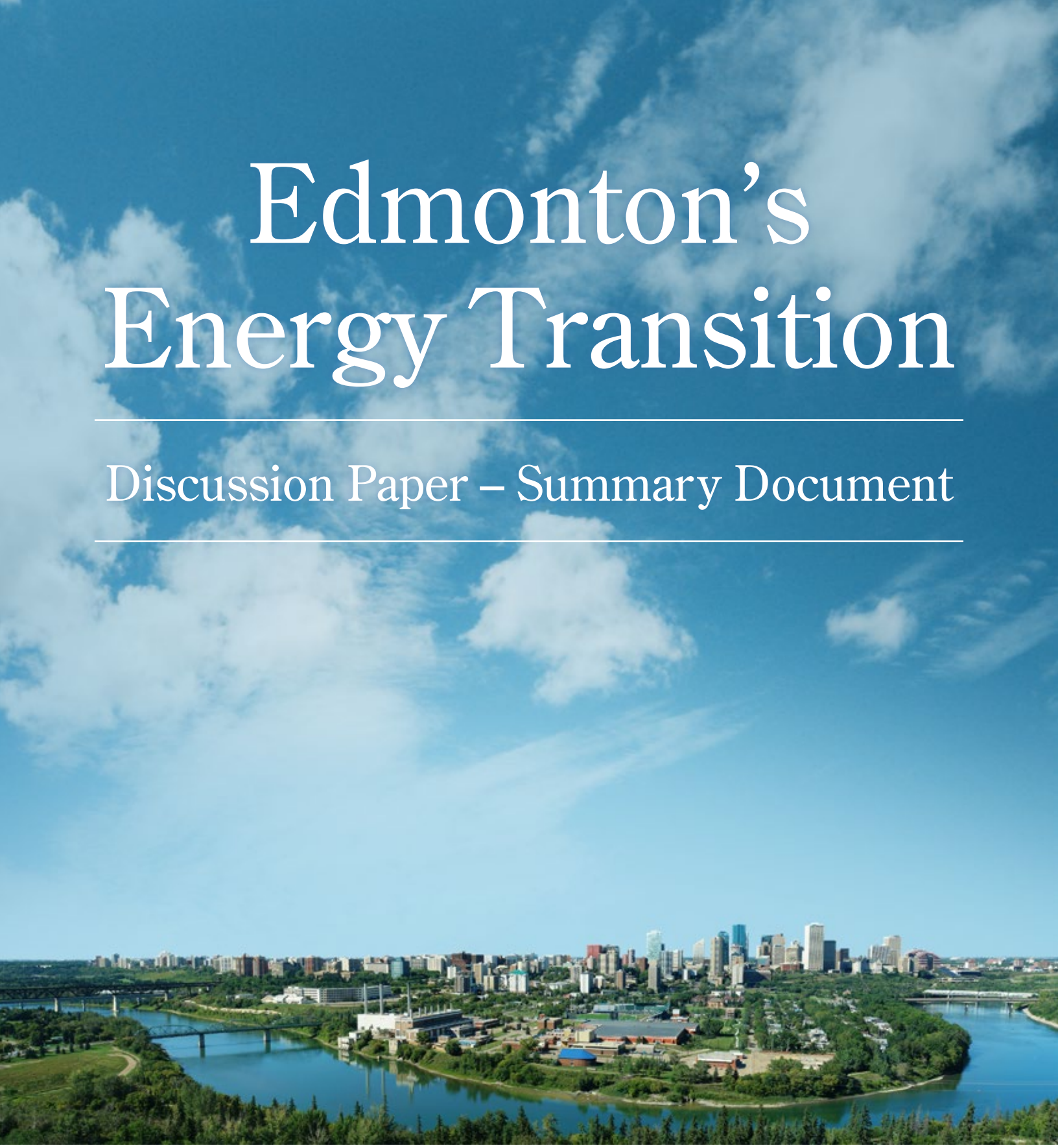
Edmonton's Energy Transition

Discussion Paper – Summary Document



Prepared for the City of Edmonton

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PEMBINA institute

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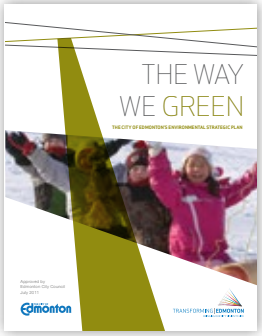
PLANNING DESIGN SUSTAINABILITY
A Member of the Golder Group of Companies

Contents

This report was compiled by the Pembina Institute and HB Lanarc.
The full discussion paper *Edmonton's Energy Transition* can be found online, www.edmonton.ca/environmental/documents/Edmonton_Energy_Transition_Discussion_Paper.pdf

Executive summary

In July 2011, Edmonton City Council approved Edmonton's environmental strategic plan, *The Way We Green*. The plan identified climate change (mitigation and adaptation) and energy (sustainability and resilience) as Edmonton's top environmental challenges. This determination was based on science-based evidence that global greenhouse gas (GHG) emissions must be reduced by 50 to 85 per cent below year 2000 levels by 2050 in order to both prevent dangerous levels of climate change, and to address concerns that Edmonton was overly dependent of fossil fuels for its energy. Although *The Way We Green* set goals for Edmonton to become a carbon-neutral, sustainable, and energy resilient city, it did not provide specific details on how these goals would be achieved.



The City of Edmonton's Way We Green plan has a clear vision for sustainability in Edmonton

Modelling and results

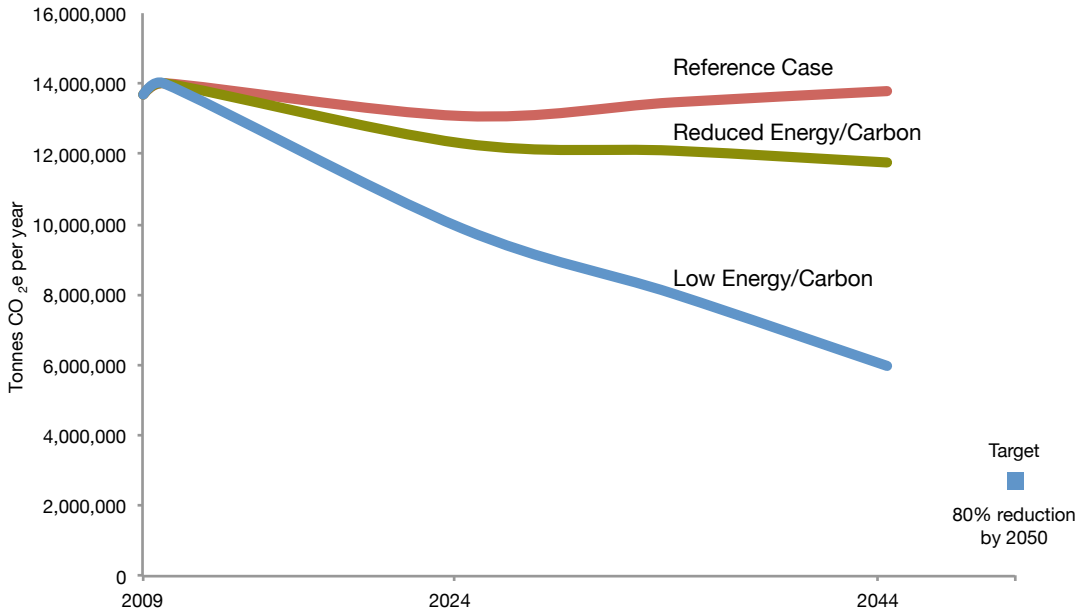
In January 2012, the authors of this discussion paper (Pembina Institute and HB Lanarc–Golder) were retained by the City of Edmonton to forecast GHG and fossil fuel reductions that were likely to occur in Edmonton as a whole under three different scenarios:

1 Reference Case business-as-usual scenario

2 Reduced Energy/Carbon this energy mix path could be achieved with moderate changes to energy policies/programs and consumer behaviours.

3 Low Energy/Carbon this energy mix path would require significant changes to energy policies/programs and consumer behavior

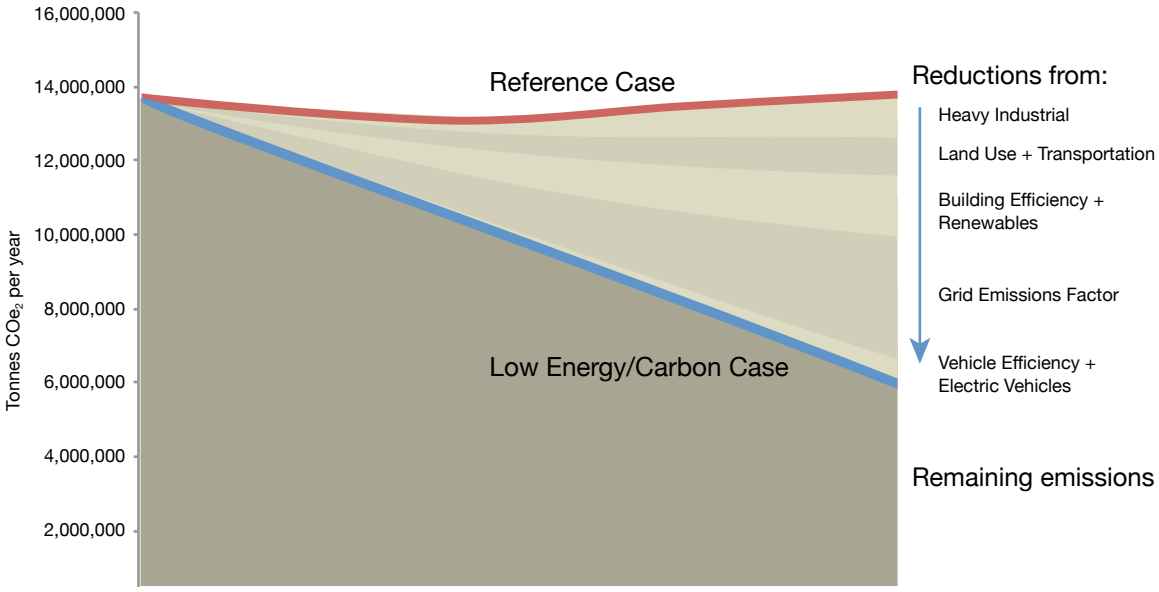
Under the Reference Case it was estimated that Edmonton's GHG emissions and fossil fuel dependence would decline slightly from 2012 to 2025, but return to current levels by 2050. Under the Reduced Energy/Carbon Case it was estimated that modest reductions in GHG emissions and fossil fuel dependence would occur from 2012 to 2025 and then level off. Despite the positive achievement of holding the line on GHG emissions during a period when the city is expected to grow by 300,000 people, these outcomes fell well short of emission reduction targets recommended by mainstream science.



Total annual GHG emissions by case compared to 2050 goal.

In search of a strategy that might bring about the desired reductions, the Low Energy/Carbon Case was also modelled. It considered a variety of cost-effective initiatives which currently are not part of *The Way We Grow* or *The Way We Move* policy framework. Results of the modelling exercise showed that it was indeed possible for Edmonton to make significant reductions — on the order of 80% lower GHG emissions and 25% less fossil fuel use by 2050. Key goals identified under this scenario included:

1. Reduce the GHG intensity of the provincial electricity grid
2. Increase the density of mature neighbourhoods
3. Reduce energy use in large industrial facilities
4. Increase the uptake of distributed energy generation
5. Increase energy efficiency of buildings
6. Reduce gasoline and diesel used in vehicles



Where emissions reductions come from under the Low Carbon/Energy Scenario.

1. Reduce the GHG intensity of the provincial electricity grid

While electricity makes up only 20% of the energy used in Edmonton, it is responsible for about 43% of Edmonton's GHG emissions. This is due to the extensive use of coal-fired power plants in the provincial electricity grid.

Although the carbon intensity of the provincial electricity grid is expected to decline in coming decades through a greater proportion of renewable energy and natural gas generation, GHG reductions from a greener grid will be largely offset by growth in electricity use.

Modelling exercises showed that in order to significantly reduce Edmonton's GHG emissions from electricity, the carbon intensity of the grid would need to be reduced much more than is currently planned. To do this, all new power plants would need to be either efficient natural gas (i.e., combined heat and power, or combined cycle) or cleaner generation (i.e., renewable energy). As well, retirement of existing coal-fired power plants would need to be accelerated. Achieving this greener power grid would contribute to a 24% reduction in emissions below the Reference Case.

The City of Edmonton's main role in this effort would be to influence (with others) the provincial and federal governments to reduce the carbon intensity of the provincial electricity grid. Other efforts could include the purchase of green power for City operations and local incentives to encourage renewable energy generation.

2. Increase the density of mature neighbourhoods

Mature neighbourhoods in Edmonton can absorb higher population densities.

The Way We Grow and *The Way We Move* encourage densification of mature neighbourhoods that will result in a density of approximately 39 people/hectare. Modelling showed that increasing the density objective to 42 people/hectare could reduce emissions by approximately 8% below the Reference Case.

To achieve this densification, the model determined that 40% of all new housing units would need to be built in existing neighbourhoods by 2044. This is more than double what is happening today, but is consistent with the City's target of "a minimum of 25 percent" [Policy 3.1.1.1 of *The Way We Grow*]).

In order to achieve this outcome, the City would need to adopt new policies affecting how developments are approved, including the creation of developer and consumer incentives to help transition the market.

Achieving this outcome would also require additional investments in transit, greater support for active modes of transportation, and encouraging the development of residential and employment opportunities around rapid transit routes.

3. Reduce energy use in large industrial facilities

Large industrial facilities are located in various areas of the city.

Edmonton can reduce GHG emissions by an estimated 8% (below the Reference Case) by 2044 through energy efficiency improvements in its large industrial facilities.

A number of roles are identified for the City including collaborating with others to encourage, coordinate, facilitate and incent the advancement of energy management systems, energy audits and new financial tools.

4. Increase the uptake of distributed energy generation

Edmonton can reduce GHG emissions by an estimated 7% (below the Reference Case) by 2044 through distributed energy generation (i.e., by generating, converting and/or sharing energy close to where it is consumed).

Initiatives include solar heat, solar power, and in-city natural gas combined heat and power plants. A number of roles for the City are identified in the paper including:

- supporting companies that provide distributed energy services,
- removing barriers to distributed generation,
- providing incentives for distributed generation,
- designing new neighbourhoods to take advantage of heat from the sun,
- requiring new buildings to be “solar ready”,
- eventually requiring on-site energy generation on larger new buildings, and
- requiring district energy in new developments where it is economically viable.

Increasing the energy efficiency of a residential buildiing by replacing windows.

5. Increase energy efficiency of buildings

Edmonton can reduce GHG emissions by an estimated 5% (below the Reference Case) by 2044 through a variety of initiatives designed to increase energy efficiency and conservation in buildings.

These initiatives are further explained in the City’s new Green Building Plan which proposes actions aimed at improving the environmental, health and socio-economic performance of all types of buildings in the city.

Key initiatives will include energy labelling for the sale of new and existing buildings, the completion of green building checklists by persons applying for building and development permits, better consumer information, capacity building within the building industry and relevant City operations, and various incentive programs. The City will have major leadership and support roles in all of these new initiatives.

6. Reduce gasoline and diesel used in vehicles

The discussion paper explains that Edmonton can reduce GHG emissions by an estimated 4% (below the Reference Case) by 2044 by reducing the amount of gasoline and diesel used in the vehicle fleet.

Achieving this goal will require city-wide reduction in gasoline and diesel fuel (i.e., 75% below current levels by 2044) and high penetration of electric vehicles (i.e., 67% by 2044).

The City could help shape this outcome with transportation strategies that favour fuel efficient vehicles, by supporting companies that provide low energy vehicles, and by encouraging the development of infrastructure for electric vehicles.

Reducing fuel use will reduce costs.

Future energy costs

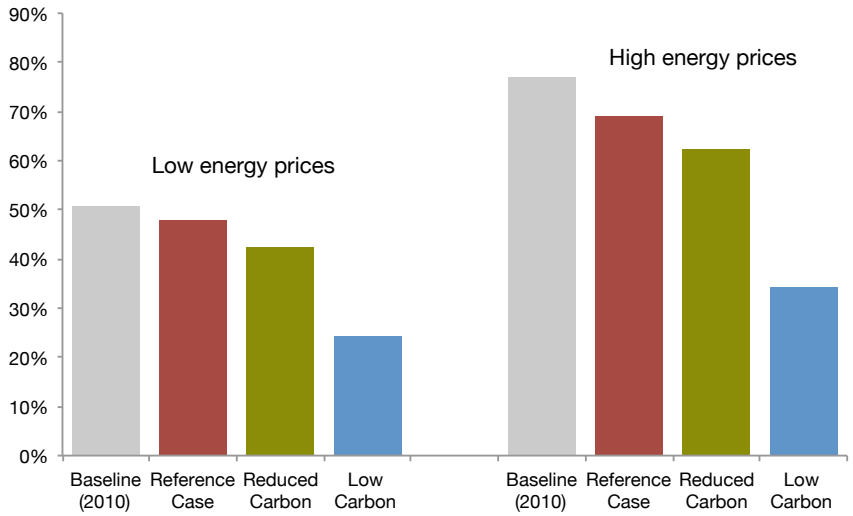
In addition to technical recommendations for becoming a low-carbon city, the authors of this discussion paper analyzed the financial benefits for Edmontonians in these scenarios.

Modelling revealed that in a future Edmonton (year 2044) where energy prices were much higher but little had been done to become a low-carbon city (i.e., the Reference Case) approximately 70% of Edmontonians would be "energy vulnerable" — they would spend more than 10% of their household income on energy.

Alternatively, under the Low Energy/Carbon Case, where Edmonton had taken steps to significantly reduce its emissions and fossil fuel use, only 35% of the population would be energy vulnerable.

The results clearly showed that if energy prices were to rise significantly in the future, Edmontonians would be better off financially living in a low-carbon city.

Approximately 70% of Edmontonians could become "energy vulnerable" — spending more than 10% of their household income on energy — if little is done to become a low-carbon city.



Share of household that are "energy vulnerable" in 2044 under different energy price scenarios

Conclusions

The research completed shows that a significant shift in energy sources and GHG emissions is possible, and that most of the opportunities consist of options that are currently either cost competitive with or less expensive than conventional energy systems. These include lower emission power plants, energy efficiency and conservation, and more compact, transit-oriented development.

Some options, such as solar energy and other emerging technologies, are currently more expensive than conventional energy systems, but are expected to become more cost competitive as they reach greater economies of scale and as the cost of emitting GHG emissions increases.

The authors of this paper recommend the City of Edmonton take advantage of the most cost-effective opportunities in the short term while preparing now for when more expensive opportunities become cost competitive.

Even though the opportunities presented in this paper are seen as being best practices, there may be barriers to their adoption in the Edmonton context. Moreover, the City of Edmonton does not have direct control over some of these opportunities and will need to work in partnership with stakeholders and other orders of government to influence change.

Closing

The work completed for this discussion paper, and the work of many other municipalities around the world, shows there are definite benefits to undertaking an energy transition and that a significant energy transition is indeed possible. A reduced reliance on fossil fuels can make a community more resilient, sustainable, affordable, economically successful, healthy and vibrant.

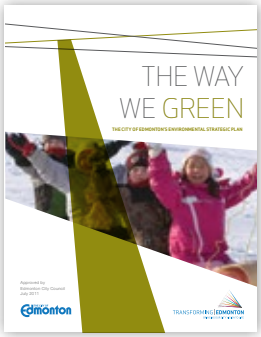
The recommendations provided for the City of Edmonton's Energy Transition Plan have been pulled from global best practices and have been selected for their practicality and combined economic, social and environmental benefits. Additional analysis will be required to determine how best to apply these practices to the Edmonton context.

The authors of this paper commend the City for examining and working to manage the risks associated with our current energy system. It is clear that the risks of 'business-as-usual' could have a significant negative impact on Edmontonians, but these risks can be reduced through a well-structured and well-executed management plan with thoroughly researched and achievable actions and goals.

Introduction

In July 2011, Edmonton City Council adopted a new environmental strategic plan called *The Way We Green*.[1] This plan sets out a clear vision and approach for Edmonton to live in balance with nature. The plan states:

While this approach is crucial for the wellbeing of the environment, it is equally crucial for the wellbeing of our society, economy, and quality of life.



The City of Edmonton's Way We Green plan has a clear vision for sustainability in Edmonton

Energy use impacts air, land, water, climate and biodiversity. It also impacts our ability to be sustainable and resilient — the two main focuses of *The Way We Green*:

1. Sustainability: our society's ability to endure over a prolonged period as an integral part of Earth's natural systems
2. Resilience: the capacity of our city to withstand and bounce back intact from environmental disturbances.

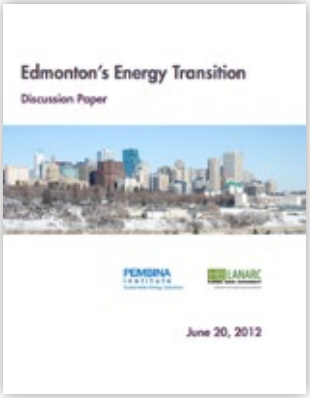
As part of the implementation of *The Way We Green,* the City is exploring what it would take to make its energy supply and use:

- more sustainable over the long term,
- more resilient to possible disturbances, and
- carbon neutral (no net greenhouse gas emissions).

Purpose of this paper

The City hired the Pembina Institute and HB Lanarc–Golder to undertake research and analysis regarding different options for Edmonton's energy future, including specific scenarios that would allow it to achieve the energy and climate change goals set out in *The Way We Green*. Their work was reviewed by a set of stakeholders from industry and academia and from within different City departments. All of the comments received by reviewers were incorporated into the paper.

This paper is being used by the City to inform further discussions with stakeholders and citizens regarding the City's Energy Transition Plan, and is being treated as one of many inputs for the conversation. It was also developed with the intention that it would be a key input in developing Edmonton's Energy and Climate Transition Plan (which will be submitted to City Council in late 2013).



The full discussion paper Edmonton's Energy Transition can be found online, www.edmonton.ca/environmental/documents/Edmonton_Energy_Transition_Discussion_Paper.pdf

Current energy use in Edmonton

Figure 1: Current energy use in Edmonton (2009) shows that most energy used in Edmonton is natural gas for heating buildings and industrial processes. Electricity and gasoline makes up most of the remainder of energy use.

Electricity in Alberta mainly comes from burning coal. The efficiency of converting coal-energy to electricity is typically between 35 and 40% with the rest of the coal-energy leaving the power plant as waste heat.

Among the end-use sectors, the commercial / institutional / industrial sector is the biggest energy user with the residential and personal transportation sectors as the second and third largest energy users respectively.

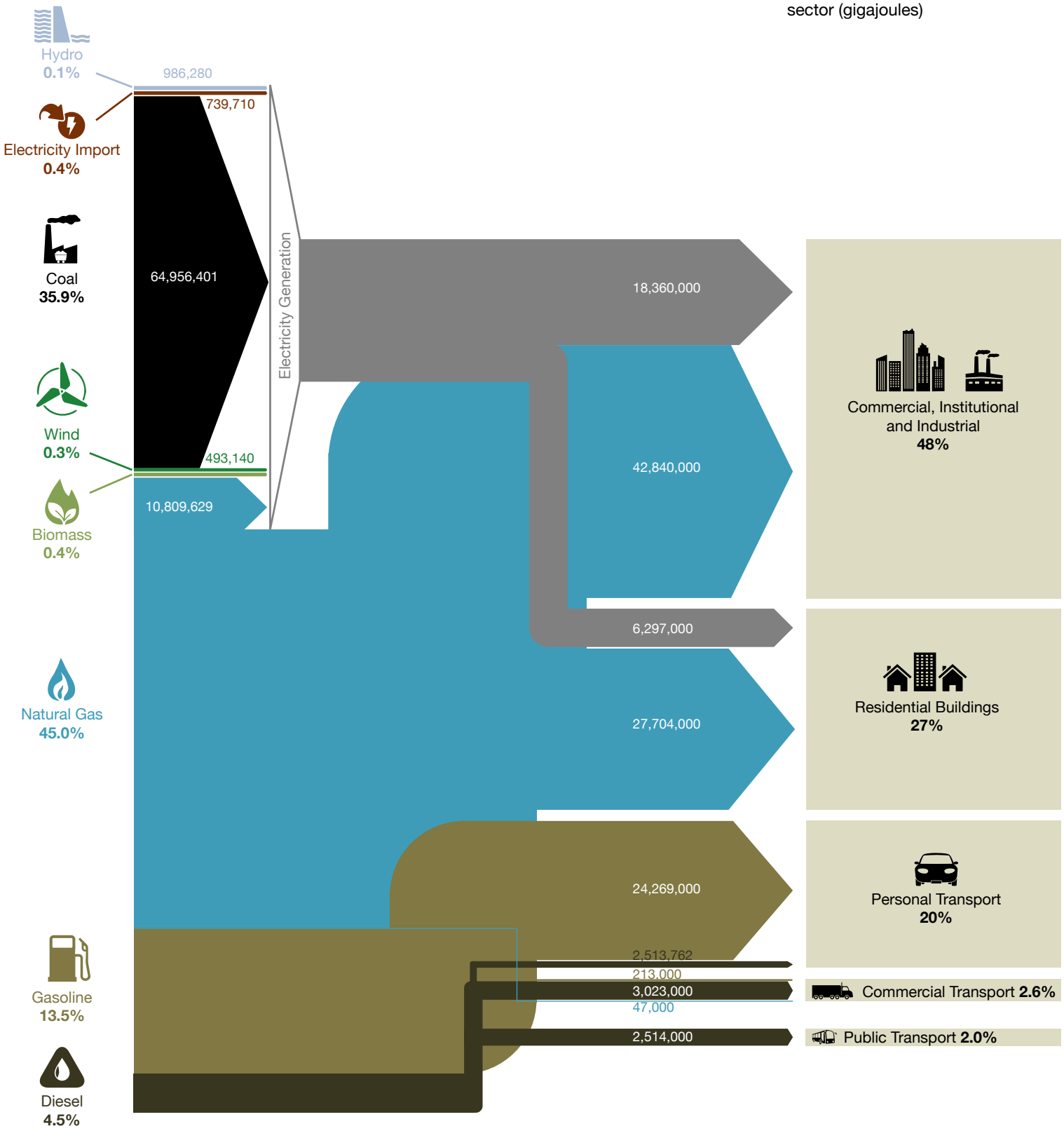


Figure 1: Current energy use in Edmonton (2009)

Risks of business-as-usual energy use

An Energy Transition Plan is being developed for Edmonton because of the risks that have been identified with current patterns of energy use. Climate change and vulnerability to energy price spikes have been identified as the two highest risks that need to be managed.[2]

Climate change

It is well accepted that burning fossil fuels is changing the Earth's climate. The projected impacts of the current climate change trend include water shortages for over one billion people, food shortages for hundreds of millions of people, hundreds of millions of people permanently displaced, the extinction of up to 40% of species, more expensive and extreme weather events, and a permanent loss of quality of life of up to 20% of GDP worldwide.

More frequent and more severe storms are predicted as the climate changes.

Edmonton and Edmontonians will not be immune from these impacts as climate change is expected to have both direct and indirect impacts on all parts of the world.

Direct impacts for Edmonton are expected to include more severe storms, floods, droughts, diseases and heat stress. Local ecosystems will change faster than ever before and there will be a significant loss of natural species.

Indirectly, Edmonton is expected to be impacted by climate change as natural disasters, conflict and economic disruptions are expected to increase worldwide. This includes major changes to the global agricultural industry due to an increase in storms, droughts and unusual weather, and major changes to the global economy as a whole.

As part of *The Way We Green*, Edmonton City Council has set a goal of becoming carbon neutral as a way to reduce the city's contribution to human-caused climate change.

Edmonton's expected contribution to GHG emissions

Under business-as-usual conditions, Edmonton is expected to maintain its current level of GHG emissions, as shown in Figure 2: Annual GHG emissions by selected sector - Reference Case. While the number of people and businesses are expected to grow, this growth is expected to be offset by higher efficiency buildings, vehicles and industries, and a shift towards more natural gas-fired power plants on the provincial grid as opposed to coal-fired power plants. The result of these currently-anticipated changes is little change in GHG emissions over the next 30-plus years.

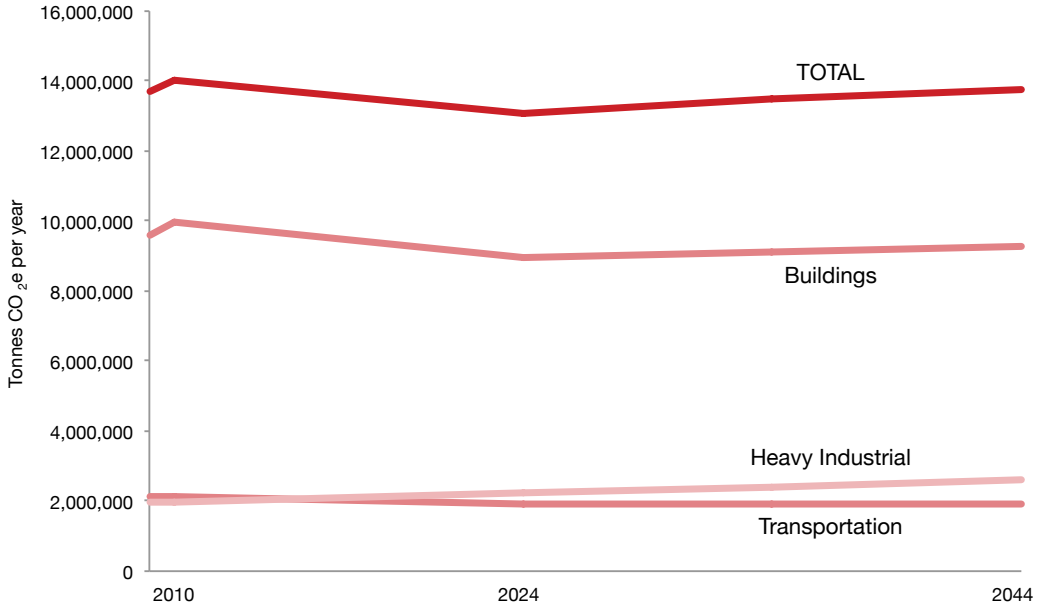


Figure 2: Annual GHG emissions by selected sector - Reference Case

This consistent level of GHG emissions for Edmonton is out of line with Council's goal to become carbon neutral. It is also out of line with national and international targets for reducing GHG emissions over the next 10 to 40 years. This means that a business-as-usual approach to GHG emissions in Edmonton will not only continue to contribute to dangerous levels of global climate change, it may also result in penalties as governments put in place increasingly stringent GHG reduction policies.

Vulnerability to energy price spikes

It is generally agreed that the price of oil will continue to climb and become more volatile in the future. While an increase in oil prices may benefit some people, it will negatively impact those Edmontonians and Edmonton businesses that don't directly benefit from higher oil prices. In addition, increasing price spikes are expected to bring tough economic times with them as they have in the past — in the last 40 years, any time oil prices have doubled, a recession has followed.[3]

> Taking all new developments and policies into account, the world is still failing to put the global energy system onto a more sustainable path.
>
> — International Energy Agency, World Energy Outlook 2012 Report

Figure 3: Projected impact of energy price spikes on Edmontonians — Share of household that are "energy vulnerable" — Reference Case shows that price spikes will also significantly increase the number of Edmontonians who are considered "energy vulnerable" if current patterns of energy use continue.

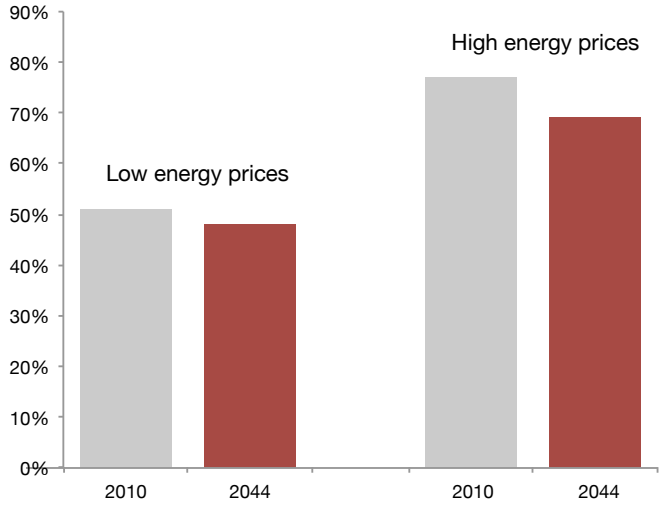


Figure 3: Projected impact of energy price spikes on Edmontonians — Share of household that are "energy vulnerable" — Reference Case

Because of moderate improvements in energy efficiency, the number of "energy vulnerable" Edmontonians (those who spend more than 10% of their household income on energy) is estimated to be less in 2044 than now. However, if energy prices spike, nearly 70 per cent of households would still reach that vulnerability cutoff.

Opportunities for energy transition

Opportunities used in the case scenarios

Based on the research completed, the following five areas present the greatest opportunities for transitioning Edmonton's energy mix and reducing GHG emissions[4]:

- Provincial electricity grid
  - » Increasing the percentage of electricity generated from wind farms and natural gas combined heat and power plants
- Urban form and transit
  - » Creating more compact, mixed-use neighbourhoods with enhanced walking, cycling and transit infrastructure, and fewer people driving
- Heavy industry
  - » Increasing energy efficiency of existing industry, and encouraging new economic development that is focused on less energy-intensive businesses
- Buildings
  - » Increasing the energy efficiency of new and existing buildings (including the building envelope, the equipment within the building and the behaviours of the occupants)
  - » Increasing distributed energy generation (such as in-city natural gas combined heat and power plants) and renewable energy generation (mainly solar heating and electricity generation) in buildings.
- Vehicles
  - » Increasing the efficiency of gasoline and diesel vehicles, and the uptake of electric vehicles

Each of these opportunities was modelled for three different scenarios:

1 Reference Case	the energy mix path that Edmonton is currently on
2 Reduced Energy/Carbon	this energy mix path could be achieved with moderate changes to energy policies/programs and consumer behaviours.
3 Low Energy/Carbon	this energy mix path would require significant changes to energy policies/programs and consumer behavior

The major assumptions used for each opportunity area and modelling case are listed in Table 1: Summary of key modelling assumptions.

Modelling results

Figure 4: Total annual GHG emissions by case compared to 2050 goal shows that the only modelling case that is close to meeting international expectations of an 80 per cent reduction in GHG emissions by 2050 is the Low Energy/Carbon Case. This case represents a future where the City of Edmonton pursues all of the energy transition opportunities listed in the previous subsection to a high but achievable level.

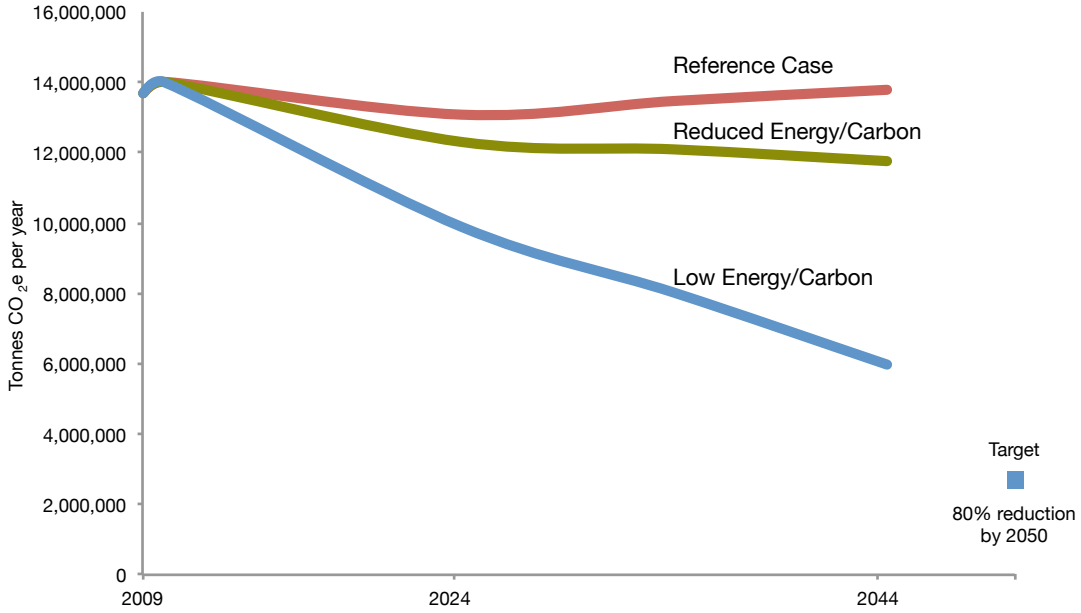


Figure 4: Total annual GHG emissions by case compared to 2050 goal

1 Reference Case	2 Reduced Energy/Carbon	3 Low Energy/Carbon
Provincial Electricity Grid		
GHG intensity of the provincial electricity grid decreases as currently expected (based on current market forces).	GHG intensity of the provincial electricity grid decreases more than currently expected (i.e., assumes the introduction of new government policy that encourages a greater shift towards lower emission power plants).	All new electricity generation in the province is a combination of renewable energy and highly efficient natural gas combined heat and power plants. Some existing coal-fired power plants are retired ahead of current schedules.
Urban Form and Transit		
Continuation of current land development patterns (currently 17% of new population growth occurs in developed areas of the city).	Faster build-out of inner city developments (e.g. downtown and airport redevelopment) than currently occurs. The current Municipal Development Plan (*The Way We Grow*) has a goal of 25% of new population growth occurring in developed areas of the city over the next 30 years. Transportation develops according to the current transportation plan (*The Way We Move*).	40% of new population growth happens in developed areas of the city, and transit networks are significantly expanded. These changes go beyond current City plans.
Heavy Industry		
GHG emissions from heavy industry (e.g. refineries and cement plants) are assumed to increase at the same rate as city-wide job growth.	GHG emissions from heavy industry do not increase dramatically from current levels as the amount of growth in the sector is offset by a combination of energy efficiency improvements and industrial development that is focused on less energy-intensive facilities.	GHG emissions from heavy industry decrease by 25% from current levels by 2044 due to significant efficiency improvements. New industrial facilities are not as energy intensive as refineries or cement plants.
Buildings		
Increased building code efficiency standards in line with, but not beyond, stated government policy.	Building code efficiency standards increase moderately beyond stated government policy.	Aggressive increase in building code efficiency standards. All existing buildings are required to undertake economic energy efficiency upgrades at time of sale. Distributed energy generation such as in-city natural gas combined heat and power plants are installed in suitable developments. Solar energy is commonplace by 2030 and installed on virtually all suitable rooftops by 2044. New buildings are built to take advantage of low-cost passive solar heating.
Vehicles		
Increased efficiency standards in line with, but not beyond, stated government policy. Electric vehicle uptake in line with projected national trends.	Vehicle efficiency standards increase moderately beyond stated government policy.	Aggressive increase in vehicle efficiency standards. Uptake of electric vehicles meets the most optimistic projections.

Table 1: Summary of key modelling assumptions[5]

Many of the opportunities that are modelled as part of the Low Energy/Carbon case are outside the direct control of the City of Edmonton. Changes in these areas will require collaboration with stakeholders, including other orders of government. Additional analysis will also be required to determine how best to apply these practices to the Edmonton context.

The GHG reductions in the Low Energy/Carbon Case are achieved through a combination of all five opportunity areas shown in Figure 5. By far the largest emission reduction comes from a shift towards lower emission electricity sources in the province. The next largest emission reductions come from changes to urban design and transit, industrial energy efficiency, building energy efficiency and distributed energy generation. Vehicle efficiency improvements offer a smaller but still significant emission reductions.

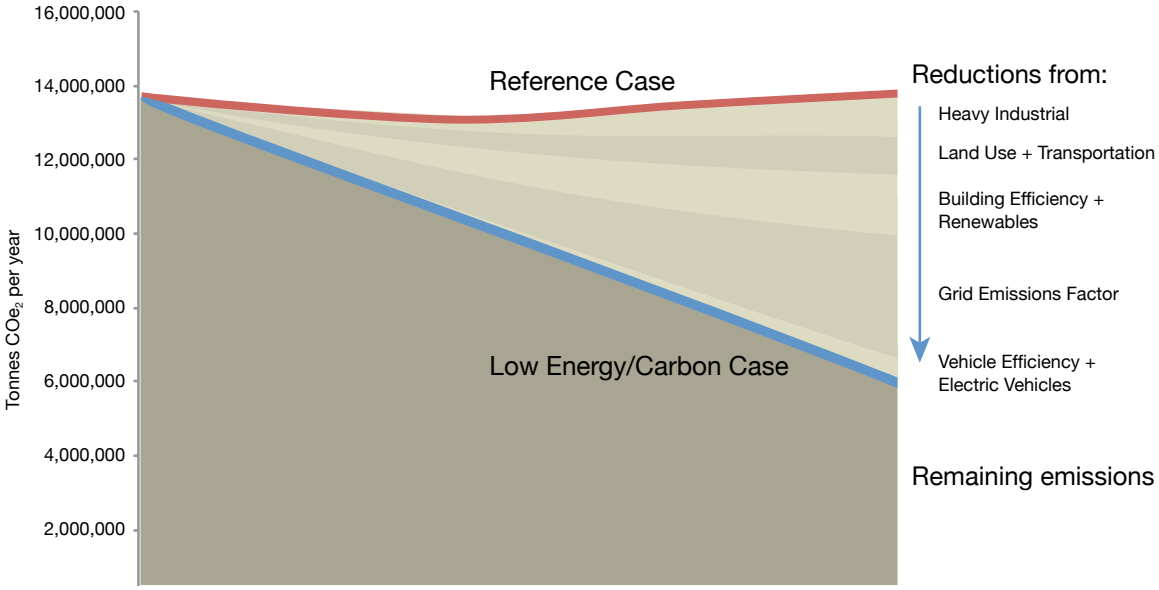


Figure 5: Low Energy/Carbon Case wedge diagram

The Low Energy/Carbon Case is also projected to significantly reduce the number of households considered "energy vulnerable" in Edmonton, as shown in Figure 6. The estimated shift in energy costs is due to:

- Much higher energy efficiencies for buildings and vehicles
- Greater use of transit, walking and cycling
- A partial shift from gasoline vehicles to electric vehicles

A reduction of this size is expected to significantly reduce Edmontonians' exposure to the volatility of global energy markets.

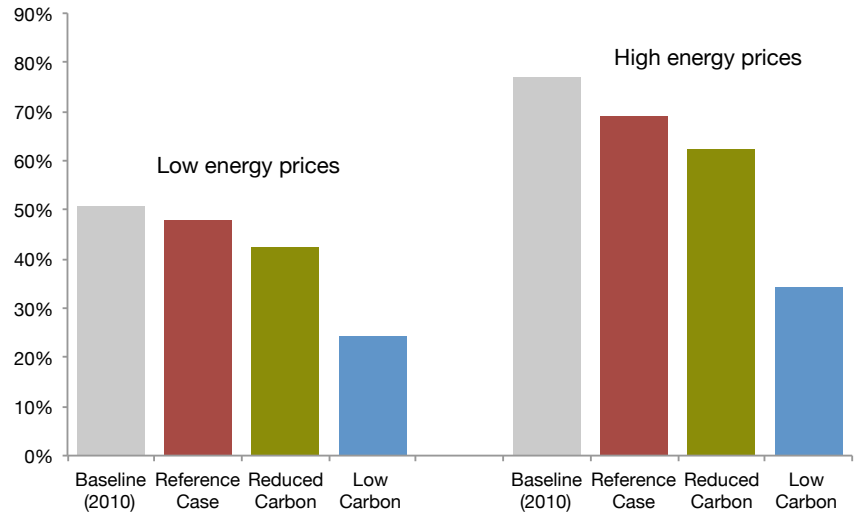


Figure 6: Share of household that are "energy vulnerable" in 2044 under different energy price scenarios

Overall, energy flows in a low energy/carbon future (Figure 7: Energy supply and use in Edmonton (2044) – Low Carbon Case, excluding heavy industry) look significantly different than current energy flows (Figure 1: Current energy use in Edmonton (2009)). Some of the key differences include:

- Much less electricity is produced from coal.
- There is a significant increase in the amount of electricity coming from natural gas, wind power, and combined heat and power plants.
- There is a significant increase in the use of solar energy.
- There is a significant increase in the amount of electricity used for transportation.

It is also important to note that while it is not easy to see when comparing Figure 1: Current energy use in Edmonton (2009) and Figure 7: Energy supply and use in Edmonton (2044) – Low Carbon Case, excluding heavy industry, per capita energy use in the city is significantly reduced in the Low Energy/Carbon Case.

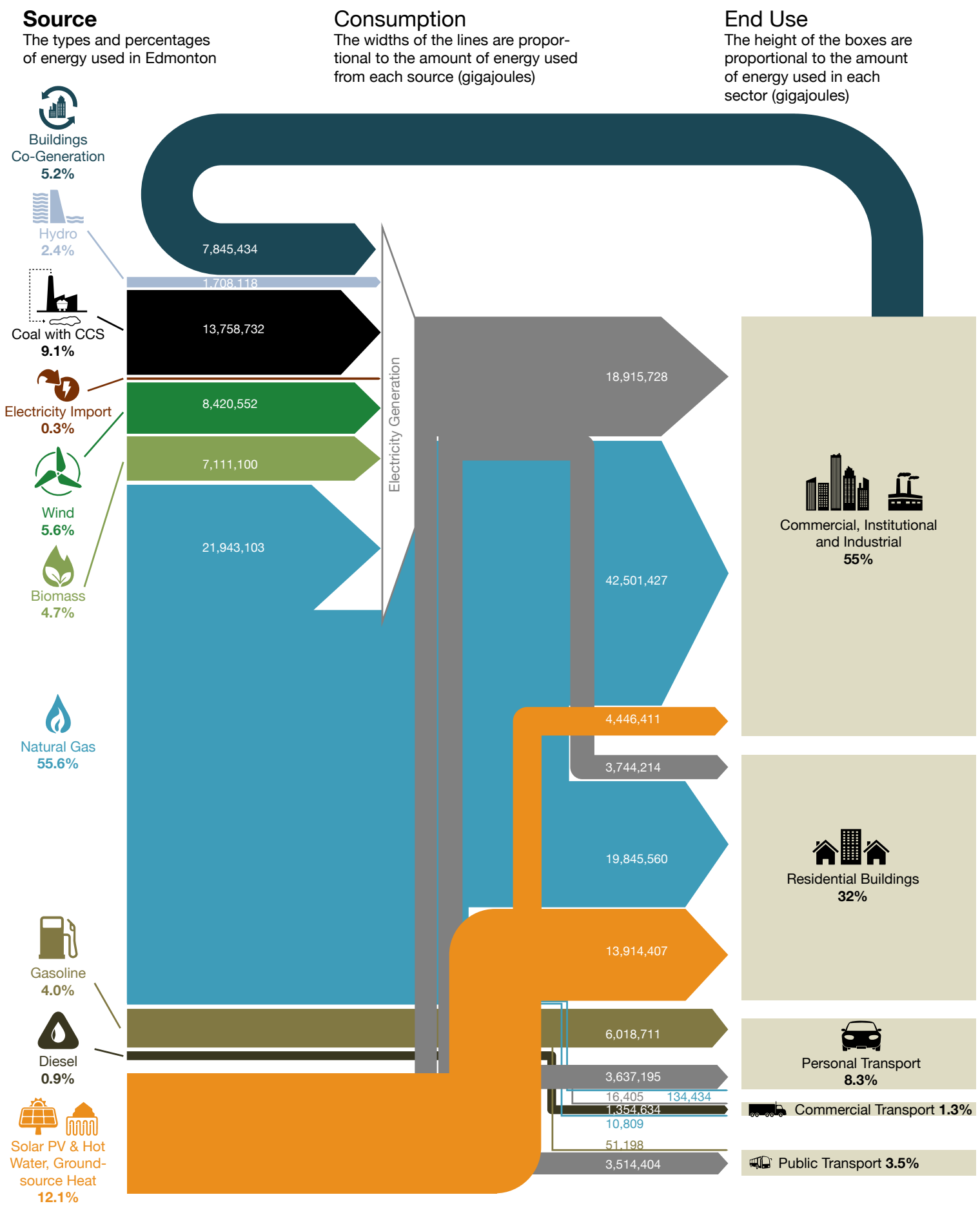


Figure 7: Energy supply and use in Edmonton (2044) – Low Carbon Case, excluding heavy industry

Net costs of options

While the Low Energy/Carbon Case is advantageous from an energy cost perspective (because it significantly reduces energy demand), it is also important to consider the full cost of different energy transition options that were examined as part of the opportunities investigated.

Active transportation can cost less than road infrastructure.

In order to have a fair 'apples-to-apples' comparison, it is necessary to consider the cost of building and running a city for both a business-as-usual future and a low energy/carbon future.

Based on the research compiled, the energy transition options fall into three net-cost categories.

Lower net cost

The following low energy/carbon options were found to have a lower net cost (including both construction and operating costs) than current approaches:

- Energy-efficient buildings, industrial facilities and vehicles
  - » While high-efficiency equipment often has a higher purchase price than low-efficiency equipment, the cost premium is typically more than recovered over the life of the product.[6]
- Use of passive solar heating
  - » By increasing the number of windows that face south, 40 to 60% of a building's heat can be supplied for free from the sun for no additional building cost.[7]
- Compact neighbourhoods, transit, walking and cycling
  - » Compact neighbourhoods require less infrastructure (roads and utilities) than neighbourhoods that are spread out. This makes them less expensive to build, operate and maintain.[8]
  - » The cost of transit, walking and cycling is less than the cost of private vehicles when you consider the costs of both the infrastructure (roads and train lines) and vehicles (purchasing and operating cars and buses).[9]

Similar net costs

The Alberta Electric System Operator has estimated that the cost of electricity from lower-emission power plants (using natural gas or wind power) is similar to the cost of electricity from new high-emission power plants (using coal).[10] GHG emissions from Alberta's electricity grid can therefore be reduced with no increase in electricity costs.

Reaching the level of emission reductions in the Low Energy/Carbon Case, however, requires that existing coal-fired power plants be retired ahead of current schedules. The impact on the price of electricity in the province has not been estimated at this time, although early retirement of existing low-cost / high-GHG-intensity power plants is expected to either raise electricity prices for consumers or reduce profits for the companies operating those facilities. The size of these impacts is not currently publicly available. It should be noted that early phase-out of power plants could also prevent price spikes that occur as a result of catastrophic failures of aging plants, as was the case in 2010 when Sundance 1 and 2 coal units were unexpectedly shut down.

Solar panels have higher net costs but the price of technology continues to drop.

Higher net costs

Some of the energy transition options investigated are currently more expensive than current practices. These include:

- Solar panels (for generating electricity or heating water)
- Electric vehicles

As these are relatively new technologies, their relative costs are expected to come down over time as production volumes increase and the cost of GHG emissions rises. This has already occurred to a large degree with solar electric (PV) panels.[11]

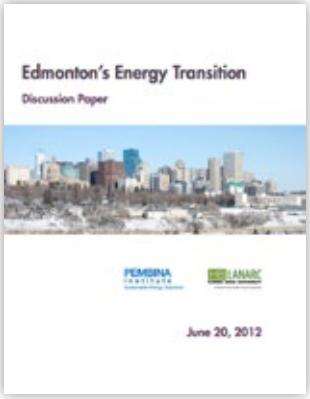
Net cost summary

The research completed shows that a significant shift in energy sources and GHG emissions is possible, and that most of the options that make up the opportunities are currently either cost competitive with or less expensive than conventional energy systems. These options include lower emission power plants, energy efficiency and conservation, and more compact, transit-oriented development.

Some options, such as solar energy and other emerging technologies, are currently more expensive than conventional energy systems, but are expected to become more cost competitive as they reach greater economies of scale and as the cost of emitting GHG emissions increases.

The recommendations in the next section allow the City of Edmonton to take advantage of the most cost-effective opportunities in the short term while preparing now for when more expensive opportunities become cost competitive.

The Low Energy/ Carbon Case modelled also demonstrates a noticeable decrease in the amount of fossil fuel-based energy used in Edmonton.



The full discussion paper Edmonton's Energy Transition can be found online, www.edmonton.ca/ environmental/documents/ Edmonton_Energy_Transition_ Discussion_Paper.pdf

Recommedations

Targets

As the City of Edmonton has already set a target of becoming carbon neutral, it makes sense to try to achieve this at the same rate that the leaders of the G8 countries have recommended for developed countries — an 80% reduction in GHG emissions (compared with 1990 to 2005 levels) by 2050.[12]

Analysis shows that this emission reduction target is possible through the opportunities identified in the Low Energy/Carbon Case, and largely depends on reducing the GHG intensity of the provincial grid; shifting towards more compact, transit-oriented communities; increasing energy efficiency in industry; increasing the uptake of distributed energy and energy efficiency in buildings; and reducing gasoline and diesel use in vehicles..

Interim targets on the road to an 80% reduction by 2050 — as shown in the Low Carbon Case — are a 20% reduction by 2020 and a 50% reduction by 2035 compared with current (2011) levels.

The Low Energy/Carbon Case modelled also demonstrates a noticeable decrease in the amount of fossil fuel-based energy used in Edmonton. The recommended target for a more diverse energy mix — based on the Low Energy/Carbon Case — is to reduce gasoline, diesel fuel and coal-based energy to 25% below current levels by 2044. The modelling assumes a fuel mix that has natural gas-based energy close to current levels and increases the use of renewable energy to 23 times above current levels. The end result would be a shift in fossil fuel use (coal, oil and natural gas) from approximately 98.5% of Edmonton's energy (currently) to 75% by 2044.

Recommended activities

Based on the research and analysis undertaken, it is clear that if Edmonton wants to reduce GHG emissions at the same rate as the G8 leaders' recommended goal for developed countries (80% by 2050), it will need to take action on all of the major emission reduction opportunities identified, and it will need to motivate other orders of government, organizations and individuals to do the same.

To reduce GHG emissions to this level and noticeably change the energy mix in Edmonton, the City of Edmonton would likely need to undertake the activities outlined below:

1. Reduce the GHG intensity of the provincial electricity grid
2. Increase the density of mature neighbourhoods
3. Reduce energy use in large industrial facilities
4. Increase the uptake of distributed energy generation
5. Increase energy efficiency of buildings
6. Reduce gasoline and diesel used in vehicles

These recommended activities take advantage of the most cost-effective options in the short term, but they also allow the City to prepare now for when more expensive opportunities become cost competitive.

Note that the timing and sequencing of these recommendations has not been evaluated or proposed as part of this discussion paper. It is recommended that the City undertake further analysis on the resource requirements for these recommendations, opportunities for implementation, readiness of the marketplace, and timing considerations within the Edmonton context in order to prioritize these recommendations and create a more detailed implementation plan as part of the City's Energy Transition Plan. This analysis should be carried out in partnership with key stakeholders.

1. Reduce the GHG intensity of the provincial electricity grid

The provincial electricity grid should shift away from coal and toward less carbon-intensive forms of energy.

Expected reduction: 24% below the Reference Case by 2044

Activity description:

a. Influence (with others) the provincial and federal governments to reduce the carbon intensity of the provincial electricity grid

This would include increasing the percentage of power from natural gas power plants and wind farms, and accelerating the retirement of existing coal-fired power plants.

Creating change within other governments in this way typically requires a long-term, coordinated effort to build support within different groups (including citizens and industry), and to engage with political decision makers on a regular basis.

b. Purchase green electricity

By voluntarily purchasing green power, the City could lead by example and also directly increase the demand for green power production.

Additional information on reducing the GHG intensity of the provincial electricity grid can be found in Appendix B – Section 2.2 and Appendix C – Section 2.5 of the full discussion paper.

2. Increase the density of mature neighbourhoods

Density is beginning to increase in some mature neighbourhoods.

Increase development undertaken to create compact, mixed-use and transit-oriented neighbourhoods within already developed areas of the city.

Expected reduction: 8% below the Reference Case by 2044

Activity description:

a. Land use and transportation planning beyond *The Way We Grow* and *The Way We Move*

These two plans include a shift from current development patterns (17% of population growth in mature neighbourhoods) to more development in existing areas such as the downtown, the airport lands and inner city (25% of population growth in mature neighbourhoods). Going beyond current plans would require even greater shifts in development (e.g., 40% of population growth in mature neighbourhoods).

b. Remove barriers to developing compact, mixed-use, transit-oriented neighbourhoods

Infill development neighbourhoods are typically more challenging to get approved than traditional greenfield suburban development. This leads to increased risk of not being approved and longer approval periods, which are barriers to undertaking infill developments.

New development guidelines and approval processes to increase the speed infill development applications and increase the quality and desirability of compact development are likely needed to make it easier for new infill developments to be approved. This would also help to increase the market demand for compact, mixed-use, transit-oriented neighbourhoods.

c. Provide incentives to buying / building in compact, mixed-use, transit-oriented neighbourhoods

Research[13] shows that incentives (such as lower mortgage rates) can encourage consumers to buy homes in particular neighbourhoods. It is recommended that the City first undertake research to determine and assess the different ways incentives could be provided before selected one or more to trial before full implementation.

d. Increase the frequency, capacity, convenience and quality of transit service in conjunction with increases in compact, walkable and transit-oriented development

This can be accomplished through:

- increased budget for transit development and operation at the municipal, provincial and/or federal levels; and
- combining areas of high population and employment densities (existing and planned) with rapid transit routes that have high levels of capacity (existing and planned).

The level of rapid transit service should be expanded by approximately five times greater than current levels

e. Increase the amount and quality of walking and cycling infrastructure and encourage its use

This can be accomplished through policies, budgets and programs to identify and build new infrastructure, engagement programs (both public and employee-based programs) and incentives. These activities can have significant social, health and economic co-benefits for residents.

f. Work with insurance companies to develop pay-as-you-drive insurance and promote it to citizens

The City will need to explore how it may be able to motivate the development of this new insurance product. A provincial or national effort may be required as insurance is regulated provincially, but most large insurance companies operate nationally or internationally.

g. Consider parking supply restrictions, and toll roads or congestion pricing for vehicles

These can be accomplished through parking and transportation policies adopted by the City.

These items were not explicitly modelled within any of the Cases, but research[14] shows that they can be effective in decreasing the amount of driving in a city as long as transportation alternatives are available. Further research is recommended to determine the feasibility, potential effectiveness and potential implementation approaches to these options including if and when they may be appropriate to use.

Additional information on increasing the density of mature neighbourhoods can be found in Appendix B – Section 2.4, and Appendix C – Sections 2.1 and 2.2 of the full discussion paper.

3. Reduce energy use in large industrial facilities

Reduce the energy use in industrial facilities through all economic energy efficiency measures and a focus on industrial developments with lower energy use.

Large industrial facilities use a large amount of energy.

Expected reduction: 8% below the Reference Case by 2044

Activity description:

a. Consider supporting[15] industrial energy management systems[16]

These systems have proven to be effective in saving energy, but they are not used in all facilities.[17] Given the specialized expertise required for this action, it is recommended that the City consider partnering with other organizations to approach industrial facilities in the city to help build capacity in this area.

b. Consider encouraging, incenting and eventually requiring energy audits of industrial facilities

Energy audits can provide valuable information on cost-effective energy efficiency upgrades. By promoting and incenting energy audits to facilities in Edmonton (again, in partnership with other organizations), the City could build familiarity and capacity for energy audits and upgrades. It is also recommended the City consider developing a bylaw to require energy audits for large energy users to ensure their universal uptake. There are ways to ensure the cost of the audits is not too onerous for facilities so that the bylaw will not be negatively received.

c. Consider providing information to industrial facilities about how their energy use compares to similar facilities (i.e. benchmarking) and supporting the development of new financing tools

Working with other organizations, the City could increase the generation and dissemination of information that encourages energy efficiency upgrades.

A similar approach could be taken to developing new financing tools so facilities can easily undertake energy efficiency upgrades and reduce their annual energy costs in a way that provides them an immediate positive cash flow.

d. Consider working with the provincial government to provide incentives for energy efficiency upgrades and eventually increase regulations that will further motivate energy efficiency upgrades

Incentives and regulations related to energy efficiency of industrial facilities are often created at a provincial level. It is recommended the City consider working with the province to create incentives and eventually increased regulations for energy efficiency in the industrial sector. Possible regulatory mechanisms include the existing Specified Gas Emitters Regulation, which provides incentives for large facilities to reduce their GHG emissions, and the regulatory approval process for large facilities that often contain specified levels of environmental performance.

e. Assess the feasibility, benefits and disadvantages of working to have future industrial development in Edmonton focus on facilities with low to moderate energy use

Shifting towards industrial facilities with low to moderate energy requirements is one way to reduce energy use and GHG emissions, but it has not been studied fully enough to determine its feasibility or implications. The City should undertake this work if it would like to use this strategy as a way to reach the recommended targets.

Although research suggest that these recommendations will help to make industry more profitable, careful consideration is needed identify and address any situations that might harm Edmonton's competitiveness.

Additional information reducing energy use in large industrial facilities can be found in Appendix B – Section 2.1 and Appendix C – Sections 2.32 of the full discussion paper.

4. Increase the uptake of distributed energy generation

Increase the uptake of distributed energy generation (e.g. solar heat and power, and natural gas combined heat and power plants) through barrier removal, capacity building, incentives and regulations. This includes meeting 5% of electricity demand and 22% of heating demand with solar energy.

Expected reduction: 7% below the Reference Case by 2044

Activity description:

a. Support[18] companies providing distributed energy services

Companies that provide services such as feasibility studies, product installations, insurance, financing or maintenance are essential to increasing the uptake of distributed energy systems. The City would need to assess the variety of opportunities available to support these service providers (e.g., direct funding, in-kind resources, training, partnerships, unique financing opportunities, or enhanced visibility) so limited resources could be used effectively and strategically.

b. Remove regulatory barriers to distributed generation

When regulatory barriers to distributed generation are identified (e.g. requiring a development permit to install a flat-mounted solar panel on a roof), work to remove these barriers.

c. Provide incentives for distributed generation

One method of increasing early market uptake of new technologies is to provide incentives. The City could provide the budget for these incentives while the incentives could be made available through either the City or a third party.

Distributed energy systems are used in some parts of the city, including the University of Alberta.

d. Design new neighbourhoods to take advantage of free heat from the sun

It is recommended that the City develop a policy for all new developments to maximize the southern exposure of buildings through optimizing street alignment for solar exposure, where reasonably possible.

Providing solar design guidelines and potentially requiring or incenting passive solar design is another step to maximizing this free heat.

e. Require all new buildings with solar access to be built 'solar-ready'

It is much more cost effective to install a conduit from the roof to the mechanical and electrical room in a building when it is being built than to add it afterwards. Adopting this relatively low-cost measure will make it much easier and affordable in the future to install solar panels on buildings that have suitable exposure to the sun.

f. Eventually require on-site energy generation on larger new buildings

Similar bylaws have been adopted in other jurisdictions as a way to increase distributed energy generation and reduce GHG emissions. The amount of on-site energy generation required is often in the range of 10%, which is considered economically possible for larger new buildings (greater than 1,000 m^2 or approximately 11,000 ft^2)

g. Require district energy in new developments where it is economic

District energy is one of the ways to increase the efficiency of heating systems and make it easier to install combined heat and power plants, which are much more efficient than generating heat and electricity at separate sites. The City could begin this process by undertaking, encouraging or requiring district energy feasibility studies on proposed high density developments, and then, if economic, include district energy as a requirement for approval.

Additional information on increasing the uptake of distributed energy generation can be found in Appendix B – Section 2.2 and Appendix C – Section 2.3 of the full discussion paper.

5. Increase energy efficiency of buildings

Increase the energy efficiency of buildings (new by 85% and existing by 22% compared to current levels) through capacity building, incentives and regulations. Reduce overall energy demand by 10% through behaviour change programs.

Energy efficiency is easily incorporated into new buildings.

Expected reduction: 5% below the Reference Case by 2044

Activity description:

a. Work with energy retailers to provide customers a way to compare the energy use of their building to that of similar buildings

This can be in the form of additional information on utility bills, online profiles or benchmarking studies that are customized for a particular customer. The feedback is provided regularly so behaviour changes can be maintained over a long period of time.

b. Support the adoption of visible meters in homes

These types of programs often include fully or partially subsidizing the cost of a meter (either a physical device or an online profile) that provides ongoing information on a customer's energy use and costs. The City could provide this subsidy or partner with others to make it available.

c. Support[19] companies providing energy efficiency services for buildings

These services are essential to creating market transformation. The City would need to assess the variety of opportunities available to support these service providers so limited resources could be used effectively and strategically.

d. Support building energy management systems

These systems have proven to be effective in saving energy, but they are not used in all buildings.[20] It is recommended the City partner with other organizations to increase the use of energy management systems within buildings in Edmonton.

e. Support and eventually require energy labelling of buildings at time of sale

Pilot projects have been used to develop the systems needed for broad energy labelling of buildings. Eventually, energy labelling will need to be required through a bylaw or other form of regulation. In order to accomplish this, it may be necessary to have a mechanism in place for sellers to easily pass the costs of energy efficiency upgrades on to the new buyer (as the benefits of the upgrade are passed on as well).

f. Support and eventually require building retrofits at time of sale

A similar process as energy labelling (i.e., piloting, developing systems, regulating and mechanisms for easy and cost-effective upgrades to be undertaken) is likely needed, so that a requirement to retrofit buildings for efficiency at time of sale is not onerous for owners and buyers.

g. Put in place a voluntary green building checklist and eventually require it

The voluntary green building checklist helps to build awareness of green building practices. Once commonly understood, a bylaw to require the checklist to be undertaken will ensure the practices are considered for all new buildings.

An independent design review panel could also be used to provide designers with free advice on how to save energy and money with their building design and construction.

h. Monitor the provincial and federal governments' efforts to continue to increase energy efficiency requirements in the building code

Increases in the energy efficiency requirements in the building code are a base assumption within the Reference Case and are important to achieving the recommended targets for the Energy Transition Plan.

i. Consider engaging facilities with large amounts of waste heat to see if this heat could be used elsewhere

Using extra heat from one facility in another is one way to reduce energy use. The amount of extra heat, its location and opportunities for its use have not been studied as part of this discussion paper. An assessment of the potential to use waste heat and its ease of implementation is recommended to ensure City work in this area is a good investment compared to other opportunity areas

Additional information on increasing energy efficiency of buildings can be found in Appendix B – Section 2.1 and Appendix C – Section 2.3 of the full discussion paper.

6. Reduce gasoline and diesel used in vehicles

Reduce the amount of gasoline and diesel used in the vehicle fleet by 75% through capacity building, incentives and regulations. 67% of all vehicles are electric.

Expected reduction: 4% below the Reference Case by 2044 (dependent on changes to the electricity grid)

Activity description:

a. Encourage the adoption of fuel-efficient vehicles

This could involve the engagement of taxi fleets, parking providers (preferred parking for hybrid and electric vehicles), the City's transportation department (HOV lanes eligible for hybrid electric and electric vehicles) and fuel providers (making alternative fuels available). Incentives can also be used to encourage these measures.

Reducing fuel use will reduce costs.

b. Support fleet fuel management programs

These types of programs have proven to be successful.[22] It is recommended the City work with the largest fleet operators in Edmonton to adopt or enhance fleet fuel management programs in a way that results in overall cost savings.

c. Support companies providing electric vehicles, natural gas vehicles, biofuels[22] and associated services

This could include purchasing vehicles and fuels, direct funding, in-kind resources, partnerships or enhanced visibility.

d. Encourage, incent and eventually require the electrification of loading spaces, truck stops and garages

This would help to ensure there is adequate infrastructure for electric vehicles and commercial vehicles that are able to plug in rather than idle to run onboard systems.

Additional information on reducing gasoline and diesel used in vehicles can be found in Appendix B – Section 2.3 and Appendix C – Section 2.2 of the full discussion paper.

Endnotes

1. http://www.edmonton.ca/city_government/city_vision_and_strategic_plan/the-way-we-green.aspx
2. More information on the sources of information for this section can be found in Appendix A of the full discussion paper: Edmonton's Energy Transition, June 20, 2012.
3. HSBC Global Research, The Global Economic Impact of Higher Oil Prices (2011).
4. Additional information on each option can be found in the full discussion paper: Edmonton's Energy Transition, June 20, 2012, p. 13 – 24.
5. Information supporting the assumptions made can be found in Appendix B of the full discussion paper.
6. Energy Sector Sustainability Table, Energy Efficiency in Canada. (2008) p. 5
7. Tim Weis et al., "Renewable Energy Potential for the City of Edmonton" prepared for the City of Edmtonon's Renewable Energy Task Force (2011) 12.
8. IBI Group, The Implications of Alternative Growth Patterns on Infrastructure Costs. (2009) page i.
9. Victoria Transport Policy Institute, Raise My Taxes, Please! Evaluating Household Savings From High Quality Public Transit Service (2010)
10. Alberta Electric System Operator, Long-Term Transmission System Planning, presentation to stakeholder meeting, November 16, 2007.
11. International Energy Agency, "Current and Projected Costs," 2010,
12. Leaders of the Group of Eight. 2009. Responsible Leadership for a Sustainable Future. http://www.g8italia2009.it/static/G8_Allegato/G8_Declaration_08_07_09_final,0.pdf
13. Cool Communities, Live Where You Go, (2012) p. 55-57
14. Row, J. et. al. Options for Reducing GHG Emissions in Calgary: Research Report Appendices, (2011) p. 55
15. Support could include funding, in-kind resources, training, partnerships, unique financing opportunities, or enhanced visibility.
16. Industrial energy management systems typically involved monitoring of energy use, identifying operational or retrofit opportunities to reduce energy use, and undertaking those opportunities that make sense. These actions occur on an ongoing basis and typically use structured management processes and staff to ensure they are done well.
17. Canadian Manufacturers and Exporters. 2010. Improving Energy Efficiency for Alberta's Industrial and Manufacturing Sectors.
18. Support could include funding, in-kind resources, training, partnerships, unique financing opportunities, or enhanced visibility.
19. Support could include funding, in-kind resources, training, partnerships, unique financing opportunities, or enhanced visibility.
20. Peneycad, M., BOMA Canada's BBEER Facts: Building Performance Nationwide. (2012) p 2.
21. City of Edmonton, Fuel Sense Project (2002).
22. Ethanol and biodiesel are currently required to be blended into gasoline and diesel fuel by law. Some biofuels create greater GHG reductions than others. It is recommended that any programs focus on the lower GHG biofuels as the more common biofuels are already being readily adopted in the marketplace.