonton home

[7] Technology Roadmap; Solar photovoltaic energy. International Energy Agency, available online at: http://www.iea.org/papers/2010/pv_roadmap.pdf

	which uses 6,302 kWh per year[8].
GHG saving potential	**Potential contribution to city emission reduction targets** • Current solar PV potential could avoid 498,525 tonnes of GHG emissions annually • This represents a 4% reduction in emissions from electricity and natural gas uses in the City
Cost	**Cost of technology for typical installation** • ~$21,000 / residential systems – installed • Depending on the size of the system (between 1-12 kW) costs are approximately $5 – 8 / watt installed. • The International Energy Agency has noted that the price for electricity from PV may become cost competitive with current retail prices in some markets by 2015. [9] **Operating cost** • Very minimal
Economic Development Opportunities	**Job creation** • In 2009, Canada's solar PV industry directly employed 2700 full-time labour place equivalents.[10] According to the Solar Alberta industry directory, there are over 150 businesses specializing in solar PV systems in Alberta • Based on experience in the Canadian solar market, the employment potential for the PV sector is around 40 jobs/MW of newly installed capacity.[11]
Social benefit	**Environmental benefits (including local air quality)** • Reduction in fossil-fuel based large-scale electricity generation. This results in the reduction in GHG emissions, NOx, SOx and other pollutants (particulates, mercury, sulphur) from coal-fired electricity that is dominant in Alberta. • Improvement in local air quality from a reduction in coal-fired electricity generation **Social benefits – long term stability of energy prices, affordability of energy, quality of life** • Given its low operations and maintenance costs, solar

[8] Based on 2009 consumption data.

[9] International Energy Agency, 2010. *Current and Projected Costs.* http://www.iea-pvps.org/pv/snapshot/costs.htm

[10] Josef Ayoub, Lisa Dignard-Bailey and Yves Poissant, *National Survey Report of PV Power Applications in Canada*, June 2010 (prepared for Natural Resources Canada and the International Energy Agency), pp. 7-8, 15. This includes jobs in research and development, manufacturing, distribution, dealing, retailing, installation, and consulting.

[11] Ayoub et al. (2010), pp. 7-8, 15.

	generation results in long-term stability in electricity prices. **Visibility of clean energy technology** • Solar PV systems are highly visible renewable energy systems – arrays of PV modules are mounted exterior to buildings, structures or on the ground.
Consideration for implementation	**Barriers to implementation (e.g. awareness in building industry)** • Solar PV systems do not have attractive paybacks because of current low prices of electricity in Alberta. Capital cost of systems remains high, though is decreasing significantly. • Subdivision design, awareness of the public, designers, builders, electrical contractors. **Programs that can support the technology** • Alberta's Micro-Generation Regulation supports the simplified process and costs to connect to the grid under most building circumstances. • Feed-in Tariff programs have been responsible for over 75% of solar PV installations globally. • Incentives provided by local, provincial or federal governments. For example – provide a rebate on the purchase and installation of a solar PV system. • Renewable Portfolio Standard (RPS) – requires a minimum amount of renewable energy be generated or purchased. • On-site Renewable Energy Requirements for Buildings – are usually implemented by local governments requiring a certain percentage of a building's energy use be generated by renewable energy on the building. These policies also encourage efficiency to lower any incremental renewable energy requirements. Such policies have been implemented in the UK since 2004 and are now common in Europe. • Merging fixed and energy-based utility prices so that all electricity bills are based on consumption levels. **Ease of implementation** • Although installation and maintenance of solar PV systems are relatively easy, implementation of these systems remain challenging mostly due to the costs of these systems in jurisdictions where conventional electricity prices are low. **Ability to monitor impacts and benefits** • Easy to monitor the amount of electricity generated and therefore can provide very accurate accounting for the conventional electricity displaced. **Public acceptance** • High visibility and strong public acceptance.

Examples, resources	**Local, regional, national cases of implementation** • Alberta Solar Showcase - www.lassothesun.ca/ • Riverdale NetZero Project - http://www.riverdalenetzero.ca • Mill Creek net zero energy house www.greenedmonton.ca • Through its Hat Smart program, the City of Medicine Hat offered residential customers a rebate of $6,000 on a single installation of a 1 kW system. The commercial sector was offered 50% of the installed cost of a system, up to a maximum of $50,000. As a result, 24 residential customers and 15 commercial businesses have installed Solar PV systems. – www.hatsmart.ca • ENMAX has launched a five-year initiative to install 8,300 home-mounted solar PV and 700 micro-wind electric installations.[12] This is partially funded by the Climate Change Emissions Management Corporation and is managed by Climate Change Central. • Canadian Solar Buildings Network references a number of commercial case studies of integration of solar technologies in commercial and residential buildings. • Gainesville, Florida implemented the first municipal feed-in tariff (FIT) program in North America aimed at supporting 4 MW of solar PV annually in the City.	
Data Gaps	• ICI building footprint (roof space). This would enable a more accurate estimate of ICI electricity generation potential.	
Further Research	• Determine ICI building footprint (ft_2) to refine non-residential potential	

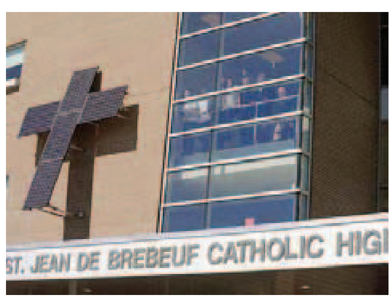

Figure 1: St. Jean de Brebeuf Catholic High School in Woodbridge, ON installed a solar PV system as part of an overall effort to become more eco-conscious

[12] O'Meara, D. (2010) *Enmax launches solar, wind power generation project aimed at 9,000 Alberta homes*. Calgary Herald. Available online at: www.calgaryherald.com/technology/Enmax+launches+solar+wind+power+generation+project+aimed+Alberta+homes/3161837/story.html#ixzz12M8ov0L5

2.2 Passive solar space heating

Evaluation Criteria	
Technology description	• Passive solar heating design converts energy from solar radiation into heat through the use of site orientation, building materials and design techniques to convert, store and distribute heat from the sun. In order to produce as much solar heat as possible, it is preferable that the long axis of the building runs east to west, with window placement on the south facing windows at 7-12% of the total floor area. The building includes thermal mass for heat storage and shading elements such as window overhangs and awnings. **Current market penetration** • Passive solar design has been utilized for centuries as a way to optimize collection of energy from the sun. Contemporary home design in Europe uses passive solar design extensively, but the concept is still emerging in North America.
Application	✓ Residential space heating – new construction ✓ Commercial small building space heating – new construction
Energy potential	**Total Energy Production – Thermal** Though passive solar design can be incorporated into housing retrofits, this analysis has excluded the application and focused on the potential to integrate passive solar heating in new developments. **10-year Potential** • Residential buildings (single detached houses, including duplex and row houses) – 1,819 TJ / year based on the anticipated new housing starts from 2011 to 2020. • Residential buildings – If all new homes built in Edmonton are designed for passive solar heating, the heating potential would represent 6.4% of Edmonton's current annual natural gas consumption (2009) for residential buildings • A passive solar designed house can contribute 40% to 60% of the energy required for space heating. This is equivalent to 32% of the total energy used by a typical single family house.
GHG saving potential	**Potential contribution to city emission reduction targets, 10-year Potential** • 90,870 t CO_{2e} /year • Reduce total residential emissions by 0.73%.
Cost	**Cost of technology for typical installation** • Passive solar design has a minimal cost over and above

	typical housing costs • May require larger lots depending on subdivision design – therefore a passive solar designed neighbourhood may consist of fewer units per area. • No operating costs.
Economic Development Opportunities	**Job creation** • Some job creation associated with construction, installation; additional planning required at the neighbourhood and building design stage.
Social benefit	**Environmental benefits** • Reduction in fossil-fuel based large-scale natural gas generation. This results in reduction in GHG emissions, and other pollutants such as airborne mercury, and acid rain precursors from natural gas exploration, production, processing, transmission, distribution and on-site use. • Increased daylight in buildings reduces electricity use from lighting; this can further reduce energy use and GHGs in the city (this impact would be additional to the analysis provided here). **Social benefits** • Passive solar design considerably reduces the cost of energy for natural gas heating per unit and contributes to the affordability of purchased grid energy • Increased building comfort and productivity associated with increased natural lighting. **Visibility of clean energy technology** • Passive solar design is not immediately visible. Building occupants typically notice improved building comfort.
Consideration for implementation	**Barriers to implementation** • Awareness and knowledge within the building industry (designers, contractors, real estate agents, taxation assessors, insurance) • Passive solar design may have more advantage in lower density settings, but innovative subdivision design can accommodate significant amounts of solar orientation **Programs that can support the technology** • Planning requirements for site orientation in new residential construction • Education and awareness programs for the development and construction industries **Ease of implementation** • Passive solar houses are straight forward to build during new construction. Passive solar design is more about

	community and building design and does not rely on commercially available discrete technologies and equipment (like solar PV and solar hot water systems) **Ability to monitor impacts and benefits** • The benefits and energy savings of passive solar design requires monitoring of the energy use of each house.
Examples, resources	**Local, regional, national cases of implementation** • Riverdale NetZero Project - http://www.riverdalenetzero.ca • Mill Creek net zero energy house www.greenedmonton.ca • Canadian Solar Buildings Network references a number of commercial case studies of integration of solar technologies in commercial and residential buildings.
Data Gaps	• Passive solar community design • Analysis of potential for passive solar design to reduce energy use and emissions from existing facilities (through renovation and building upgrades).
Further research	• Examine possible changes to new building code to include solar orientation and passive solar gain

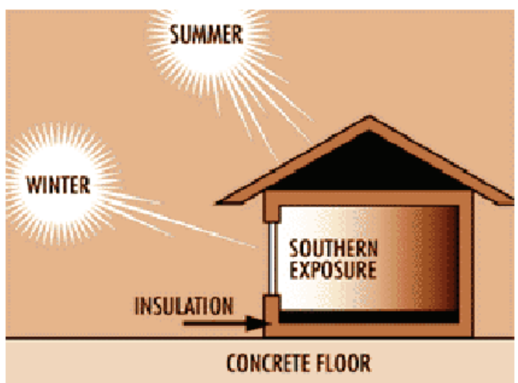

Figure 2: Diagram of how passive solar heating works in a home[13]

[13] Photo courtesy of Solar Energy Society. www.solarenergysociety.ca/2003/passive.asp

2.3 Solar hot water heating

Evaluation Criteria	
Technology description	• Solar hot water systems convert energy from solar radiation into heat and transfer the heat into a storage tank, either directly in cases where the water is unlikely to freeze, or through the use of anti-freeze and heat exchanger in colder climates. Solar water heating does not replace the conventional water heater – it supplements it, and reduces the amount of grid energy needed to heat the water. SHW systems are designed to be mounted on the roofs of houses and in Canada are ideally built facing south. SHW system components include solar collectors, heat exchanger, solar storage tank and a system controller. **Current market penetration** • Solar water heating (SHW) is a proven technology that has been used for several decades in Canada. • A survey of the solar thermal collector industry in Canada for the year 2008 indicated annual revenue of $18 million, which is an increase of 44% from 2007. The revenue from domestic sales increased by 79% from 2007 to 2008. • Though Ontario dominates in the revenue generated by solar thermal collection systems, the Prairie provinces increased their share of revenue compared to the rest of the Canadian market in 2008 by 5%.[14]
Application	✓ Residential domestic hot water heating ✓ Commercial / Industrial hot water heating
Energy potential	**Total Energy Production – Thermal** **Current Potential - Total** • Residential buildings (single detached houses, multi-unit buildings, row houses) – 367,065 MWh / year based on a 2-collector SHW system. • ICI buildings – 73,413 MWh / year, based on 20% energy potential of ICI buildings compared to residential. **10-year Potential - Total** • Residential buildings (single detached houses, multi-unit buildings, row houses) – 436,721 MWh / year based on a 2-collector SHW system. • ICI buildings – 76,896 MWh / year, based on 5% growth in ICI buildings.

[14] Science Applications International Corporation (2009) Survey of Active Solar Thermal Collectors, Industry and Markets in Canada 2008. Available online at: http://www.cansia.ca/sites/default/files/NRCan%20Solar%20Thermal%20Collector%20Survey%202008.pdf

	Potential impact on energy use of building (% of building energy supply) **Current Potential** • Residential buildings – Annual average - 60% hot water needs met with 2-collector system. • ICI buildings – Dependent on annual hot water consumption and available roof space of buildings.
GHG saving potential	**Potential reduction of building emissions** • Assuming displacement of natural gas (and not grid electricity), the emissions savings are 92,332 tonnes per year. • Reduce total City of Edmonton emissions by 0.7%. • Total reduction of energy use in the residential sector of 4.5%.
Cost	**Cost of technology for typical installation** • Residential building - $8,000 typical installation cost for a 2-collector system. • ICI building – Average installation cost - $1,100 / m^2 **Operating cost** • Minimal operating and maintenance costs.
Economic Development Opportunities	**Job creation** • For every $1M invested in the solar thermal industry, 28 jobs could be created.[15] • Job creation primarily in the building and trades.
Social benefit	**Environmental benefits** • Reduction in on-site fossil-fuel combustion, typically natural gas in the City of Edmonton. • Improvement in local air quality from a reduction in coal-fired electricity generation where water is heated electrically. **Social benefit** • Reduces energy costs for homeowners and building operators. • Low risk technology with high visibility in residential neighbourhoods. • SHW systems that are larger (pools, hotels) provide a great opportunity to showcase the technology and increase awareness.
Consideration for	**Barriers to implementation (e.g. awareness in building industry)**

[15] SouthGrow Regional Initiative, *Solar Energy Opportunity Profile,* available online at: http://southgrow.com/sites/southgrow.com/files/SolarEnergyProfile_1.pdf

implementation	• SHW systems do not have attractive paybacks because of current low prices of natural gas in Alberta • SHW systems **Programs that can support the technology** • Incentives provided by local, provincial or federal governments to encourage the uptake of SHW technology. Rebates on the capital and installation cost of SHW systems could offset the high upfront costs and encourage implementation. **Ease of implementation** • Installations of typical residential and ICI solar thermal systems are not common in Canada, although the skills required to install them are readily available if there was some basic training. Flat-plate collectors are more common than evacuated tubes. **Ability to monitor impacts and benefits** • Heat meters can easily measure the amount of heat produced from solar domestic water heating systems and therefore can provide very accurate accounting for the natural gas displaced. **Public acceptance** • High public acceptance of solar water heating systems for building applications.
Examples, resources	**Local, regional, national cases of implementation** • Drake Landing solar Community (domestic hot water and space heating) - http://www.dlsc.ca/ • Okotoks Community municipal pool • Through its Hat Smart Program, the City of Medicine Hat has supplied a rebate of $3,000 to its residential customers who choose to install a SHW system. To date, 22 residential systems have been installed. • In British Columbia, the provincial government developed a model bylaw for SHW readiness construction. All local governments that adopt the bylaw can require new construction to be 'SHW ready', thereby removing some of the initial barriers to SHW implementation. • In Spain, the building code requires that 30-70% of water heating demand be met with renewable energy for new buildings and major renovations; in Barcelona the requirement is 60% for residential water use, 100% for uncovered swimming pools, and 20% for industrial hot

	water.[16]
Data Gaps	• Job creation potential, hot water heating energy consumption for ICI buildings. Suitability of different ICI building types for SHW systems.
Further Research	• Further investigation into SHW potential for ICI buildings in Edmonton • Examination of SHW opportunity for swimming pools

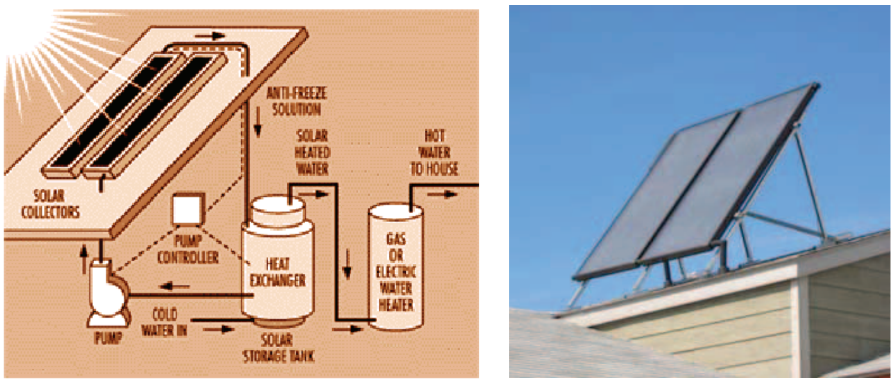

Figure 3: Solar hot water schematic[17] (left), and actual photo of system in Wha Ti, NWT (right)

[16] Horne, Matt and Hayes Zirnhelt. On-Site renewable energy requirements for buildings. January 2010. Pembina Institute. www.greenbuildingleaders.ca.

[17] Photo courtesy of Solar Energy Society. www.solarenergysociety.ca/2003/passive.asp

2.4 Solar air heating

Evaluation Criteria	
Technology description	• Solar hot air heating (SHA) systems convert energy from solar radiation into heat and transfer the heat into air used for ventilation or space heating. These are a Canadian-developed technology that pre-heats air as it enters buildings. The primary manufacturer of solar air heating systems is a Toronto-based firm - Conserval Engineering (www.solarwall.com). • SHA systems are most applicable for institutional or industrial buildings that have large south-facing walls, HVAC systems and significant space heating needs. Buildings such as industrial warehouses and institutional buildings (community buildings, etc). **Current market penetration (commercially available)** • There are over 1,000 SolarWall installations in 30+ countries worldwide[18]
Application	✓ Multi-unit residential / Commercial / Industrial space heating
Energy potential	**Total Energy Production – Thermal** **Current Potential** • ICI buildings – 285,516 GJ / year, based on solar air energy studies potential of ICI buildings. **10-year Potential** • ICI buildings – 299,790 GJ / year, based on 5% growth rate of ICI buildings in Edmonton **Potential impact on energy use of building (% of building energy supply)** • ICI buildings – SHA systems can reduce space heating energy demand by 30% - 40%. Varies depending on building type orientation.
GHG saving potential	**Potential contribution to building emissions** • ICI buildings – For on-site fossil fuel heated systems (natural gas, propane, heating oil), SHA systems can reduce GHG emissions by 30% - 40%. • Assuming displacement of natural gas (and not grid electricity), the emissions savings are 14,970 tonnes per year. • Reduction of all City of Edmonton emissions from electricity and natural gas use by 0.12%.

[18] http://solarwall.com/en/case-histories.php

Cost	**Cost of technology for typical installation** • ICI buildings - SHA systems can pay for themselves in as little as 2 years when they are installed on new buildings. • Typical costs for SHA systems are $290/ m² installed for SHA systems that are larger than 1,000 m². **Operating cost** • Minimal
Economic Development Opportunities	**Job creation** • Jobs created in the installation and commissioning of facilities.
Social benefit	**Environmental benefits** • Reduction in on-site fossil-fuel combustion, typically natural gas in Edmonton. **Social benefits** • Reduces energy and operating costs for building owners; low cost technology and low risk technology. **Visibility of clean energy technology** • The SolarWall technology is very visible, as installations are physically located on the exterior of a large south facing walls; while rooftop mounted solar air ducts are less visible. However, a SolarWall installation does not look markedly different than typical cladding, and are not easily identifiable to the untrained eye.
Consideration for implementation	**Barriers to implementation** • Relatively low number of applications results in lack of awareness. **Ease of implementation** • SHA systems require integration with a building's conventional HVAC system, and are typically straight-forward to install when the orientation of the building and the existing HVAC is correct. SolarWall can usually be installed right over the existing building wall and is an excellent alternative when wall upgrade or replacement is required or when a new building is constructed. **Ability to monitor impacts and benefits** • It is more difficult to monitor the direct energy production from SHA systems. The direct decrease in fossil fuel consumption can be measured if historical data has been collected, although it can difficult be difficult to account for natural variations in usage resulting from annual weather differences. **Public acceptance** • High acceptance as the technology is easy to use and

	integrated with planned or existing buildings. Can provide a visual renewal to existing buildings.
Examples, resources	**Local, regional, national cases of implementation** • Beaver Lake Cree Nation North of Edmonton installed SHA unit on its community recreation building in 2006; SHA has been used in Yellowknife at public facilities.
Data Gaps	• Information on the job creation potential of the technology; additional detail on current potential in Edmonton.
Further Research	• More accurate SHA potential could be developed through audits by SolarWall sales representatives.

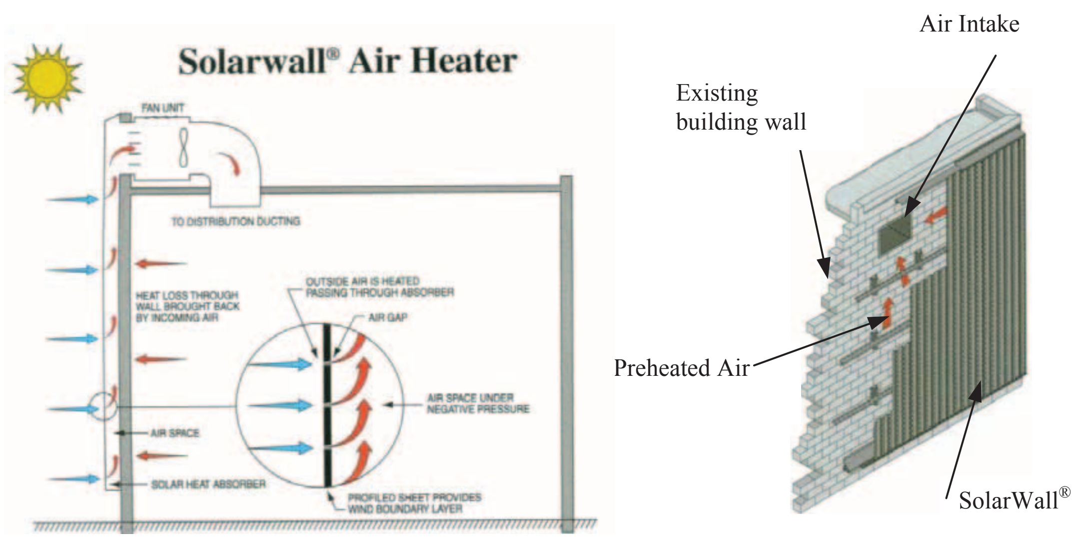

Figure 4: How a solar air heater works

Figure 5: Recreation centre with Solarwall® in Beaver Lake Cree Nation, North of Edmonton.

2.5 Ground-source heat pumps

Evaluation Criteria	
Technology description	• Ground source heat pumps (GSHP), or geoexchange technology use the relatively constant temperature beneath the surface of the earth to heat and cool buildings. Geoexchange systems are able to produce three to four units of free thermal energy from the ground for each unit of electricity input. • Heat pumps require electricity to move around a working fluid to heat and cool the building. The costs and cleanliness of the electricity that is being used therefore has an impact on the overall environmental and economic benefits of a ground source heat pump. In Alberta, where the electricity is heavily coal-based, the emissions reductions are therefore not as significant as they would be in a province such as British Columbia or Manitoba. Most electricity systems in North America (including Alberta) are reducing their emissions intensities, leading to future emissions reductions from GSHPs installed today. **Current market penetration** • Global adoption of geoexchange technology is expanding, with the majority of recent growth occurring in the United States, Japan and Europe. In Sweden, government support and industry standards since the 1980s have grown geoexchange to approximately 40% of the residential market. In Canada, the market is growing – currently there are about 30,000 residential units and 6,000 commercial and institutional units installed.
Application	✓ Residential space and domestic hot water heating ✓ Commercial space and domestic hot water heating
Energy potential	**Total Energy Production – Thermal** **Current Potential** • Residential buildings (single detached, duplex, row houses, and apartments) – 2,320 TJ / year, based on installation of GSHP in 10% of current housing stock. • ICI Buildings – 6,420 TJ / year, based on installation of GSHP in 50% of current buildings. **10-year Potential** • Residential buildings (single detached, duplex, row houses, and apartments) – 2,920 TJ / year, based on installation of GSHP in 25% of the anticipated new housing starts from 2011 to 2020. • ICI Buildings – 7,060 TJ / year, based on installation of GSHP in 100% of new ICI buildings (estimated 5% growth

	rate)	
	Potential contribution to city's energy supply / demand **Current Potential** • Residential Buildings – GSHP energy generation is 8% of the 2009 natural gas consumption for the residential sector. • ICI Buildings – GSHP energy generation is 37% of 2009 natural gas consumption for commercial and institutional buildings. **10-year Potential** • Residential buildings – GSHP energy generation is 10% of the 2009 natural gas consumption for the residential sector. • ICI buildings – GSHP energy savings is 39% of the 2009 natural gas consumption for the ICI sector. **Potential impact on energy use of building (% of building energy supply)** • A residential house that uses GSHP technology contributes approximately 43% of the total energy used by a typical single family house.	
GHG saving potential	**Potential contribution to City emission reduction targets** • In Alberta, assuming a GSHP coefficient of performance of approximately 3.0, the GHG emissions reductions are generally close to break even. This is because although GSHPs can have an efficiency on the order of 300%, the GHG emissions intensity of electricity production in Alberta (primarily coal based) is much higher than burning natural gas in a furnace/boiler. If a building is initially heated using electricity, the installation of a GSHP has a significant emissions reduction potential. It is important to note however, that once a GSHP is installed, steps can be taken to reduce the GHG intensity of the purchased electricity (installing solar PV, purchasing green power or via the trend of grid GHG intensity reductions). By comparison, once a high efficiency furnace is installed, there are no further reductions that can be made.	
Cost	• GSHPs typically have higher capital costs than conventional heating and cooling systems; increased efficiency and lower operating costs mean annual savings in energy costs. • Residential systems cost $9-11 per sq.ft for horizontal loop systems, or $15-25 for vertical loop systems. The total cost for a 2,500 sq.ft home, or $20,000 - $40,000. Payback varies depending on natural gas and electricity prices as well as whether the system is installed as a retrofit or for a new home. Savings also need to be compared against whether a replacement furnace was required anyway, as well as	

	whether the system also replaces an air conditioning unit. Payback can range from 10-30 years depending on the permutations of variables. • Commercial system costs are $9-11 per sq.ft for horizontal loop systems, or $15-25 for vertical loop systems. The total installed cost is dependant on the size of the building and corresponding system. The typical payback can range from almost immediate to 10 years, largely because cooling is often a more significant load in commercial buildings than in homes.
Economic Development Opportunities	**Job creation** • Employment in construction, installation and maintenance of systems.
Social benefit	**Environmental benefits** • Reduction in fossil-fuel based large-scale natural gas dependence for heating. **Social benefits** • GSHPs do not generate onsite emissions or indoor air pollutants **Visibility of clean energy technology** • Ground Source Heat Pumps are not a visible technology, since the heating and cooling system is situated below the structure.
Consideration for implementation	**Barriers to implementation** • Awareness and knowledge within the building industry. • Upfront capital costs of the technology. **Programs that can support the technology** • Incentive programs and financing mechanisms to encourage the installation of GSHPs. • Education and awareness programs for the development and construction industries. **Ease of implementation** • GSHPs are a proven technology in Canada and are straight forward to install and operate. **Ability to monitor impacts and benefits** • Electricity consumption of GSHPs can be measured providing insight on the energy savings and GHG emission benefits, when combined with assumptions about the GSHP's coefficient of performance. **Public acceptance** • High public acceptance. There is no visual impact of the technology. Relatively high capital cost may decrease public acceptance despite significantly lowered operating

		energy costs.
Examples, resources	**Local, regional, national cases of implementation**	
	•	West Jet Campus – Calgary – A geoexchange system provides simultaneous heat and cooling for West Jet's 315,000 ft² building. The system has reduced energy consumption by 35 percent.
Data Gaps	•	Potential for economic development and job creation
Further research	•	n/a

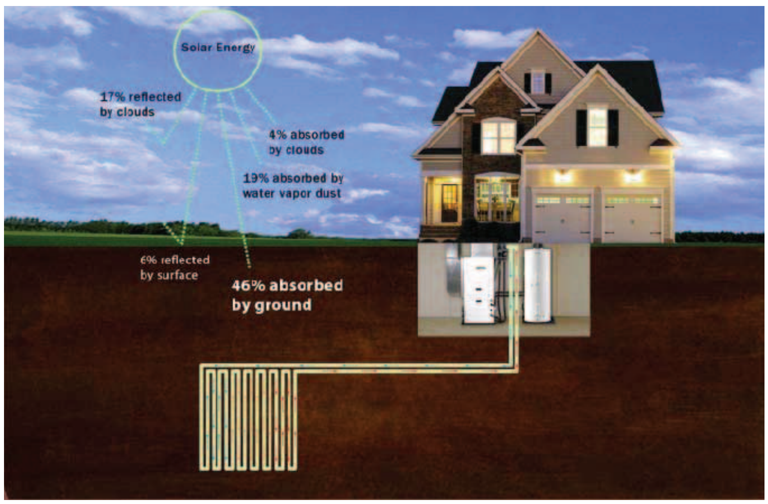

Figure 6: Ground source heat pump diagram (Picture credit: CleanEnergy Developments)

Figure 7: Photo caption: WestJet head office equipped with ground source heat pump, located in Calgary, Alberta. (Photo credit: CleanEnergy Developments)

2.6 Biogas

Evaluation Criteria	
Technology description	Biogas can be burned as a fuel in a boiler or furnace, used to run a generator to create electricity and heat, or cleaned and concentrated for use as a natural gas replacement. Organic matter includes manure, sewage sludge, municipal solid waste, biodegradable waste, and agricultural slurry, but the biggest potential for biogas technology lies in the agricultural sector. Anaerobic digestion of organic matter by microbiological activity under anaerobic conditions produces a mix of methane and carbon dioxide called biogas, as well as a nutrient-rich slurry.
Application	✓ Small scale electricity consumption ✓ Replacement of natural gas for heating[19] ✓ Industrial combined heat and power
Energy potential	**Resources available:** • 1.7 to 1.8 million tonnes per year of feedstock available within a 50 km radius of Edmonton. • The bulk of this material (1.67 million tonnes) is crop residues (i.e. straw and chaff) from surrounding farms; competing demands for this resource (has uses on farms such as bedding material) and difficulty in collecting this feedstock may make it unavailable without considerable incentives[20]. **Potential capacity:** • Total electricity capacity: 80-120 MW (3.5 – 9 MW without crop residues) • Total annual thermal potential (with electricity): 4,430 – 6,560 GJ (260 – 685 GJ without crop residues) • Total annual thermal energy (no electricity): 11,400 – 17,900 GJ (670 – 1,760 GJ without crop residues) • Natural Gas equivalent: 467,700 m^3 (4,958,000 kWh) or 46,000 m^3 without crop residues (487,800 kWh)
GHG saving potential	**Reduction of greenhouse gases:** • 616,700 - 925,055 tCO_2e per year.

[19] Biogas can be used for in all applications where natural gas is currently used, including heating, appliances (cooking) and transportation. The City of Toronto, for example, has begun generating biogas that will be converted to compressed natural gas for use in its natural gas fleet vehicles. City officials estimate that the Disco plant alone would produce enough biogas to convert the city's fleet of 290 solid waste vehicles from diesel to natural gas from 90,000 tonnes per year of organics

[20] The City of Edmonton's waste management department suggested it has looked into collecting these residues, and had determined it was largely inaccessible.

	• Reduce overall City emissions by 6.9% An additional GHG benefit not counted in this figure is the avoided methane release from decomposition of biomass in landfill.
Cost	**Cost to produce biogas:** Cost is currently higher than conventional natural gas ($32.22/MMBtu[21] compared to current natural gas price of $4.46 per MMBtu). **Cost of power production:** • Ontario's Feed-in Tariff prices for biogas ranges from 10.4 to 19.5 cents per kilowatt hour (kWh) plus a community adder of 0.4 cents per kWh may be available. This tariff price is set to provide a fair and reasonable rate of return for project developers. **Capital cost of facilities** • $4 to $6 million capital cost per MW for a biogas facility. • Anaerobic digestion system at $6.7 to $10 million per installed MW.
Economic Development Opportunities	• Job creation in construction, commissioning and operation of biogas facilities.
Social benefit	**Additional Environmental Benefits** • Environmental benefits include conversion of materials into energy resulting in lower sludge production than with composting; elimination of odours and reduced run-off, decreased incidence of pathogens. **Social benefits** • Flexible end-use possibility (power, heat, transportation). **Economic Benefits** • Value-added products can be recovered. • Cost effective from a life-cycle perspective; fuel supply available at low cost.
Consideration for implementation	**Barriers to implementation** • Availability of resource, in terms of competing demands, but also in a lack of infrastructure to collect and process the residues. • High capital cost barriers, still considered high-risk investment due to longer return-on-investment. **Ease of implementation** • Biogas systems are complex systems and require considerable know-how, and ongoing demands of time and

[21] Based on calculations using municipal solid waste as a feedstock at the City of Toronto's Dufferin Organics Processing Facility.

	attention to operate successfully. **Alignment with existing programs** • The Alberta Bioenergy Producer Credit Program (BPCP) offers 0.02 $/kWh for production from capacity of 3 MW or more and 0.06 $/kWh for production from capacity of less than 3 MW. The current program offers an incentive for electrical power that is a by-product of biorefining or biomass processes.
Examples, resources	**Local, regional, national cases of implementation** • In Europe, the widespread adoption of anaerobic digestion has been driven by considerable financial incentives that are not in place in Canada. • Highmark Renewable (IMUS) - Vegreville; dry feedlot manure, 1MW electricity[22] • Iron Creek Hutterite Colony (BioGem) - Bruce; liquid manure and meat processing waste, 375 kW electricity[23] • Cargill Foods – High River; meat rendering waste, natural gas replacement to fuel two boilers • Lamb Weston & McCanns – Taber; potato processing, natural gas replacement to fuel 1 boiler
Data Gaps	• Availability of crop residues – this is the largest potential source for feedstock but the least certain in terms of reliably securing this feedstock due to its dispersed nature and valuable alternative uses.
Further Research	• Determining the incentive required for farmers to provide their crop residues to a central biogas facility would provide a basis for calculating the economic benefit of developing biogas energy in the Capital Region.

[22] http://www.arc.ab.ca/Index.aspx/ARC/5157 and http://www.aic.ca/conferences/pdf/2005/Mike_Kotelko_ENG.pdf

[23] http://www.climatechangecentral.com/resources/BioGem.pdf

Figure 8: On-farm biogas facility in Ontario (photo credit: Kris Stevens, OSEA)

2.7 Biomass

Evaluation Criteria	
Technology description	**Direct Combustion:** • Direct combustion of biomass sources for heat or power. Efficiency of these systems is typically 25-30%, but can achieve up to 40%. **Gasification:** • Transforming a fuel (e.g. wood biomass) into a highly combustible gas. Efficiency from 40-50%. **Combined heat and power (CHP):** • CHP systems recapture the majority of the waste heat from a combustion system and provide it as a usable output. Efficiency depends on parameters of system design and user needs, but can reach up to 77%.
Application	✓ Residential – district heating, or combined district heating and electricity consumption. ✓ Non-residential – heat only, or combined heat and power.
Energy potential	Sources of biomass considered here include biomass resources only available within the City, such as clean chip, shavings, sawdust, end-cuts and broken dimensional, whole pallets and crates, urban forest green wood, materials from construction, demolition and renovation, residential wood waste, and other wood waste from the industrial and commercial sector. **Resource availability** • 136,000 to 158,000 tonnes of feedstock available per year. Energy content of the wood is 18,000 MJ or 5 MWh per tonne. **Energy production** • Electricity production: 170-198 GWh / year (equivalent to facility of ~ 20MW). • Heat only: up to 4,703 and 5,472 GJ/day.
GHG saving potential	**Reduction of greenhouse gases:** • Total GHG savings if biomass used for electricity generation: 133,603 to 155,421 tCO_{2e} annually. • Reduction of City emissions by 1.25%. • For every kWh generated from combustion of biomass, 0.784 kg CO_{2e} are avoided.

	In some cases, such as the use of biomass that would otherwise be left to naturally biodegrade, combustion of biomass can produce net negative GHG emissions since the methane that would have been produced (and which has 21 times the global warming potential of carbon dioxide) is avoided.
Cost	**Energy production cost** • 0.078 to 0.088 $/kWh for gasification in combined cycle facility.
Economic Development Opportunities	• Job creation in construction and operation, as well as harvesting, collection and processing of biomass supply from the various sources.
Social benefit	**Additional Environmental Benefits** • Diversion of waste from landfill.
Consideration for implementation	• CHP is best suited to applications with consistent demand for industrial grade heat relatively near to the site. **Alignment with provincial programs** • The Alberta Bioenergy Producer Credit Program (BPCP) offers 0.02 $/kWh for production from capacity of 3 MW or more and 0.06 $/kWh for production from capacity of less than 3 MW. The current program offers an incentive for electrical power that is a by-product of biorefining or biomass processes.
Examples, resources	• In North America there are over 500 biomass based plants, mostly wood based.
Data Gaps/ Further Research	• Estimates of quantities of wood waste going into privately owned landfills may need updating and refinement; the availability of wood waste will depend on a competitive rate compared to the tipping fees charged by private companies collecting wood waste and landfilling or incinerating it.

2.8 Low-head Hydro

Evaluation Criteria	
Technology description	• Hydroelectric power converts the energy in falling or moving water to electricity. • Different types of turbines and applications are available depending on factors such as flow rate and available head (the difference in height between water levels where the power will be generated). • Low-head and ultra low-head hydro applications are available. • Zero-head applications, on 'in-stream' hydroelectricity systems, that take advantage of flowing water can produce electricity as well. Examples include water wheels and in-stream turbines (imagine underwater wind turbines).
Application	✓ Electricity generated into the provincial electricity grid.
Energy potential	• Within the City of Edmonton, the North Saskatchewan is the only major watercourse. The average annual flow rate of the North Saskatchewan river is 213-245 m^3/s. There is no significant change in elevation of the river within the City boundaries. • The energy potential of a river without a significant change in elevation is a function of the volume of water flowing, and the velocity of water flow. • The annual energy potential of identified sites (Carvel Site and Hairy Hill site) on the North Saskatchewan outside city boundaries is 790 GWh/year and 800 GWh/year. These sites would be designed as dams, and would require approvals and significant investments. • The annual energy potential at each of these sites is approximately 11% of the total electricity demand in Edmonton. • The potential for in-stream turbines is significantly lower. The electricity generation potential for this type of generating project would be less than 1% of total city electricity use.
GHG saving potential	• The greenhouse gas savings of the sites outside Edmonton city boundaries would be ~ 650 tonnes CO_{2e} per year. The impact of developments within city boundaries would be less than 0.1% of total City emissions.
Cost	• Cost of in-stream applications not known.
Economic Development Opportunities	• Economic development potential in the construction, operation and maintenance of facility.
Social benefit	• The project would provide a source of clean electricity to

		the provincial electricity grid.
Consideration for implementation	•	Approval processes to build or operate a hydroelectric resource on major interprovincial watercourses would require multiple levels of approvals.
	•	Would require a small number of investors to realize the project; would not leverage investments from the residential and commercial sectors in the city because a small number of companies would be involved in the project.
Examples, resources	•	River turbines are being demonstrated in the St. Lawrence river near Montreal. Two TREK turbines, over 2m in diameter and rated at 250kW each, will generate electricity using the flow of the river.[24] Each turbine could generate some 2,190 MWh per year.
	•	Verdant Power is generating clean electricity in the St. Lawrence river near Cornwall with a different style turbine[25]. Phase I – demonstration pilot – is planned to be complete in 2011. Testing included units with 5 m diameters, rated at 60-80kW each.
Data Gaps	•	Detailed analysis of developable potential within city boundaries, including cost analysis.
	•	Review public acceptability of hydro-electric developments within city boundaries.
Further Research	•	Additional research on the state of the art of ultra low-head hydro could be undertaken

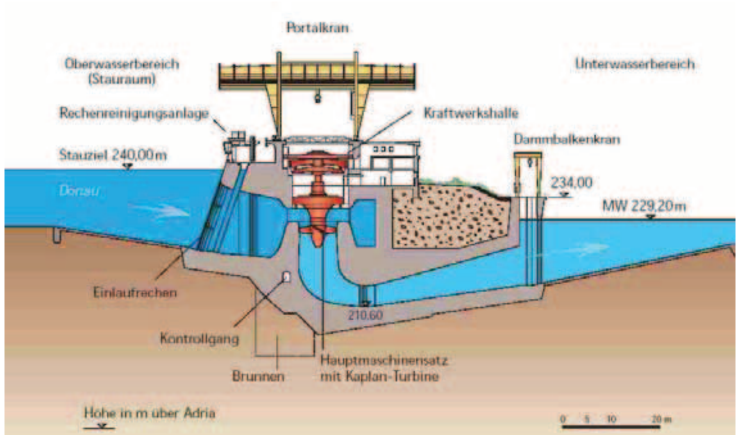

Figure 9: Schematic of low head hydro generator[26]

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[24] http://www.rerhydro.com/turbinesTrek.php

[25] http://verdantpower.com/what-core/

[26] Image courtesy VERBUND-Austrian Hydro Power.

2.9 Small wind electricity generation

Evaluation Criteria	
Technology description	• Small wind turbines are increasingly accessible through major retail outlets, as well as larger machines that are typically available through speciality dealers. The smallest scale of wind turbine tends to be in the range of less than 1,000 W. These are most commonly used in off-grid applications. Residential scale machines typically range from 1-10 kW and farm scale equipment tends to range from 10-300 kW. • The power that is available in the wind is cubically proportional to the wind speeds (Power $\propto$ velocity^3). Small changes in wind speeds have major impacts on power availability. • Most wind turbines require at least 4 m/s winds to begin to produce any energy, and average annual wind speeds of at least 5 m/s measured at 10 m above the ground before wind is considered a viable option.
Application	✓ Electricity generated into the provincial electricity grid.
Energy potential	• Given the low wind speeds in Edmonton (average of 4.24 m/s annually at 30 m above the ground), there is very little opportunity for wind energy development within the City boundaries.
GHG saving potential	• n/a
Cost	• **Mirco** (<1 kW) Turbine costs range from $2,800-$3,500 per kW, and installation costs increase the total by more than double, typically to $5,000-7,500/kW total • **Residential** (1-10 kW) Turbine cost often range from $3,000-4,000/kW with total installed costs being $6,000-8,000/kW • **Farm/Acreage Scale** (10 kW+) Turbine costs ~$2,000-$2,500/kW and total installed costs $3,000-4,000/kW
Economic Development Opportunities	• Wind energy is one of the fastest growing segments of the global electricity market. The overwhelming global investment is in large, utility scale machinery. Most likely opportunities for economic development are in project development of wind farms outside of the city itself, as we service potential part manufacturing.
Social benefit	• Small wind turbines can be a more cost effective method of producing electricity for individuals than other personal systems such as solar panels, if, and only if they are properly installed, in a decent wind regime and regularly maintained. • Wind turbines can be highly visible. This may be

	considered a negative to some, but being visible can also assist in fostering discussions and interest in local renewable energy development.
Consideration for implementation	• The performance of any wind energy equipment is very site-specific, and while the wind resource is poor within the City of Edmonton, there may be micro-climates and/or local topographic formations that would enable viable installations in regions surrounding the City. • Taller towers result in significantly better performance. • Roof-top mounting of wind turbines is typically discouraged. • The Canadian Wind Energy Association's Small wind turbine purchase guide states: "Generally, turbines should be set back at least by the height of the tallest point on the turbine from all buildings, electrical lines, roads and property lines… Specific local zoning restrictions may include other setback requirements, notably for noise requirements." These restrictions significantly limit potential sites for urban wind development. • Like any rotating equipment, all wind turbines require regular servicing to operate safely, and require regular attention and care to work properly. Turbine towers complicate this essential maintenance. Some towers can be tilted down although they still require special training in tower safety and operators need special equipment. • Neighbours can raise concerns about noise and other safety issues within City boundaries.
Examples, resources	• There are no utility-scale wind turbines operating in the Edmonton region. • The Ontario Municipal Review Board rejected an appeal to install a small wind turbine in a residential location in Ottawa in 2009.[27]
Data Gaps	• n/a
Further Research	• n/a

[27] http://www.cbc.ca/technology/story/2009/07/03/ottawa-wind-turbine-backyard.html

Figure 10: A small residential wind turbine near Waterloo, Ontario (photo credit: Tim Weis)

2.10 Summary of Energy and GHG Potential

		Total Energy Potential				GHG Savings	
Energy Source	**Notes**	Residential	ICI	Residential	ICI	tCO_2e / year	as % of Edmonton Elec + Natural gas emissions
Solar PV	Displaces grid electricity	419,800 MWh	224,700 MWh	22%	4%	567,219	4.06%
Passive solar	Displaces grid natural gas space heating	505,300 MWh (heat energy)	n/a	6.4%	n/a	90,870	0.73%
Solar hot water	Displaces grid natural gas water heating	436,700 MWh (heat energy)	76,900 MWh (heat energy)	4.5%	0.2%	92,332	0.74%
Solar hot air	Displaces grid natural gas space heating	n/a	83,275 MWh (heat energy)	n/a	0.25%	14,970	0.12%
GSHP	Switch from grid natural gas space heat to efficient system that uses grid electricity	811,700 MWh (heat energy)	1,961,400 MWh (heat energy)	8.3%	5.8%	Null	null
Biogas	Can be used for electricity generation, heat, or combined heat and power	1,051,200 MWh (electricity), or 1,814,350 MWh (heat)		Up to 14.6% (total electricity)		925,100*	6.9%*
Biomass	Can be used for electricity generation, heat, or combined heat and power	198,000 MWh (electricity), or 554,800 MWh (heat)		2.8% (total electricity)		155,400*	1.25%*
Low-head Hydro	Displaces grid electricity	6,700		0.09%		5,500	0.04%
Small wind	Displaces grid electricity	n/a	n/a	n/a	n/a	n/a	0.00%

n/a: There is no analysis done in this area for this report, as the potential is considered lower or it is not possible to develop (within the scope of the current project) a credible estimate.

* Assumes resource is used to displace electricity.

3. Discussion and Conclusions

The following criteria were used to assist in determining the relative merits the different technologies options within the City of Edmonton. Each energy technology is scored on a scale of one through five (five being best possible score), and each criteria is weighted equally for simplicity, although it is important to note that depending on city priorities, the relative merits of each technology might vary.

- **Renewable energy delivered.** The quantity of renewable energy that could be delivered on an annual basis from this technology. This is an important indicator of the opportunity for each technology, although it is important to note that there are significant differences in displacing electricity compared to displacing natural gas. Electricity is significantly more polluting and more expensive in Alberta today on a per unit of energy basis, and so it tends to be more favourable to displace electricity rather than natural gas. In the long term (several decades), prices for natural gas may increase as deposits are depleted, and the relatively cleanliness of the electricity system may decrease as renewable energy comes online. Eventually, both heating and natural gas need to be derived from renewable energy sources, and so the quantity of renewable energy available is important.
- **Consumer friendly.** Does the technology engage Edmonton residents and businesses? Is it relatively simple to understand, evaluate and implement? Solar PV and solar hot water score high here, because residents and businesses can access services in the city to evaluate, purchase and install the technology; biogas scores lower because of the complexity of a project requires significant study, engineering and design and can't be accessed by 'consumers' until an end-use product becomes available.
- **GHG benefit**. What is the potential scale of greenhouse gas emission reductions, city wide, if the technology is adopted as outlined in the analysis? The assessment completed in this report shows that the potential for GHG reduction is highest for biogas, biomass and solar PV. The total reductions of GHGs is lower for low-head hydro and GSHP.
- **Economic value.** At a high level, this represents the overall economic benefit to the city, the resident, or the business. It attempts to represent the capital cost of installing the equipment or technology, the rate of return on the investment or simple payback period. It also captures the overall economic benefit for the community – does it lead to additional job creation in the city? The economic value of Passive Solar ranks highly because there is little added cost for homes and buildings if passive design strategies are included up-front. Solar air heating also ranks highly as it is a low cost energy alternative for commercial buildings, provides rapid payback for building owners, and it creates local jobs in the design, installation and commissioning.
- **Social benefit**. The social benefit criterion attempts to represent the variety of beneficial externalities of a technology. Buildings that include with passive solar design concepts typically have greater comfort levels for occupants, and greater access to natural lighting, and higher levels of productivity. Biomass diverts waste from landfill.

- **Ease of Implementation.** Can the City provide the framework or incentives for the expansion of the technology within the city of Edmonton? Building low-head hydro facilities would likely require provincial and federal approvals for any intervention on regulated rivers, and as such risks being a long, complex project with many stakeholders. By contrast, there are examples of municipalities and cities across Canada and around the world that have implement programs or policies that have catalyzed the uptake of solar water heating.

- **Visibility.** A vision for greening Edmonton requires significant public engagement. A powerful tool to accomplish this is the direct engagement of citizens with renewable energy technologies. Solar PV panels on a neighbours rooftop may spark curiosity and productive 'competition'; between homeowners and businesses for example, leading to greater uptake. By contrast, a central biogas facility will not be visible to consumers as the end product would be virtually indistinguishable from natural gas. Here solar PV and solar hot water rank well while biogas and biomass for example score low.

	Evaluation Criteria (5 = highest, 1=lowest)								
Energy Source	Renewable Energy Potential	Consumer friendly	GHG benefit	Economic value	Social benefit	Ease of implementation	Visibility	Total Score	Rank
Solar PV	3	5	4	2	4	3	5	26	1
Solar air	2	3	2	5	3	3	2	20	5
Solar hot water	3	5	3	3	3	3	4	24	2
Passive solar	3	3	3	5	4	3	2	23	3
Biomass	3	2	4	3	3	2	1	18	7
Biogas	5	1	5	3	2	2	1	19	6
GSHP	5	4	1	4	3	3	2	22	4
Low-head hydro	1	1	1	1	2	1	3	10	8
Small wind	1	1	1	1	2	1	3	10	8

Based on the above criteria, this analysis finds that solar energy represents some of the most strategic opportunities. Solar PV systems represent a significant opportunity not only for producing local electricity but also for reducing greenhouse gas emissions. Solar hot water systems were found to be the next most promising opportunity to deliver energy in the city. In both cases, the high number of individual residents, as well as ICI buildings that could implement these technologies raise their technical potential as well as their social and participatory benefits.

Passive solar heating and solar air heating systems are the two most economic opportunities, but have a more limited potential as they depend heavily on the orientation of existing structures. However, these two technologies are very important to consider for all new buildings.

Ground source heat pumps have significant potential to deliver very high levels of renewable energy in the city. Heat pumps require one unit of electricity, for every three to four units of usable heat that they deliver, and as such their environmental and economic performance depends on the overall cleanliness and retail prices of the province's electricity system. Alberta's electricity system is the most polluting Canada, and in spite of very high efficiencies of ground-source heat pumps, the use of predominantly coal-fired almost entirely negates any greenhouse gas savings. Nonetheless, in the longer-term, it is very likely that the electricity system will become more and more renewably based; thereby improving the overall benefits of ground source heat pumps.

There is a significant potential for both biomass and biogas opportunities in Edmonton. The accessibility of such systems is limited to most citizens in Edmonton. The biogas potential for Edmonton included a feedstock analysis including a 50 km radius outside the city. The overwhelming majority of biogas feedstock is found on farms surrounding the city, although the accessibility of this feedstock is questionable given there are competing uses for it on farms, as well as limits to how it can be harvested and processed.

Finally, low head hydro and small wind energy opportunities were determined to have very low potentials in Edmonton. In both bases, there is a poor natural resource in the city, as well as very likely social challenges to attempting to try to harness either resource. Industrial equipment in the North Saskatchewan River within the city limits is likely be resisted, as would small wind turbines in an urban setting. It should be noted that hydro systems and wind turbines both play significant roles on the overall electricity system in Alberta, and are better suited for non-urban environments.

4. Appendices

4.1 Solar PV

As can be seen in Figure 11 below, Edmonton's solar potential is higher than the average potential in major Canadian cities. In fact Edmonton's solar resource is better than that of Miami, Florida during the summer months of June, July and August[28]. Natural Resource Canada calculates the theoretical output of a solar PV module in Edmonton to be calculates 1, 248 kWh per year[29] is possible in Edmonton. In practical terms however, solar PV modules will likely have reduced performance due to snow cover, occasional shading and sub-optimal mounting angles due to roof constraints. The potential was reduced by 10% to account for these factors to an annual production of 1,120 kWh/kW installed, which is still over 35% better Tokyo, one of the world's leading solar cities[30].

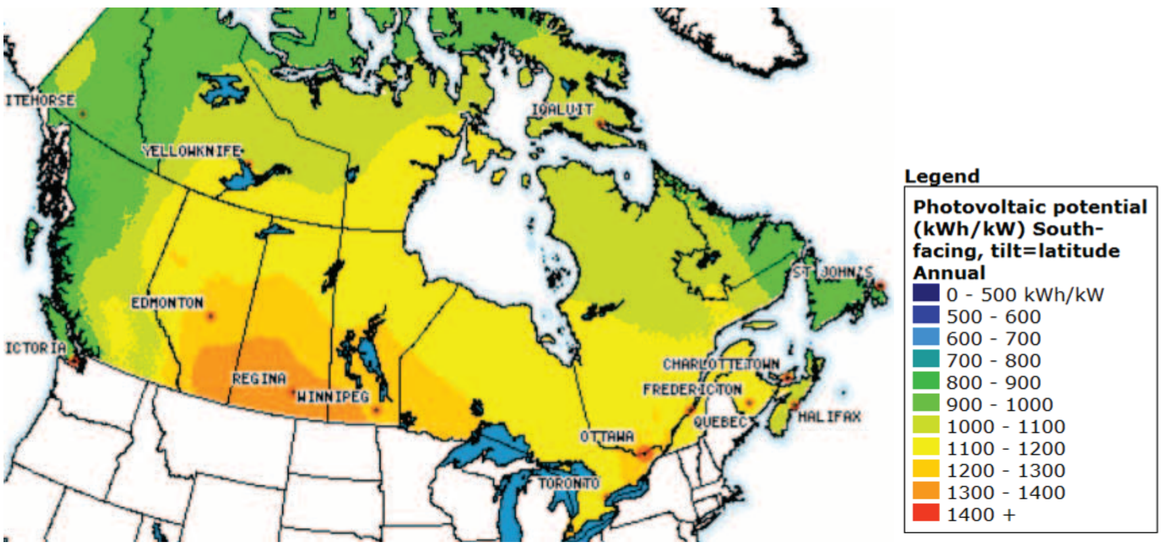

Figure 11: Canadian photovoltaic potential[31]

Methodology – Residential

- Average annual solar energy potential – 1,120 kWh/kW installed
- Typical solar PV system size – 3 kW
- Current potential – % of residential dwellings suitable for solar PV installation[32]

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[28] Using data compiled from NASA Atmospheric Science Data Center, Surface meteorology and solar energy; http://eosweb.larc.nasa.gov/cgi-bin/sse/sse.cgi

[29] Natural Resources Canada (https://glfc.cfsnet.nfis.org/mapserver/pv/municip.php?n=720&NEK=e)

[30] Calculated using PV Watts, Version 1, A performance calculator for grid-connected PV Systems, developed by the National Renewable Energy Laboratory available at: http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/

[31] Source: Natural Resources Canada, Photovoltaic potential and solar resource maps of Canada https://glfc.cfsnet.nfis.org/mapserver/pv/index.php?lang=e

[32] Based on assumptions made in *Smart Generation: Powering Ontario with Renewable Energy*, David Suzuki Foundation, page 92.

  - Residential houses – 44%
  - Duplex/triplex/fourplex – 52%
  - Row Houses – 57%
- 10-year potential
  - 12% growth rate from 2011 to 2020
  - Assuming additional regulations were implemented that required new houses to be built with proper solar orientation
  - Single Detached – 59%
  - Semi-Attached – 65%
  - Row House – 75%

Methodology – Institutional, Commercial, Industrial

- Average annual solar energy potential - 1,150 kWh/kW[33]
- Estimated typical solar PV systems size – 10 kW
- Current potential - % of ICI suitable for solar PV installation
- ICI buildings – 50% of available roofs[34]

4.2 Passive Solar Design

Methodology

- Brief description of methodology, assumptions for energy and GHG calculations
- Description/assumptions/references for cost information (if applicable)
- Energy used for space heating is reduced by 50%
- Source for space heating is assumed to be natural gas
- 10 year potential based on estimated number of housing starts for single family units for years 2011 to 2020 = 36588.4

Citations/References

Charron, Remi, (2008) "A review of design processes for low energy solar homes" CanmetENERGY. http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/buildings_communities/buildings/pv_buildings/publications/2008170.html

City of Vancouver (2009) Passive Design for Homes. http://vancouver.ca/sustainability/documents/58346PassiveKitBookPrt9.pdf

City of Vancouver (2009) Passive Design Toolkit http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/29236.pdf

Henderson, S. D. Roscow & J. Ward. (2009) Canadian Solar Home Design Manual. Solar Nova Scotia.

4.3 Solar hot air

Methodology – Institutional, Commercial, Industrial

[33] https://glfc.cfsnet.nfis.org/mapserver/pv/municip.php?n=720&NEK=e

[34] Estimation based on assumptions made in Solar Opportunities for the City of Toronto, by the Pembina Institute, December 2008

- Solar air heating potential taken from Toronto study and scaled to Edmonton based on energy use in ICI buildings.
- Toronto potential for SHA – 423,781 GJ / year

4.4 Solar hot water

Methodology - Residential

- Average annual solar energy potential – 3.57 kWh/m^2/day[35]
- Typical SHW system size – 2-panel, flat-plate glazed closed-loop collector system
- Current potential – Certain % of residential dwellings suitable for SHW installation[36]
    - Residential houses – 63%
    - Duplex/triplex/fourplex – 63%
    - Row Houses – 65%
- 10-year potential
    - 12% growth rate from 2011 to 2020
    - 100% of new residential houses have installed SHW systems

Methodology – ICI

- SHW potential for ICI buildings – 20% of potential for SHW residential[37]

4.5 Ground Source Heat Pumps

Methodology

- Calculations for space heating only, not for cooling
- Energy source for space heating is assumed to be natural gas
- Coefficient for performance (COP) for the GSHP is 3.0

Residential – Current Potential

- GSHP potential applied to 10% of current housing stock (single family, duplex, row houses, apartments)

Residential – 10-year Potential

- Based on estimated number of housing starts for single family units for years 2011 to 2020, 36,588.4 units.
- GSHP potential applied to 25% of estimated new housings starts from 2011 – 2020.

Citations/References

The Pembina Institute (2010). "Geoexchange: Energy under foot. Fact Sheet" www.pembina.org/pub/2049

[35] RETSCreen International - http://www.retscreen.net/

[36] Taken from a Solar Potential Study for the City of Toronto

[37] Estimation

4.6 Biogas

- Important parameters for the biogas generation rates are
  - the digestion time;
  - species of feeding substrate;
  - temperature;
  - pH and alkalinity;
  - the total solid (TS) concentration in the slurry;
  - organic loading rate (OLR);
  - hydraulic retention time (HRT);
  - enzyme species/amount of enzyme;
  - mixing of the digesting material; and
  - the particle size of the material being digested.
- Biodigestors use "wet" fermentation or "dry" fermentation. Wet digestion, as for municipal wastewater treatment sludges, are typically in the 2-5% solids range, while "dry" digestion prepared feedstock figures of 15-45% solids, so it is still more than half water.
  - Wet biodigestors must be cleaned out every 1 to 3 years.
  - Dry biodigestors do not have to be cleaned out as often
  - Dry biodigestors are typically considered to have longer lifetimes, although with good maintenance and occasional upgrading, digesters can last many decades. Sludge ("wet") digesters 1-4 at Gold Bar Wastewater Treatment Plant were built in the early 1960s and are still operating.
- Digestor designs vary according to operating temperature, processing time, size, number of chambers and type of throughput (batch, continuous flow or plug flow).
- Mesophilic digesters operate at 30-35°C optimal range, with the feedstock remaining in the digester for approximately 15-30 days. These digesters are more robust, and require less process heat to maintain, but typically involve larger chambers, have less biogas output, and do not sanitize the feedstock as thoroughly.
- Thermophilic digesters operate at 50-55°C optimal range, with the feedstock remaining in the digester for 10-15 days. Advantages include slightly higher biogas production, faster throughput, and more complete sanitization, but are more expensive, require more process heat, and are less stable.

Feedstock availability:

Biomass Source	Quantity available annually	Notes
Residential MSW	0	All residual residential MSW is going into ethanol facility
Agricultural residue within 50 km of Edmonton	1,665,340 tonnes[38]	Harvestable straw and chaff. Competes with other uses on farms.
Institutional/ Commercial/ Industrial Food Waste	109,090 tonnes	Currently landfilled
Biosolids	4,000 to 5,000 dry tonnes	After installation of enhanced primary treatment this amount will be surplus to what the city can compost and land apply
Total Biogas Feedstock Material	**~1,778,500 tonnes**	

Sources for calculations of feedstock:

Calculated using: Statistics Canada, *2006 Census of Agriculture*, Farm data and farm operator data tables, 2007. http://www.statcan.gc.ca/pub/95-629-x/2007000/4123856-eng.htm;

Alberta Agriculture and Rural Development, *Direct Seeding: Estimating the Value of Crop Residues*, 2008. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex2512;

Alberta Agriculture and Rural Development, *Alberta 2007 Crop Season in Review with Feed Availability Report*, 2008.
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sdd12176!OpenDocument&Click= ;

Alberta Agriculture, *Soil Group Map of Alberta*, 2002.
http://www1.agric.gov.ab.ca/soils/soils.nsf/soilgroupmap?readform; and

Agriculture and Agrifood Canada, Municipal Districts and Counties of Alberta,
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex10301

City of Edmonton, Waste Management Branch, *Sustainable Waste Management*, The Edmonton Sustainability Papers – May 2010 Discussion Paper 10 – Sustainable Waste Management.
http://www.gov.edmonton.ab.ca/city_government/documents/Discussion_Paper_10_Sustainable_Waste_Management.pdf;

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[38] Previous experience with the City of Edmonton in trying to obtain crop residues as a source for composting was that it was too valuable to farmers that were already using it as hay, or that if they were leaving it on the field it was because they did not have the additional equipment to harvest and prepare it in a bale form for handling and transport. To overcome this, there would thus have to be some sort of economic incentive to the farmer.

Statistics Canada, Waste Management Industry Survey, 2002. Catalogue no. 16F0023XIE

Allan Yee, Edmonton Waste Management Centre of Excellence, personal communication, 14 December 2010.

Table 3: Biogas potential

Summary Table		
Potential		
Organics from ICI portion of MSW		
Total Electricity (high)[39,40]	6.85	MW
Total Electricity (low)[41,42]	3.20	MW
Total Heat (with electricity high)	517.71	GJ/d
Total Heat (with electricity low)	241.92	GJ/d
Total Heat (solo high)	1,331.26	GJ/d
Total Heat (solo low)	622.08	GJ/d
Agricultural Residues		
Total Electricity (high)[43,44]	114.12	MW
Total Electricity (low)[45,46]	75.84	MW
Total Heat (with electricity high)	6,274.70	GJ/d
Total Heat (with electricity low)	4,169.90	GJ/d
Total Heat (solo high)	16,134.95	GJ/d
Total Heat (solo low)	10,722.60	GJ/d
Municipal Waste Water		

[39] Navaratnasamy, Mahendran, Brian Kobertstein, and Jim Jones. 2008. Biogas Energy Potential in Alberta. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11397/$file/768-3.pdf?OpenElement.

[40] Biogas yield ranges from 143-214 m^3/tonne. Methane percentage is 60%.

[41] Hyder Consulting Pty Ltd. "Kompogas Process Description and Costings." 2007. pg. 19, Navaratnasamy, Mahendran, Brian Kobertstein, and Jim Jones. 2008. Biogas Energy Potential in Alberta. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11397/$file/768-3.pdf?OpenElement.

[42] Kompogas estimates only 100 m^3/tonne Source Separated Organics, put as lower bound.

[43] Navaratnasamy, Mahendran, Brian Kobertstein, and Jim Jones. 2008. Biogas Energy Potential in Alberta. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11397/$file/768-3.pdf?OpenElement.

[44] Estimate for straw and other roughages

[45] Navaratnasamy, Mahendran, Brian Kobertstein, and Jim Jones. 2008. Biogas Energy Potential in Alberta. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11397/$file/768-3.pdf?OpenElement.

[46] Estimate for straw and other roughages

Total Electricity (High)[47,48]	2.21	MW
Total Electricity (Low)	0.27	MW
Total Heat (w/ electricity high)	166.93	GJ/d
Total Heat (w/ electricity low)	20.27	GJ/d
Total Heat (high)	429.25	GJ/d
Total Heat (low)	52.12	GJ/d
Total		
Total Electricity (High)	123.18	MW
Total Electricity (Low)	79.31	MW
Total Heat (w/ electricity high)	6,959.34	GJ/d
Total Heat (w/ electricity low)	4,432.09	GJ/d
Total Heat (high)	17,895.45	GJ/d
Total Heat (low)	11,396.80	GJ/d
Natural gas equivalent	467,732.72	m3

GHG saving potential

The lifecycle emissions from a biogas plant are estimated to be 11 g CO2e/kWh. Alberta's electricity grid has a GHG emissions intensity of 810 g/kWh. If a biogas facility in Edmonton generated between 695 million and 1,079 million kWh annually, then the GHG emissions avoided would be in the range of 555,106 to 862,162 tonnes per year.

Electricity Generation

- Capital cost for a biogas facility that produces one 1 MW of power ranges from $4 to $6 million range depending on the level of infrastructure at the site.[49] Costs are as follows for a manure based system:[50]
    - Manure Collection and System Processing - $100,000 to $600,000 range (June 2006 pricing)
    - Digestion System - $300,000 to $500,000 range
    - Solid-Liquid Separation of Digestate - $200,000 to $300,000 range depending on need for secondary storage (nutrient recovery/water recycling not included)

[47] Navaratnasamy, Mahendran, Brian Kobertstein, and Jim Jones. 2008. Biogas Energy Potential in Alberta. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11397/$file/768-3.pdf?OpenElement.

[48] Assumption - wet sludge is 90% water.

[49] Alberta Agriculture, *Biogas (Methane) Overview*, September 26, 2008. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/afi11109

[50] Ibid.

  - Biogas Utilization - $3 to $3.5 Million for hydrogen sulphide scrubbing systems, cogeneration units, metering, grid connection, and flare system (add on an additional $1 million for CO_2 removal if gas is preferred over electricity marketing);
  - Post-Digestion System (secondary storage of digestate with further biogas collection), without solid-liquid separation) - $200,000 to $400,000.
- Ontario Ministry of Agriculture, Food and Rural Affairs provides a higher estimate the capital costs for an anaerobic digestion system at $6.7 to $10 million per installed MW.[51]

Cost of technology per unit of energy produced

- Ontario's Feed-in Tariff prices for biogas ranges from 10.4 to 19.5 cents per kilowatt hour (kWh) plus a community adder of 0.4 cents per kWh may be available. [52]

Operating cost (and cost savings)

- On a weight basis, capital costs are estimated at $50 - $70 per tonne of feedstock that can be processed on an annual basis, (plus/minus 30%), of which electrical generation equipment represents roughly 25%.[53]
- Annual operating costs are between $500 and $1500 per m^3 of reactor volume.[54]
- Annual maintenance costs are roughly 3% of the budget for processing equipment and 0.5% of the budget for other capital items.[55]

Transportation Fuel

- The expected average per-tonne cost of source separated organics processing at existing private facilities in the City of Toronto is approximately $143.59 per tonne of feedstock.[56]If each tonne generates $123m^3$ of clean biogas, this is equivalent to $1.16 per cubic meter or $32.22 per MMBtu (natural gas is currently priced at $4.46/MMBtu). [57]

Cost

Cost of technology for typical installation

Electricity Generation

[51] Ontario Ministry of Agriculture, Food and Rural Affairs, *Biogas (Anaerobic Digestion),* July 7, 2010. http://www.omafra.gov.on.ca/english/engineer/ge_bib/biogas.htm#1
[52] Ibid.

[53] Integration of Renewable Energy on Farms, *Anaerobic Digestion Technology*, 2008. http://www.farm-energy.ca/IReF/index.php?page=technology-2

[54] Ibid.

[55] Ibid.
[56] City of Toronto, Authority to Negotiate and Enter into an Agreement with AECOM Canada Ltd. to Design, Build, Commission and Operate a New SSO Processing Facility at Disco Transfer Station, January 18, 2010. http://www.toronto.ca/legdocs/mmis/2010/pw/bgrd/backgroundfile-26686.pdf

[57] City of Toronto, Authority to Negotiate and Enter into a Sole Source Agreement for Repairs and New Construction at the Dufferin Organics Processing Facility, August 9, 2010. http://www.toronto.ca/legdocs/mmis/2010/ex/bgrd/backgroundfile-32998.pdf

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[58] Alberta Agriculture, *Biogas (Methane) Overview*, September 26, 2008. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/afi11109

[59] Ibid.

[60] Ontario Ministry of Agriculture, Food and Rural Affairs, *Biogas (Anaerobic Digestion),* July 7, 2010. http://www.omafra.gov.on.ca/english/engineer/ge_bib/biogas.htm#1

[61] Ibid.

[62] Integration of Renewable Energy on Farms, *Anaerobic Digestion Technology*, 2008. http://www.farm-energy.ca/IReF/index.php?page=technology-2

[63] Ibid.

[64] Ibid.

generates 123m^3 of clean biogas, this is equivalent to $1.16 per cubic meter or $32.22 per MMBtu (natural gas is currently priced at $4.46/MMBtu).[66]

Energy Benefits[67]

- Instead of consuming energy, it is a net energy producing process
- The process does not use electricity or fossil fuels and displaces fossil fuels
- Generates high quality renewable fuel in form of biogas
- Biogas is employed in numerous end-use applications
- Energy balance is high and positive

Environmental[68]

- Significantly lower sludge production than with composting
- Excess sludge generally well stabilized.
- Viable sludge can be preserved unfed for long periods of time (more than 1 year)
- Eliminates odors
- Reduces run-off
- Can substantially decrease incidence of pathogens (mainly thermophilic process)
- Can substantially decrease use of fossil fuels and associated GHG emissions
- Maximizes recycling benefits
- Captures methane that is produced, not allowing its release into the atmosphere.[69]

Economic, operational and social[70]

- Obtainable at very low costs. In fact, anaerobic digestion is more cost-effective than other treatment options (for manure and biosolids) from a life-cycle perspective
- Small footprint
- When combined with proper post-treatment, products like ammonia and sulphur can be recovered
- Has low nutrient requirement
- Can be applied practically in any place and at any scale. Suitable for on-site application in residential areas and industry, with good potentials for closing water cycles
- Destroys virtually all weed seeds[71]

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[65] City of Toronto, Authority to Negotiate and Enter into an Agreement with AECOM Canada Ltd. to Design, Build, Commission and Operate a New SSO Processing Facility at Disco Transfer Station, January 18, 2010. http://www.toronto.ca/legdocs/mmis/2010/pw/bgrd/backgroundfile-26686.pdf

[66] City of Toronto, Authority to Negotiate and Enter into a Sole Source Agreement for Repairs and New Construction at the Dufferin Organics Processing Facility, August 9, 2010. http://www.toronto.ca/legdocs/mmis/2010/ex/bgrd/backgroundfile-32998.pdf

[67] Demirbas, M. Fatih and Balat, Mehmet (2009) 'Progress and Recent Trends in Biogas Processing', International Journal of Green Energy, 6: 2, 117 — 142.

[68] Ibid.

[69] Integration of Renewable Energy on Farms, *Anaerobic Digestion Benefits*, 2008. http://www.farm-energy.ca/IReF/index.php?page=benefits-14

[70] Demirbas, M. Fatih and Balat, Mehmet(2009) 'Progress and Recent Trends in Biogas Processing', International Journal of Green Energy, 6: 2, 117 — 142.

[71] Integration of Renewable Energy on Farms, *Anaerobic Digestion Benefits*, 2008. http://www.farm-energy.ca/IReF/index.php?page=benefits-14

- Creates a uniform end product that retains the nutrient properties of the material used for use as a high quality fertilizer / soil amendment that can be applied with precision[72]

Consideration for implementation

- The primary challenge in Canada is unproven economics. Even with the premium rate of 11 cents per kWh available in Ontario, anaerobic digesters are often considered undesirable from a return on investment perspective.
- In Europe, the widespread adoption of anaerobic digestion has been driven by considerable financial incentives not in place in Canada. [73]
- On-farm digesters have a high historical failure rate in North America, (in the 80% range). The complex systems require considerable know-how, absolute consistency, and ongoing demands of time and attention to operate successfully. If they are allowed to deviate from optimum, they can quickly deteriorate to total failure, requiring a lengthy restart. Modern systems can incorporate a high degree of automation, lessening the operating burden, but such automation adds to the capital costs involved. [74]
- Other challenges include[75]
  - significant capital and operating costs involved,
  - lack of an established base of anaerobic digesters in Canada,
  - potential for environmentally harmful emissions resulting from the combustion of biogas (such as sulphur related compounds),
  - increase in traffic a project can entail if it includes off-farm feedstocks, and
  - noise an anaerobic digester facility can introduce into a rural environment.

Programs that can support the technology

Alberta introduced the Bioenergy Producer Credit Program (BPCP), which is an incentive for producers of bioenergy and is intended to encourage bioenergy development and production. The BPCP will be available for a wide variety of bioenergy products including renewable fuels, electricity and heat. The current program commenced in April 1, 2007, and terminates March 31, 2011 but a new BPCP starts in April 2011 and will end in March 2016.

The current program offers 2 cents per kilowatt hour (kWh) for production from capacity of 3 megawatts (MW) or more and six cents per kWh for production from capacity of less than 3 MW. The current program offers an incentive for electrical power that is a by-product of biorefining or biomass processes. The new rates starting in 2011 are shown in the table below.[76]

Table 4. Bioenergy incentives available in Alberta

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[72] Integration of Renewable Energy on Farms, *Anaerobic Digestion Benefits*, 2008. http://www.farm-energy.ca/IReF/index.php?page=benefits-14

[73] Integration of Renewable Energy on Farms, *Anaerobic Digestion Technology*, 2008. http://www.farm-energy.ca/IReF/index.php?page=technology-2

[74] Integration of Renewable Energy on Farms, *Anaerobic Digestion Technology*, 2008. http://www.farm-energy.ca/IReF/index.php?page=technology-2

[75] Integration of Renewable Energy on Farms, *Anaerobic Digestion Technology*, 2008. http://www.farm-energy.ca/IReF/index.php?page=technology-2

[76] Alberta Energy, Bioenergy Producer Credit Program Frequently Asked Questions, 2010-03-31, http://www.energy.alberta.ca/BioEnergy/1826.asp (accessed Aug 10, 2010).

Bioenergy Product: Electricity	Production from capacity less than 3 megawatts	Production from capacity greater than 3 megawatts
Electricity production from biogas, synthetic gas or gasification of biomass	$0.06 per kilowatt hour kWh	$0.017 per kWh
Electricity production from combustion of biomass	$0.02 per kWh	$0.02 per kW

4.7 Biomass

Technology description

Direct Combustion

A direct combustion energy system is one that burns biomass in excess air to produce heat. Direct combustion technologies are the most conventional and proven of all biomass electricity generation options. Systems that use steam-driven turbine generators with heat produced by the direct combustion of biomass generally have conversion efficiencies between 25 and 30 per cent[77], although some technologies can achieve efficiencies up to 40 per cent.[78]

There are a number of different direct combustion technologies, most of which fall into two categories: 1) grate firing or systems that rely on a moving grate and 2) fluidized bed systems.

Moving grate combustors feed fuel onto a grate that continuously provides fuel to the system, supports the fuel while allowing a pathway for air during combustion, then discharges the spent fuel.[79] This technology is well-established technology but achieves efficiencies that are normally limited to the range of 25 to 30 per cent for electrical generation.[80]

Wood-fired fluidized beds are a relatively newer biomass combustion technology that uses a jet of air blown through a bed of inert particles to suspend fuel in a 'fluid-like' state during combustion.[81] The mixing effect and increased heat transfer rates of the fluidized bed creates more consistent combustion conditions, which can increase efficiency and improve emissions.[82] This technology achieves electrical conversion efficiencies of approximately 30 to 40 per cent.[83]

[77] Frank Rosillo-calle, et al. (eds)., 2007. The Biomass Assessment Handbook Bioenergy for a Sustainable Environment, Earthscan (publisher) http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=2281

[78] Ibid.

79 U. S. E.P.A. Combined Heat and Power Partnership Biomass Combined Heat and Power Catalog of Technologies (2007) www.epa.gov/chp/documents/biomass_chp_catalog.pdf (accessed November 24, 2009).

[80] Organisation for Economic Co-operation and Development, *Developments in Bioenergy Production Across The World - Electricity, Heat and Second Generation Biofuels,*2008. http://www.oecd.org/dataoecd/55/61/41667488.pdf

81 U. S. E.P.A. Combined Heat and Power Partnership Biomass Combined Heat and Power Catalog of Technologies (2007) www.epa.gov/chp/documents/biomass_chp_catalog.pdf (accessed November 24, 2009).

82 Ralph P. Overend, "Biomass Conversion Technologies" (National Renewable Energy Laboratory, Golden, Colorado, 2002) Accessed September 24, 2009 (http://libdigi.unicamp.br/document/?view=30).

[83] Organisation for Economic Co-operation and Development, *Developments in Bioenergy Production Across The World - Electricity, Heat and Second Generation Biofuels,*2008. http://www.oecd.org/dataoecd/55/61/41667488.pdf

Gasification

Gasification is a technology that involves transforming a fuel, wood biomass for example, into a highly combustible gas.[84] When biomass fuel is heated and oxidized in an oxygen-deprived environment, the combustion process is prevented from fully completing and the fuel releases a gas referred to as synthesis gas (syngas).[85]

Gasification systems can achieve efficiencies greater than direct combustion technologies.[86] When used for power generation, biomass gasification efficiency ranges between 40 and 50 percent.[87]

While still under development, one example of a biomass gasification application used to produce electricity is an integrated gasification with combined cycle.[88] In this system, biomass is first converted into syngas then burned in a combined cycle power generation facility. It is expected that efficiencies of 40 per cent are possible.[89]

Combined Heat and Power

The most significant means of improving the energy value extracted from a biomass resource is the use of a Combined Heat and Power (CHP) system. A biomass (CHP) system recaptures the majority of the waste heat from a combustion system and provides it as a usable output. Provided that there is a market demand or industrial use for heat, CHP applications are an excellent way to increase overall efficiency. However, heat cannot be stored for long periods of time. This means that CHP is limited to applications with consistent demand for industrial grade heat relatively near to the site.[90]

It is important to note that CHP is not a single technology, but an integrated energy system that can be modified depending upon the needs of the energy end user.[91] Therefore, if electricity is the main product, the efficiency of electricity generation can be maintained while waste heat is recovered. For example, the EPA presents the typical performance parameters for gas turbine CHP among five system configurations. The electrical efficiency for these five systems range from 21.9 to 37% and the total CHP efficiency varies from 67 to 73%.[92] The power-to-heat ratio does affect the overall efficiency of the system in a non-linear way. In an example provided by the EPA, overall efficiency declines from 77% with 10% electric output and 90% thermal output to 48% overall efficiency with 80% electric output and 20% thermal output.[93]

Current market penetration (commercially available)

84 Yan Jinyue, Per Alvfors, Lars Eidensten, and Gunnar Svedberg, "A future for biomass" (The American Society of Mechanical Engineers, 1997). http://www.memagazine.org/backissues/membersonly/october97/features/biomass/biomass.html (accessed September 24, 2009).

85 Carolyn Roos. Northwest CHP Application Centre. 2008. Clean Heat and Power Using Biomass Gasification for Industrial and Agricultural Projects.

86 Frank Rosillo-calle, et al. (eds)., 2007. The Biomass Assessment Handbook Bioenergy for a Sustainable Environment, Earthscan (publisher) http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=2281

87 IEA, "IEA Energy Technology Essentials: Biomass for Power Generation and CHP", (January 2007).

88 Organisation for Economic Co-operation and Development, *Developments in Bioenergy Production Across The World - Electricity, Heat and Second Generation Biofuels*,2008. http://www.oecd.org/dataoecd/55/61/41667488.pdf

89 Ibid.

90 Harald H. Welling and Thom J. Shaw, "Energy From Wood Biomass Combustion In Rural Alberta Applications" (Kalwa Biogenics, 2007) Accessed September 24, 2009 (http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/apa11648).

91 U.S. Environment Protection Agency, *Catalog of CHP Technologies*, 2008, http://www.epa.gov/chp/documents/catalog_chptech_full.pdf.

92 Ibid.

93 Ibid.

In North America there are over 500 biomass based plants, mostly wood based.[94]

Applications

- **Residential**
  - ✓ Combined heat & power with district energy systems
  - ✓ District heating (without power)
- **Commercial / Industrial**
  - ✓ Combined heat & power or heating only

Energy potential

Table 5. Biomass combustion feedstocks available in the Edmonton area

Biomass Source	Quantity available	Notes
Category 1: Clean chip, shavings, sawdust	0	97% diverted 3% spilled
Category 2: End cuts, rejects, broken dimensional, damage pallet plat and stringer, smaller saw post volumes	3,500 to 4,500 tonnes	In ICI stream
Category 3: Whole pallets and crates	50,000 to 65,000 tonnes	
Category 4: Urban forest green wood	11,250 to 17,500 tonnes	Currently landfilled/ incinerated
Category 5: Construction, renovation and demolition	38,000 tonnes	Currently landfilled/ incinerated
Category 6: Miscellaneous woodwaste from the ICI	29,450 tonnes	Currently landfilled
Category 7: Residential woodwaste	4,050 tonnes	Currently landfilled
Total Wood Waste	**136,250 – 158,500 tonnes per year**	From 2001 study (prior to sorting for ethanol facility); contamination is a problem with much of this wood waste

[94] Kuma, Amit, Jay Cameron and Peter Flynn, Biomass Based Power in Alberta, University of Alberta. http://biomassinnovation.ca/pdf/Research/Developments%20in%20Biomass/Biomass%20Based%20Power%20in%20Alberta.pdf

The energy content of solid waste wood is 18,000 MJ or 5 MWh per tonne.[95] At 25 % conversion efficiency to electricity, 170 to 198 GWh of electricity can be produced annually. This is equivalent to a 19 to 22.6 MW capacity facility. Alternatively, if the wood waste were used to produce heat only, between 4,703 and 5,472 GJ/day would be generated at a conversion efficiency of 70%.

GHG saving potential

The emissions intensity of biomass using an agricultural residue (wheat straw) is 25.54 g CO2e/kWh. This is because of the use of fossil fuels in seeding and harvesting the straw. The emissions intensity of biomass from other sources can be even lower if more efficient collection is utilized. In some cases, such as the use of biomass that would otherwise be left to naturally biodegrade, combustion of biomass can produce net negative GHG emissions since the methane that would have been produced (and which has 21 times the global warming potential of carbon dioxide) is avoided.

The emissions intensity of Alberta's electricity grid is 810 g CO2e/kWh. For every kWh generated from combustion of biomass, 784.46 g CO2e are avoided. Generation of 170 to 198 GWh of electricity from biomass combustion of wood waste avoids 133,603 to 155,421 tonnes of CO2 annually as a conservative estimate. Depending on the alternate disposal of the wood waste, the emission reductions could be even higher.

Cost

Table 6 shows the different cost components of the biomass power cost using direct combustion technology.[96]

Table 6. Cost of power from biomass using direct combustion technology, year 2000 Canadian $/MWh, at full capacity and optimum size[97],[98]

Cost element	Whole tree harvest	Forest harvest residue	Agricultural residue
Capital Recovery	25.79	31.50	24.80
Transportation	10.25	36.37	18.96
Harvesting	10.24	8.23	9.20
Maintenance	7.74	9.43	7.50
Operating	0.89	3.80	0.96
Administration	0.37	1.98	0.60
Field Cost of Biomass	3.72	3.49	3.49
Silviculture	2.11		

[95] Statistics Canada, 2005. Report on Energy Supply and Demand in Canada.

[96] Kuma, Amit, Jay Cameron and Peter Flynn, *Biomass Based Power in Alberta*, University of Alberta. http://biomassinnovation.ca/pdf/Research/Developments%20in%20Biomass/Biomass%20Based%20Power%20in%20Alberta.pdf

[97] Kumar A., Cameron J.B., and Flynn P.C., Biomass Power Cost and Optimum Plant Size in Western Canada, accepted for publication in *Biomass and Bioenergy*, 2002, Vol. 24(6), pp. 445-464.

[98] Kumar A., Cameron J.B., and Flynn P.C., Optimum Biomass Power Plant Size in Western Canada, presented at *The Tenth Biennial Bioenergy Conference, BIOENERGY 2002*, Sept. 22-26, 2002, Boise, Idaho, USA.

Road Construction	7.89		
Nutrient Replacement			10.09
Transmission	2.31		
Ash disposal	0.38	0.97	0.86
Total	**71.68**	**95.76**	**76.46**

The average cost per MWh of energy produced using gasification technology is reduced to $88.62 if forest residual feedstock is used in the optimally sized system of 130MW, assuming power generation efficiency to be 39.7%.[99] The improved efficiency of gasification is beneficial for fuels which have high delivered cost, but is detrimental for low cost fuel, which is why the costs for whole forest and agricultural residues rise in comparison to direct combustion, as shown in Table 7.

Table 7. Power cost and optimum size for a biomass integrated gasification combined cycle power plant[100]

Biomass fuel	Optimum size of the power plant (MW)	Power cost at the optimum size ($/MWh)
Whole forest	910	81.11
Forest harvest residues	130	88.62
Agricultural residues	260	78.22

Economic Development Opportunities

Local companies and personnel can provide the goods and services required for both the construction and operation of biomass systems. Local craftsmen usually provide the construction of any biomass heating systems, including boiler rooms, fuel storage facilities, and heat-distribution systems. Depending on the size of the individual system, both operation and maintenance are long-term services, which can be undertaken by local individuals and businesses. Given the significant role that local communities, individuals and businesses can play in the construction and operation of biomass facilities, the employment impact on local and regional economies from such facilities can be significant.[101] In Edmonton however, the limited opportunity to pursue biomass combustion facilities means that the employment gains from this application, will be minimal.

Consideration for implementation

[99] Kuma, Amit, Jay Cameron and Peter Flynn, Biomass Based Power in Alberta, University of Alberta. http://biomassinnovation.ca/pdf/Research/Developments%20in%20Biomass/Biomass%20Based%20Power%20in%20Alberta.pdf

[100] Cameron J.B., Kumar A., and Flynn P.C., Optimizing Technology for Biomass for Power Generation, presented at *The 12th European Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection*, 17-21 June 2002.

[101] Welling, Harald and Thom Shaw, *Energy from Wood Biomass Combustion in Rural Alberta Applications*, Kawa biogenics.

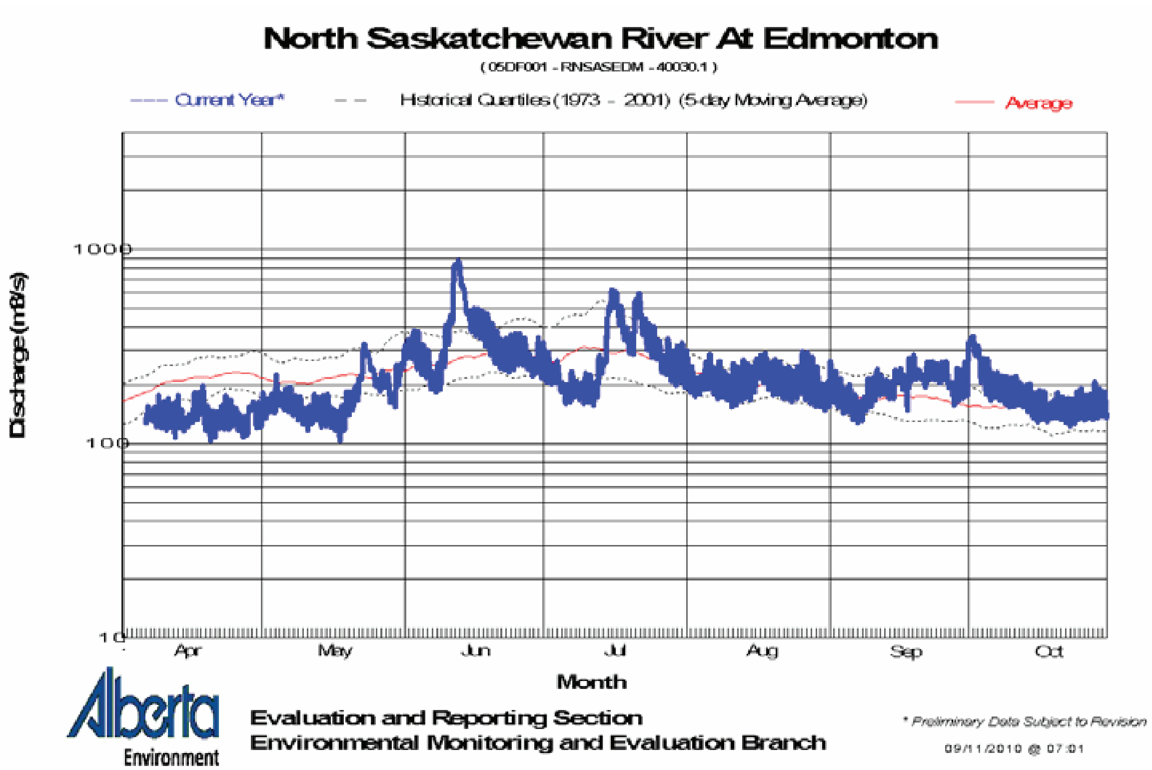
The Bioenergy Producer Credit Program provides 2¢/kWh of electricity generated from biomass or biogas facilities with a capacity of 3MW or more, and 6¢/kWh for facilities with a capacity less than 3MW. The program ends on March 31, 2011.[102]

Both the Biorefining Commercialization and Market Development Program and Bioenergy Infrastructure Development Program (refer to Section 3.2.2) apply to biomass under the same conditions.

The federal Budget 2010 includes measures to promote energy investments, through establishing the Next Generation Renewable Power Initiative, with $100 million over the next four years to support the development, commercialization and implementation of advanced clean energy technologies in the forestry sector.[103]

4.8 Low-head hydro

The North Saskatchewan does not have a significant drop in or around Edmonton, but is a major river in Western Canada with an average discharge on the order of 150 m^3/s. Currently, ULHH technology is implemented in Europe and the U.S., but not yet in Canada.



Examples of ultra-low head hydro (ULHH) technology include Kaplan in-stream axial flow turbines that are capable of generating over 1 MW of electricity. Such a system does not require a dam and has no effect on the downstream water quantities.

[102] Government of Alberta, "Bio-fuel and Bio-gas Producer Credit Program Guidelines."
[103] Department of Finance Canada, *Budget 2010—Leading The Way On Jobs And Growth*, 2010. http://www.budget.gc.ca/2010/glance-apercu/brief-bref-eng.html

4.9 Wind electricity generation

Methodology

The output of wind turbines is heavily dependent on the local wind regime, as the power that is available in the wind is cubically related to the wind speed. As illustrated by the wind map below, Edmonton site in a particularly low wind region in Alberta, with average wind speeds at 30 m heights averaging less than 5 m/s (18 km/h) as seen in Figure 12. This is significantly lower than south-eastern Alberta, particularly in the Pincher Creek region, where the majority of the wind energy development has occurred to date, as illustrated in Figure 13 below.

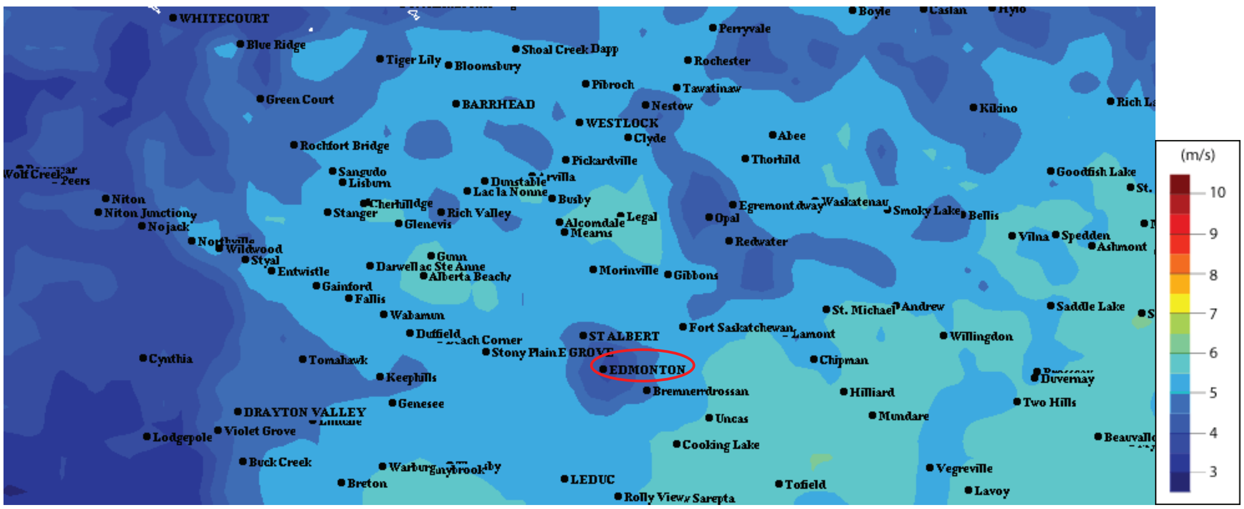


Figure 12: Average wind speeds at 30 m height near Edmonton (source: www.windatlas.ca)

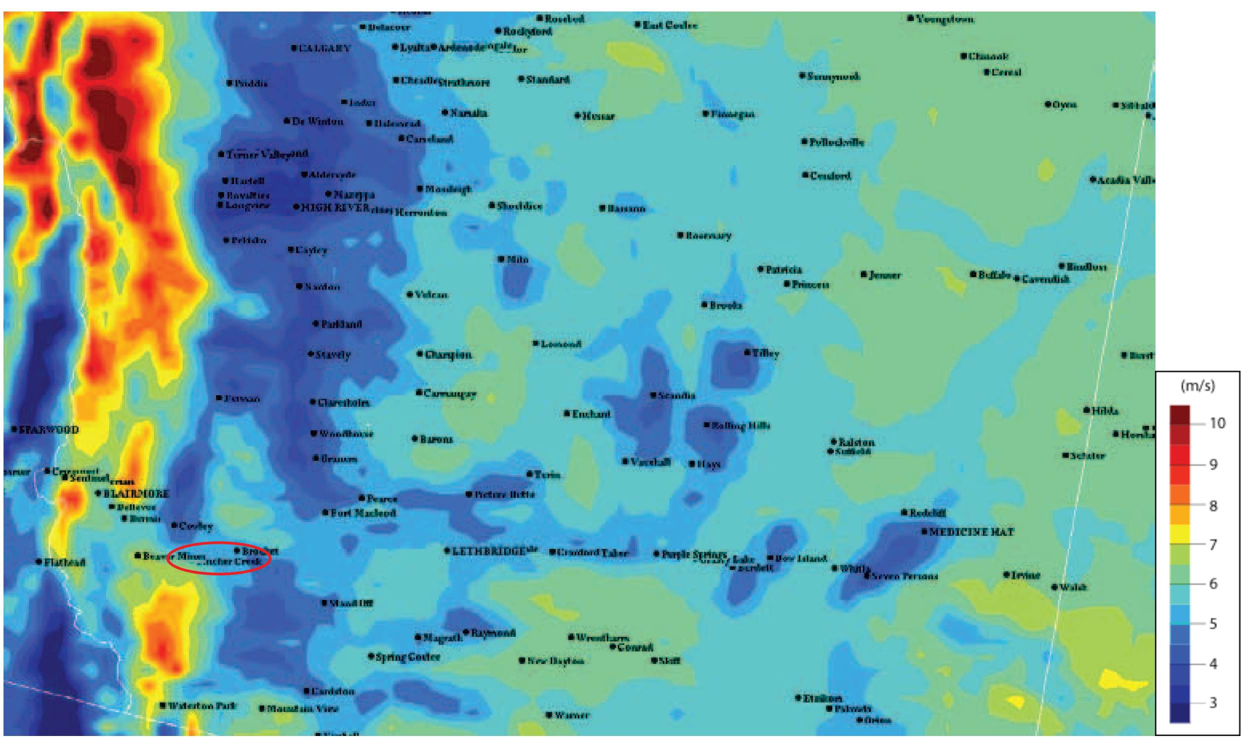


Figure 13: Average wind speeds in southern Alberta (source: www.windatlas.ca)

Many small wind turbines require a minimum of at least 4 m/s (14.4 km/h) simply to start producing even small amounts of energy, and do not reach their rated output until wind speeds of more than 10 m/s (36 km/h) are reach as shown in a sample power output curve below.

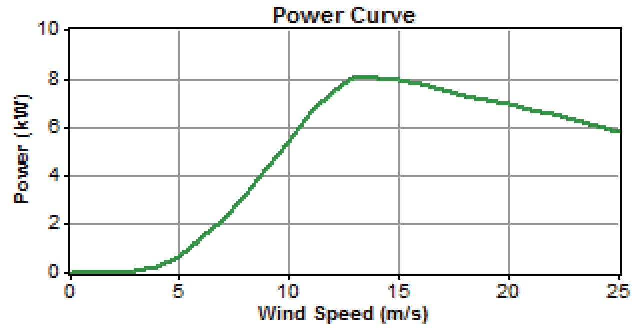


Figure 14: Sample small wind turbine power curve

Wind speeds tend to increase at higher heights above the ground, as well as in unobstructed landscapes. Both pose a challenge for cities, as houses, buildings and trees physically slow the winds that pass through the city, as well as increasing its turbulence. Additionally, tower heights are typically limited within a city for safety and/or aesthetic reasons. Mounting wind turbines on roofs has larger been considered to be a bad idea given the turbulence that is generated by the building a turbines might be mounted on, as well as insufficient roof strength in many cases. A recent study in the UK found that some roof mounted wind turbines were net consumers of electricity as they needed to be powered in order to turn on[104].

Typically, an annual average wind speed of at least 5 m/s at a height of 10 m above the ground is required for wind energy to be considered as a potential option. Environment Canada wind speed data for Edmonton suggest that this minimum is not reached even at 30 m above the ground as shown below.

Table 8: Environment Canada average annual wind speeds in Edmonton, AB at 30 m height

Period	Mean Wind Speed	Mean Wind Energy
Annual	**4.24 m/s**	**81.63 W/m^2**
Winter (DJF)	4.90 m/s	109.50 W/m^2
Spring (MAM)	3.89 m/s	61.75 W/m^2
Summer (JJA)	3.50 m/s	48.13 W/m^2
Fall (SON)	4.45 m/s	86.25 W/m^2

Citations/References

Environment Canada, Wind Atlas of Canada, www.windatlas.ca

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Canadian Wind Energy Association's *Small Wind Turbine Purchasing Guide*, available online at http://www.canwea.ca/images/uploads/File/SmallwindturbinesFINAL.pdf

Paul Gipe's online archive of articles and commentary on wind and solar energy, technical and policy issues, www.wind-works.org