C3 - Energy. Ideas. Change.

Energy Transition Drivers

1.4(a) A literature review on the experience of other cities in pursuing energy transition goals

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EXECUTIVE SUMMARY

The following literature review was assembled with the intent to determine if a policy direction that supported lower energy and overall sustainability, including the promotion of sustainable transit, energy efficiency in residential, commercial, institutional and industrial facilities, mixed use and higher density residential development that supported transit oriented development, would effectively enhance the economy of the city and make it a better place to live for its citizens. Based upon our literature review, and the statistical analysis comparing cities with sustainability programs there is a strong correlation that this does take place.

In the context of Edmonton's Energy Transition Plan, observations from 27 major urban centers across North America suggest that cities with higher levels of energy efficiency, reduced GHG intensity, increased penetration of "green" buildings, greater availability of sustainable transport options, and higher levels of water conservation, will tend to have:

- Higher (lower) rates of employment (unemployment);
- Higher GDP per capita;
- Lower rates of violent crimes;
- More graduates (higher levels of educational attainment);
- Lower levels of perceived stress among residents (improved mental health);
- A greater sense of community among citizens; and
- Higher levels of investment in new commercial and institutional buildings.

Cities that do not support effective sustainability policies do run a risk of not being able to keep pace with growth as suburbs grow further away from infrastructure bases such as water treatment plans, electrical substations, and water pump stations. Each of these pieces of infrastructure requires resources to maintain, operate and energy to support their operation. Add to this other pieces of infrastructure required, - public transit, streets and highways. In the end the lack of policy such as this is economically impossible to maintain. Additionally, the social consequences of a longer commute to work increases the disconnection because there is no sense of community.

It is clear that the City of Edmonton, in its Energy Transition Plan, can join these dynamic cities. The actions contained in this plan have been developed and worked on by other cities throughout North America and beyond. The key to success appears to be in the approach:

- Not everything has to be done at once.
- There are partners that can assist.
- There are easy and quick wins, many with co-benefits that should be the first priority.
- Ongoing citizen engagement and reporting will help to carry momentum.
- Innovation does not always mean a direct financial cost – there are many policy instruments available.
- Urban built form planning is the biggest challenge, but start modestly and work towards a goal.
- Build on regulatory reform that will enable program success (for example: have the solar permit process streamlined and well understood before launching a solar program).
- Include the protection and enhancement of green space as part of the overall strategy.
- The growth of populations to cities is inevitable.

Overall, the evidence suggests that it is actually a combination of economic, environmental, and social factors – and not solely economic prosperity - that produce a higher quality of life, and create conditions that attract and retain residents and businesses.

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INTRODUCTION

The purpose of this document is to provide background information and evidence of the experience of other cities that have moved towards actions to reduce energy and address climate change. These actions will be compared and contrasted with the City of Edmonton's Energy Transition Plan.

THE OBJECTIVE OF THIS DOCUMENT IS:

To collect robust evidence from the experience of other cities that demonstrates the social and economic benefits of becoming a sustainable energy city and being at the forefront of a global transition to a low carbon economy. Is there evidence from other cities that supports a hypothesis that a sustainable, low carbon city is a wealthier and healthier city?

The methodology to carry this work out will be to examine literature from other cities to determine:

- Cost savings, economic and social benefits of being a sustainable city.
- Identify components of a sustainable city that are consistent with goals of the COE's Energy and Transition Strategy
- Address how the COE's Energy and Transition Plan will make Edmontonian's heather, happier, wealthier and better off

C3 has examined literature from the most credible sources possible – reports from the cities we have identified as those being leaders largely in Canada and the United States, but also from cities from around the world. Developing world examples can be both practical and inspirational in their approach and the way they deliver their programs.

The United Nations Environment Program (UNEP) assembled a large paper entitled: *Towards a Green Economy – Pathways to Sustainable Development and Poverty Eradication,* in 2011. Although the document provides a world view on Sustainability and the need to move forward worldwide on the issue, it offers some excellent and documented successes that have been and continue to take place. The Cities section of this report is very good at providing a starting point for both the need, but also the successes and the key learnings, so far. They provide seven key messages (UNEP, 2011[i]) that set the stage very well:

1. ***Urban development will have to fundamentally change to facilitate the transition to a green economy.*** The challenges world wide as urban areas now the home to over 50% of the world's population and account for between 60-80% of energy and almost the same greenhouse gas emissions. Rapid urbanization exerts pressure on fresh water supplies, sewage, the living environment, and public health, affecting the urban poor the most. The most profound affects related to this rapid urbanization is sprawl and the move of settlement to the cities periphery, which causes energy costs to rise, significant capital investment in infrastructure and the use of productive (farmland) land for housing. Even more sinister is the social effects on the population, in which people do not feel, connected to a community.

2. ***Unique opportunities exist for cities to lead the greening of the global economy.*** Compact, relatively densely populated cities, with mixed-use urban form, are more resource-efficient than any other settlement pattern with similar levels of economic output. Integrated design strategies, innovative technologies and policies are available to

improve urban transport, the construction of buildings and the development of urban energy, water and waste systems in such a way they reduce resource and energy consumption and avoid lock-in effects.

3. ***Green cities combine greater productivity and innovation capacity at lower costs and reduced environmental impact***. Relatively high densities are a central feature of green cities, bringing efficiency gains and technological innovation through the proximity of economic activities, while reducing resource use and energy consumption. Urban infrastructure including streets, railways, water and sewage systems comes at considerably lower costs per unit as urban density rises. Issues such as congestion can be addressed through mixed use buildings, and an efficient public transit system.

4. ***In most countries, cities will be important sites for the emerging green economy***.
    - The proximity, density and variety intrinsic to cities deliver productivity benefits for companies and help stimulate innovation;
    - Green industries are dominated by service activities – such as public transport, energy provision, installation and repair – which tends to be concentrated in urban areas where consumer markets are largest;
    - Some cities will also develop high-tech green manufacturing clusters in or close to urban cores, drawing on knowledge and skills spill overs from universities and research labs.

5. ***Introducing measures to green cities can increase social equity and quality of life***. Enhancing public transport systems can reduce inequity by improving to public services and other amenities and by helping to relive vehicle congestion in poorer neighborhoods. Cleaner fuel for transport and power generation can reduce both local pollution and health inequality. Reducing traffic and improving conditions for pedestrians and cyclists can help foster community cohesion, an important aspect of quality of life, which also positive impacts on economic resilience and productivity.

6. ***Only a coalition of actors and effective multilevel governance can ensure success of green cities***. The most important fundamental enabling condition is the coalition of actors from the national and local state, civil society, the private sector and universities who are committed to advancing the green economy and it urban prerequisites, placing it centrally within the top strategic priorities for the city. The central task of this coalition is to promote the idea of a long term strategic plan for the city.

7. ***Numerous instruments for enabling green cities are available and tested but need to be applied in a tailored, context-specific way***. It is possible to envisage a range of planning, regulatory, information and finance instruments applied at the local level to advance green infrastructure investments, green economic development and a multi-track approach to greater urban sustainability.

WHO ARE THE LEADING CITIES?

Almost intuitively some people may know or may have an educated guess of cities that seem to be at the cutting edge of sustainability or pushing a low carbon future agenda. This could be based upon reports they have read or even because of visit to one of these centres where sustainable actions are highly visible. Rather than speculate, we have examined some of the annual surveys of sustainable cities to see who is in fact cutting edge, Table 1 illustrates the ranking of various cities based upon various assessments described below for 2012.

NORTH AMERICAN CITIES – SUSTAINABILITY SCORECARDS AND INDEXES

Three sustainability indexes were reviewed and summarized for common themes and primary energy or climate change policy or policies that may propel them onto the list.

1. SIEMENS GREEN CITY INDEXii: http://www.siemens.com/entry/cc/en/greencityindex.htm

   A research project conducted the Economist Intelligence Unit, sponsored by Siemens, measures and compares the environmental performance of 27 major US and Canadian cities, representing a number of the most populous metropolitan areas.

   Methodology: The cities were picked independently rather than relying on requests from city governments to be included, in order to enhance the Index's credibility and comparability. The Index scores cities across nine categories – CO_2, energy, land use, buildings, transport, water, waste, air quality and environmental governance – and is composed of 31 indicators. Sixteen of the Index's 31 indicators are derived from quantitative measurements – e.g., a city's CO_2 emissions, electricity consumption, prevalence of public transport and levels of air pollutants. The remaining 15 indicators are qualitative assessments of cities' environmental policies, aspirations and ambitions – e.g., a city's commitment to consuming energy produced from green and local sources, the extent to which it promotes the usage of public transport and makes efforts to reduce road traffic, the ambitiousness of its waste reduction and water management policies, and the stringency of its environmental strategy.

2. CORPORATE KNIGHTS NORTH AMERICAN SUSTAINABLE CITIES SCORECARDiii: http://www.corporateknights.com/report/north-american-sustainable-cities-scorecard/ranking

   The 2013 ranking is the sixth iteration of the Corporate Knights' sustainable cities ranking, and the first one to attempt a direct comparison between Canadian and US urban areas.

   Methodology: Twenty cities were chosen and assessed against 27 social, environmental and economic indicators in 5 categories that since 2009 have represented our best attempt to measure sustainability the Corporate Knights way: along the social, environmental and economic pillars. Roughly half of the indicators were carried over from the 2011 rankings, a core of traditional measures (such as air pollution, household spending on shelter, population density, education). One change is the breadth of

sources collected to serve an international ranking, including international reports from the World Bank, WHO, in addition to heavy reliance on both countries' national statistics. Another change is a slight shift away from goal or vision-oriented indicators, towards measuring recent infrastructure and socio-technological change. New metrics were incorporated like congestion and "walkability", as well as cycling infrastructure, believing these affect citizens' quality of life as well as economic and environmental performance of cities. And finally the ranking was not done with benchmarks or targets for which more than one city could get a perfect score. Our focus this year was purely on rankings, meaning no two cities could get the same score on any indicator.

3. MERCER 2012[iv] QUALITY OF LIVING WORLDWIDE CITY RANKINGS: http://www.mercer.com/press-releases/quality-of-living-report-2012

Mercer's 2012 Quality of Living Survey evaluates living conditions in more than 460 cities worldwide. For this study, only North American cities were reviewed, highlighted and included.

Methodology: Living conditions are analyzed according to 39 factors in 10 categories including political and social, economic and natural environment categories.

- *Political and social environment* (political stability, crime, law enforcement)
- *Economic environment* (currency exchange regulations, banking services)
- *Socio-cultural environment* (censorship, limitations on personal freedom)
- *Medical and health considerations* (medical supplies and services, infectious diseases, sewage, waste disposal, air pollution, etc.)
- *Schools and education* (standard and availability of international schools)
- *Public services and transportation* (electricity, water, public transportation, traffic congestion, etc.)
- *Recreation* (restaurants, theatres, movie theatres, sports and leisure, etc.)
- *Consumer goods* (availability of food/daily consumption items, cars, etc.)
- *Housing* (rental housing, household appliances, furniture, maintenance services)
- *Natural environment* (climate, record of natural disasters)

The scores attributed to each factor allow for city-to-city comparisons. The result is a quality-of-living index that compares relative differences between any two locations that we evaluate.

Table 1 - A Comparative Review of Sustainability Rankings of North American Cities

City	Siemens	Corporate Knights	Mercer
San Francisco	1	1	29
Vancouver	2	4	5
New York City	3	9	44
Seattle	4	7	44
Denver	5	13	Not ranked
Boston	6	6	35
Los Angeles	7	19	Not ranked
Washington DC	8	2	43
Toronto	9	5	15
Chicago	11	12	42
Ottawa	12	3	14
Philadelphia	13	8	Not ranked
Calgary	14	10	32
Houston	16	16	Not ranked
Dallas	17	11	Not ranked
Montreal	19	14	23
Atlanta	21	17	Not ranked
Miami	22	15	Not ranked
Pittsburgh	23	Not ranked	49
Phoenix	24	18	Not ranked
	27 cities ranked	*20 cities ranked*	*50 cities ranked*

The following summaries are from the 2011 Siemens *US and Canada Green City Index*. Cities are listed alphabetically.

The report noted that generally Canadian cities have higher policy scores on average – at 78 points out of 100 overall, compared with 70 for American cities, which demonstrates the commitment they have made to improving environmental performance. There is a correlation between how cities perform in the US and Canada Green City Index and their income (as measured by GDP per capita). Wealthier cities can afford better projects – environmental or otherwise.

BOSTON

Boston has comprehensive plans for promoting energy efficiency. Boston excels in its policies for local and green energy projects. In 2008 the city launched Solar Boston, a program to encourage the widespread adoption of solar energy. Details include easing permitting

requirements, mapping feasible locations, and planning for purchasing, financing, and installing of solar technology. Through these efforts Boston increased its solar campaign, *Sparking Boston's Climate Revolution*, to identify ways for the city to reduce greenhouse gas (GHG) emissions.

CALGARY

In October 2009 Calgary – along with 14 other global energy-producing cities such as Houston, Texas and Stavanger, Norway – signed the *Calgary Climate Change Accord*, pledging to reduce greenhouse gas emissions from city operations by 20% by 2020 and 80% by 2050 from 1990 levels. The plan focuses on increasing the use of renewable energy, capturing methane from landfills for energy production, greening the vehicle fleet, conserving energy and water in city buildings, and piloting innovative environmental technologies and practices.

CHICAGO

The *Chicago Climate Change Action Plan* outlines 26 actions to reduce greenhouse gases and nine actions to prepare for climate change, helping the City, residents, and businesses reduce greenhouse gases by 25 percent below 1990 levels by 2020 and 80 percent below 1990 levels by 2050. The Chicago Climate Task Force, in consultation with hundreds of stakeholders, recommended these actions for the City of Chicago and every Chicago business and resident. Chicago is using funding sources such as the state's Energy Efficiency Portfolio Standard, as well as other state and federal grants, to finance these measures.

DENVER

Greenprint Denver outlines a number of actions to reduce greenhouse gas emissions. The main areas identified were energy conservation, greater energy efficiency in buildings, renewable energy and carbon offsets.

HOUSTON

Houston unveiled a *Multi-Pollutant Emissions Reduction Plan* in 2008, which includes a series of ongoing energy efficiency and renewable energy measures. Specific projects include municipal building retrofits, and the installation of a combined heat and power system at Houston's wastewater treatment facilities, which are responsible for over 30% of the city's energy usage. In 2013, The City of Houston has signed an agreement to purchase over 140 MW of renewable power for the next two years. The City's purchase of green power will account for half of its annual electricity demand.

MONTREAL

Montréal made a commitment to reduce GHG emissions by 30% by 2020 during the fourth Municipal Leaders' Summit on Climate Change held in December 2005 in Montréal. The *Montreal Community Sustainability Development Plan* includes a target to reduce greenhouse gas emissions by 30% by 2020 compared with 1990.

NEW YORK CITY

Launched in 2007, New York's *PlaNYC* established a goal of reducing greenhouse gas emissions by 30% below 2005 levels by 2030. Around 50% of the reductions will come from efficiencies in buildings, 32% from improved power generation and 18% from transportation.

OTTAWA

In 2005 Ottawa's *Air Quality and Climate Change Management Plan* established targets for greenhouse gas reduction and outlined the types of measures that would, if fully implemented, achieve the plan's targets. The government pledged to reduce emissions from its own activities by 20% from 1990 levels by 2007, a goal the city met.

SAN FRANCISCO

San Francisco's *Climate Action Plan*, unveiled in 2008, targets a 25% reduction in citywide greenhouse gas emissions by 2017 compared with 1990 levels. The 2025 target is 40% below 1990 levels, stretching to an 80% cut by 2050. Between 2001 and 2010 energy efficiency programs, including the installation of greener appliances in residences and businesses, reduced electricity consumption in San Francisco by 29 megawatts – enough to power 29,000 households. On the auto front, San Francisco is considered the electric vehicle capital of the US, with over 160 public charging stations and plans to install an additional 2,750.

SEATTLE

In 2010 the city council adopted carbon neutrality as one of its 16 priorities. This commitment builds on Seattle's history of environmental leadership including efforts in 2000 to create the first carbon neutral electric utility, and the 2005 effort to get cities across the nation to commit to meet the Kyoto Protocol targets for greenhouse gas reduction and Seattle's *Climate Action Plan*. Seattle's current plan calls for the reduction of greenhouse gas emissions 30% below 1990 levels by 2024, and 80% by 2050.

TORONTO

In 2007 Toronto launched its *Climate Change, Clean Air and Sustainable Energy Action Plan*, with the goal of reducing CO_2 emissions from 1990 levels by 6% by 2012, 30% by 2020, and 50% by 2050. The plan allocated initial funding of $42 million for energy conservation measures, $20 million for renewable energy projects, and $22 million for retrofitting city facilities through revolving loans to non-profit organizations, institutions, and some private enterprises.

VANCOUVER

Vancouver's *Community Climate Change Action Plan* in 2005 aimed to reduce the city's greenhouse gas emissions by 6% from 1990 levels by 2012. The plan included initiatives for integrated land use; more sustainable energy; green building standards; road space allocation and pricing programs that promote walking, cycling and mass transit; and waste reduction. In 2010 Vancouver unveiled a new plan – the Greenest City Action Plan, which aims to accelerate the current momentum by reducing greenhouse gas emissions by 33% by 2020 from 2007 levels and reach its stated aim of becoming the "greenest city in the world". In addition, the city runs the voluntary Corporate Climate Leader program for local businesses.

WASHINGTON, DC

Washington has a greenhouse gas reduction strategy; included in the strategy is a goal to reduce greenhouse gas emissions by 20% by 2020, compared with 2006 levels. In September 2010 Washington launched a sweeping plan to reduce greenhouse gas emissions throughout the city. As a starting point, the city has committed to reducing greenhouse gas emissions from

municipal operations by 20% by 2012, 30% by 2020 and 80% by 2050, based on a 2006 baseline.

Note:

Portland was not included in Siemens *US and Canada Green City Index* because it fell outside the selection criteria, yet because of the city's environmental track record it provides many examples of best-practice leadership that can serve as models to other US and Canadian cities.

PORTLAND, OREGON

The City of Portland was the first US city to adopt a local strategy to reduce CO_2 emissions, their goal being a 20% reduction below 1990 levels by 2010 through the Portland metropolitan area. The strategy includes specific objectives in six areas: energy efficiency, recycling, renewable resources, transportation, tree planting and influencing federal policy. (ICLEI, 2011[v])

As of 2008, carbon emissions were 19% below what they were per person in 1990. I the greater Portland region is considered the actual emission reduction has been 1%. That 1% decrease compares to 14% increase in total emissions nationally over the same period.

Since 1990, Portland's recycling rate has tripled to 67% of waste generated at homes and businesses. The number of bicyclists crossing bridges has increased fivefold. Bus ridership has doubled.

The 2009 Portland – Multnomah County plan continues to advance carbon reductions with programs that offer tax credits for businesses that install eco-roofs and solar panels. Additional innovative programs are included in the plan for transportation and growth planning. One of the aggressive targets in the plan calls for 60% of Portland's population driving electric vehicles, by 2030. (The Oregonian, 2009[vi])

THE CARBON DISCLOSURE PROJECT

In 2013, the Carbon Disclosure Project[vii] (CDP), in partnership with C40 and AECOM conducted surveys with 110 cities across globe to better understand how cities are taking action on climate change and the co-benefits of taking action. The survey includes many of the world's largest cities such as London, Tokyo, New York, and Jakarta. This survey represents the largest and most comprehensive collection of self-reported data on climate change action in cities ever assembled. In general, the survey found that the benefits of taking action on climate change are not limited to reducing emissions and adapting to climatic change. *Cities are saving money, creating more attractive investment environments, and enabling citizens to live healthier lives*.

Three Canadian cities are included in the survey - Montreal, Vancouver and Toronto. All three of these Cities believe that climate change:

- poses social risks to the community;
- will present significant physical risks that will threaten the ability of businesses to operate successfully; and
- presents many economic opportunities.

A summary of the greenhouse gas reduction goals, how they are achieving those goals, and the co-benefits and rationale for climate change action in these three Canadian cities are summarized below.

GHG REDUCTION TARGETS

- Montreal has committed to a 20% reduction in GHGs related to Municipal Operations by 2012 (from 2002 levels), and 30% reduction in community GHGs by 2020 (from 1990 levels)
- Vancouver has committed to a 20% reduction in GHGs related to Municipal Operations by 2012 (from 2007 levels), and 33% reduction in community GHGs by 2020 (from 2007 levels)
- Toronto has committed to a 80% reduction in GHGs related to municipal operations and community by 2050 (from 1990 levels)

APPROACH TO GHG REDUCTION

Planning Approach

All three Canadian Cities have incorporated GHG reduction strategies into their master planning for the City (e.g. Municipal Development Plan).

In Montreal, the existing master plan (Plan d'urbanisme de Montréal 2004) targets GHG emission reductions through investments in the public transit system, increased densification, supporting transit oriented development, investing in infrastructure dedicated to active transportation, and by supporting the development of green housing.

In Vancouver, GHG reduction strategies are integrated into their Greenest City Action Plan which includes several initiatives aimed at increasing the number of 'green jobs' in the City and the number of companies actively engaged in greening their operations.

The City of Toronto has included GHG reduction strategies in its Official Plan and Green Development Standard. Toronto's "Power to Live Green: Toronto's Sustainable Energy Strategy" is the City's Energy Transition Plan with a goal to significantly conserving, renewing and smartly distributing electricity and natural gas to meet GHG reduction targets, while maintaining energy reliability and affordability

Corporate Emission Reduction Activities

The following is a summary of specific corporate emission reduction activities undertaken by Montreal, Toronto and Vancouver, including (if known) anticipated emissions reductions from the activity:

MONTREAL

- sustainable development policy adopted for municipal buildings requiring a *green building standard* to be met for construction of new buildings;
- adoption of a *building performance rating and reporting program* to assess building performance according to energy consumption, intensity of energy sources, and operating costs;
- building retrofit actions undertaken according to *building performance rating and reporting program* rating - insulation, lighting upgrades, furnace upgrades, etc.;
- $3 million Energy Fund created in 2008 provides interest free financing for eligible energy efficiency projects in the City (*1,525 metric tonnes CO2 per year reduction*);

- gradual replacement of heating oil as an energy source in municipal buildings with natural gas, hydro-electric or geothermal sources *(10,000 metric tonnes CO_2 per year reduction)*;
- installed an open-circuit geothermal system at the Montreal Biodôme and a closed-circuit system at the Montreal Insectarium (*2,750 metric tonnes CO2e per year reduction*);
- replacement of high-consumption appliances and equipment with certified low-consumption models in municipal buildings;
- purchasing department has developed and adopted a sustainable purchasing policy that favours low-carbon products and services;
- modifications to City fleet including purchase of low-consumption vehicles, integrating energy saving accessories, using biodiesel, retiring older models, and training employees in fuel-efficient driving *(4,400 metric tonnes CO2e per year)*;
- gas captured at the inner-city landfill is used as an energy source;
- two major methanisation plants are being constructed to convert organic waste into renewable energy (methane);
- many ice skating and hockey arenas have eliminated CFCs from their cooling operations (*3,500 metric tonnes CO_2e per year*); and
- burners are being upgraded at the wastewater treatment plant to reduce natural gas consumption in the post-combustion chamber (*4,600 metric tonnes CO_2 per year*).

VANCOUVER

- building retrofit actions undertaken on a significant number of City-owned buildings, including replacement of boilers and installation of solar thermal heating systems;
- The City is working towards implementation of a landfill gas capture project;
- A Green Operations strategy is being developed which will include initiatives to reduce energy, water, and waste including a fleet fuel reduction program, a Green IT strategy, a Green Workplace Challenge and a construction material reduction initiative;
- Various initiatives aimed at reducing GHG's in the City fleet including:
  - a 'Jump Start' program focused the right-sizing of vehicles, anti-idling and use of B20, E10 fuels
  - green fleet practices program including driver training, idle stops and tire inflation checks;
  - increased proportion of bio-fuel in the City's fuel supplies;
  - increased utilization of hybrid and battery electric vehicles; and
  - reducing fleet size by providing City staff access to a fleet car-share program.

TORONTO

- converting all traffic and pedestrian signals to use LED lighting technology which will provide savings of about $2 million per year;
- Green Fleet Plan in place to reduce consumption and increase efficiency of fleet (*15,000 metric tonnes CO_2 over lifetime*);
- Renewable Energy Utility Model in place to allow companies to install solar thermal energy systems on City buildings and the City purchases the energy from the company;
- Toronto has developed the world's largest lake-source cooling system, which uses the cold waters of Lake Ontario to cool many downtown towers and buildings (*80,000 metric tonnes CO_2 per year*);

- The Toronto Green Standard (TGS) is a set of performance measures related to sustainable site and building design for new public and private development;
- Green Roof Bylaw requires a green roof be constructed on new buildings over 2,000 square meters. New industrial buildings have the option of installing a green roof or a cool roof;
- The Toronto Food Policy Council (TFPC) connects diverse people from the food, farming and community sector to develop innovative policies and projects that support a health-focused food system. On City lands there are 54 community gardens, 18 children's gardens and 12 allotment gardens; and
- Local Food Procurement Policy (LFPP) requires that products or primary agricultural ingredients be of Ontario origin and/or 80% of the processing costs must be returned to Ontario.

CITY-WIDE EMISSION REDUCTION ACTIVITIES

The following is a summary of broad city-wide emission reduction activities undertaken by Montreal, Toronto and Vancouver, including (if known) anticipated emissions reductions from the activity:

MONTREAL

- transportation system upgrades including street modifications to enhance non-motorized use and public transportation, bikeway expansion, increased investment in the public transit system, reserved bus lanes and electric vehicle charging stations installed throughout the City;
- planning actions to limit urban sprawl, including the encouragement of compact residential development and conversion of obsolete factories, aging commercial buildings, and outdoor parking lots into residential complexes in the downtown core; and
- sustainable management of green spaces and protection or urban forests, including a tree planting program and the creation of new parks.

VANCOUVER

- enhancement to the City building code requirements requires all buildings constructed from 2020 onward to be carbon neutral;
- many programs being offered to businesses and residents to reduce their energy consumption including the Home Energy Loan Program for energy retrofits, the Condo retrofit program, a Corporate Climate Leaders Program and a Business Energy Audit program;
- incentives for solar hot water heater installation;
- food security programs aimed at increasing food assets, community kitchens, community gardens, food hubs, etc.
- EcoDensity was a policy supporting densification through increase in laneway housing and secondary suites;
- 150,000 trees planted as part of the Greenest City Action Plan;
- Providing infrastructure to support charging of private electric vehicles;
- Engaging large developers to install or connect to low carbon district energy systems;
- Increasing mode share towards bike, walk and transit options through various means;
- Launching a public bike share program; and
- Reducing solid waste to landfill

TORONTO

- public transit expansion
- the Toronto Walking strategy aims to build physical and cultural environments that support and encourage walking;
- the Toronto Bike Plan encourages cycling through building bicycle friendly streets policies; expanding the bikeway network; improving bicycle safety; promoting cycling for everyday travel; providing secure bicycle parking; and improving the links between cycling and transit;
- the Live Green Toronto Program provides tips and resources to help Torontonians live green;
- the Live Green Toronto Community Grant program provides financial support to community groups to initiate projects that reduce greenhouse gas and help neighbourhoods adapt to climate change;
- the Tower Renewal program works to improve the energy efficiency of the more than 1,000 high rise residential concrete buildings in Toronto;
- Toronto's Eco-Roof Incentive Program promotes the use of green and cool roofs for commercial, industrial and institutional buildings;
- Renewable Energy Amendment to the Zoning Bylaw permits renewable energy devices and co-generation energy devices in all zones of the City; and
- Increasing the Tree Canopy program is designed to increase the tree canopy across the city from about 27% to 40%.

OPPORTUNITIES AND BENEFITS OF GHG REDUCTION

The Cities of Montreal, Vancouver and Toronto have all identified significant benefits and opportunities associated with taking action on climate change. All three cities believe that climate change represents a significant economic opportunity for their City. Opportunities identified by each City are outlined below:

MONTREAL

- The efforts undertaken to reduce the community's GHG emissions will also reduce its energy dependence and, consequently, reduce energy costs
- Measures that have been adopted, or that are being considered, to reduce GHG emissions or to adapt to climate change will also directly serve other environmental sectors: water quality; air quality; biological conservation; waste management. These sectors will also profit from the population's increased awareness of climate change issues.
- Certain seasonally-defined industries such as golf, water activities, recreational fishing, outdoor markets, and tourism may flourish with a shortened winter season

VANCOUVER

- Under the Greenest City Action Plan (GCAP), Vancouver is working towards:
  - Increasing the number of 'green' jobs through creation of trade, boosting the Green Capital brand to attract businesses, creating demonstration hubs, hosting a Cities Summit conference, green tech demonstrations, etc.;

    - Increasing the number of businesses actively engaged in 'greening' their businesses.
    - developing a comprehensive sustainability plan for the community that looks at areas such as Local Food, Access to Nature, Clean Water and Green Buildings and others.
- The Vancouver Economic Commission has laid out a strategy for economic growth for the City which includes supporting the green economy and new businesses.
- Through the BC Carbon Action Revenue Incentive Program, rebates are provided for the purchase of fuel that has a carbon tax, this provides a new funding source for the City's operations and continued work on the GCAP

TORONTO[1]

- Increased crop yield and ability to introduce new agricultural products.
- Lowered heating costs from more mild winters
- Lowered transportation operations cost via less snow clearing and less wear and tear on road infrastructure.
- Increased business operations and revenue from increased tourist season
- Information provided to local universities and colleges on skill sets needed to address climate change. Local engineering, environmental and sustainability consulting firms may be able to sell their services locally and externally in support of energy efficiency and climate change adaptation.
- We ran a seminar on climate change as an economic opportunity.

ADAPTATION

Serious risks identified:

MONTREAL

- More frequent and intense heat waves
- More frequent droughts
- Milder winters (more flooding/storms)

VANCOUVER

- Sea level rise
- Increased frequency of large storms
- Cumulative effects on buildings (heating and cooling systems, rain on snow loads, wind durability etc.) and the lifecycle of other infrastructure
-

TORONTO

- Hotter and drier summers
- More intense rainfall
- Increased frequency of large storms
- Water level drop in Great Lakes Basin
- More hot days
- More frequent and intense heat waves

[1] It would appear that Toronto interpreted this question differently from Vancouver and Montreal – looking at opportunities from climatic change, rather than opportunities from taking action

- Increase average annual rainfall
- Increased urban heat island effect

UN HABITAT STATE OF WORLD CITIES – CITY PROSPERITY INDEX

The Five Dimensions of Prosperity

The UN Habitat conceptualizes urban prosperity analogously as a 'wheel' to represent their five dimensions of prosperity (the City Prosperity Index), which include:

- **Productivity** - generating the income and employment that afford adequate living standards for the whole population;
- **Infrastructure** - physical assets and amenities such as adequate water, sanitation, power supply, road network, information and communications technology, etc.;
- **Quality of life** - education, health, recreation, safety and security, etc.;
- **Environmental Sustainability** –air quality, CO_2 emissions, energy and indoor pollution.
- **Equity** – inequality of income/consumption, and social and gender inequality of access to services and infrastructure.

Table 2 below lists the various cities around the world according to City Prosperity Index. Many of the developed world cities are located at the top end of the scale. It is one of the few assessments that has incorporated a measure of quality of life.

Table 2 - UN Habitat city prosperity.

Group **(by prosperity factors)**	Characteristics	Cities
Cities with very solid prosperity factors (0.900 and above)	• Strong integration of the 5 dimensions of prosperity. • High production of goods and services, strong economic fundamentals, high productivity. • Urban power functions (good governance, urban planning, laws, regulations and institutional frameworks) work fairly well, creating safe and secure environments.	Vienna, Warsaw, Milan, Barcelona, Copenhagen, Zurich, Amsterdam, Auckland, Melbourne, Tokyo, Paris, Oslo, Dublin, Helsinki, Stockholm, London, **Toronto**, New York.
Cities with solid prosperity factors – first category (0.800–0.899):	• The dimensions of prosperity are connected, generating a self-reinforcing, cumulative momentum. • Relatively strong institutions, responsive legal and regulatory frameworks. • Large availability of public goods.	Ankara, Mexico City, Guadalajara, Bucharest, Shanghai, Almaty, São Paulo, Moscow, Seoul, Prague, Athens, Budapest, Lisbon.
Cities with solid prosperity factors – second category (0.700–0.799):	• Show 'less coordinated', ill-balanced development in the 'spokes'. • Institutions, legal and regulatory frameworks and urban management practices are undergoing consolidation.	Casablanca, Cairo, Manila, Johannesburg, Jakarta, Cape Town, Beijing, Yerevan, Kyiv, Bangkok, Amman.

Group **(by prosperity factors)**	Characteristics	Cities
Cities with moderate prosperity factors (0.600–0.699):	• Wider discrepancies among the 5 dimensions of prosperity. • Institutional and structural failings. • Less balanced development. • Neat divide between rich and poor.	New Delhi, Yaoundé, Guatemala City, Ulaanbaatar, Phnom Penh, Nairobi, Mumbai, Chisinau, Tegucigalpa.
Cities with weak prosperity factors (0.500–0.599):	• Production of goods and services is still too low. • Historic structural problems, chronic inequality of opportunities and widespread poverty. • Inadequate capital investment in public goods. • Lack of pro-poor social programmes.	Lusaka, Dar es Salaam, Harare, Dakar, Addis Ababa, La Paz, Accra, Lagos, Kampala, Dhaka, Kathmandu, Abidjan.
Cities with very weak prosperity factors (below 0.500):	• Dysfunctional systems, institutional failings. • Sluggish economic growth, widespread poverty and destitution. • Post- or ongoing conflict countries.	Monrovia, Conakry, Antananarivo, Bamako, Niamey.

Based upon the assessment above, most of the developed world, including Canada and the United States would rate their cities at the highest level of prosperity in the index. The follow are some key points based upon this report.

- Prosperity refers to a sense of general and individual socioeconomic security for the immediate and foreseeable future which comes with the fulfilment of nonmaterial needs and aspirations.
- The prevailing view of prosperity is generally confined to economics – this shuts out other dimensions that are integral to human well-being (quality of life, environmental integrity, etc.)
- This report is primarily focused on “The need for transformative action in favour of people-centred, sustainable urban development which supports ‘prosperity’ ”
- The Prosperous City of the 21st century is one that:
    - Reduces disaster risks and vulnerabilities for all, including the poor, and builds resilience to any adverse forces of nature;
    - Stimulates local job creation, promotes social diversity, maintains a sustainable environment and recognizes the importance of public spaces;
    - Comes with a change of pace, profile and urban functions and provides the social, political and economic conditions of prosperity.

Note: Toronto is rated as one of the most prosperous cities in the world! Their infrastructure and environment indicators rank particularly high.

ANALYSIS – EDMONTON'S TRANSITION PLAN AND ACTIONS OF OTHER CITIES

The table that follows is intended to illustrate how recommended actions in the transition plan compare against actions in other cities.

Table 3 – Edmonton's Energy Transition plan compared with actions in other cities

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
Goal #1 **Reduce the GHG intensity of the provincial electricity grid** Anticipated Target: **24% below reference case by 2044**				
Activity #1: Influence (with others) the provincial and federal governments	Government of Ontario eliminates coal power plants by 2014 – the motivation is to improve local air quality.	75% reduction in GHG emissions	Estimated $4.4 billion per year in health, environmental and financial costs. Smog from coal-fired generation stations has been associated with 668 premature deaths, 928 hospital admissions and 1,100 emergency room visits in Ontario.	Source: (Ontario's Action Plan on Climate Change, 2007[viii]) News release, Nov 25, 2013[ix] There was no literature found that discussed about municipalities influencing action on the grid intensity.
Activity #2: Purchase Green Electricity	City of Calgary 100% renewable energy by 2012 (for city operations).	In 2009 428,000 MWh, estimated to grow to 556,000 MWh by 2026 Over the life of the agreement (20 years) it is expected to avoid 7 million tonnes of GHG emissions	No economic benefits disclosed	Source: 100% renewable by 2012, no date[x]

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
Goal #2**:** **Increase the proportion of development undertaken to create compact, mixed-use and transit-oriented neighbourhoods within already developed areas of the city.** Anticipated Target: **Expected reduction: 8% below the Reference Case by 2044**				
Activity # 1: Land use and transportation planning beyond *The Way We Grow* and *The Way We Move*	See discussion in detailed case studies.	In comparison to low-density suburban development, compact suburban development reduces VMT by 20 percent and urban development reduces VMT by up to 60 percent. In comparison to outer-edge suburban development patterns, compact development reduces VMT by 20 to 40 percent. Doubling residential density reduces VMT by 5 to 12 percent. If doubling density is combined with other changes, such as an		In the literature there were few direct examples of the application of high density housing and transportation planning illustrating the quantified greenhouse gas and economic benefits. The approach is being widely taken in urban plans across the United States and Canada. For that reason more specific details about the rationale for compact growth and multi-use development are presented after this table. Source: (Urban Land Institute, 2010)

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
		increase in mixed use development and transit improvements, the study estimates an upper limit of 25 percent for VMT reductions from compact development.		
Activity #2: Remove barriers to developing compact, mixed use, transit-oriented neighbourhoods	Many cities are applying policy and planning approaches that support this: • Environ Eugene (Oregon) compact mixed use design			There has been no quantification studies found that provide GHG savings or economic benefits so far. Source: Envision Eugene - City of Eugene, p. 2-11 March 2012[xi]
Activity #3: Provide incentives to buying/ building in compact, mixed-use, transit-oriented neighbourhoods	State of Massachusetts – sets statewide goal of 10,000 multi-family units per year	Promotion of smart growth districts.	The program offers incentives to developers through a local-option real estate tax exemption and a state tax credit for 10 percent of eligible costs, up to $1 million.	This program combines efforts to address job creation, and reduce homelessness particularly for veterans. Source: Press release – Office of the Governor, November 2012[xii]
Activity #4: Increase the frequency, capacity, convenience and quality of transit service in conjunction with increases in compact, walkable and transit-oriented development	• Bus Rapid Transit – Madison Wisconsin • Curitba Brazil, BRT		• Service to 15 to 20K reducing travel times from 19 to 42% • Operating cost $182.5 M, Operating Revenue $201 M (USD)	Source: (Capital Region Sustainable Communities, 2013[xiii]) Source: UNEP, Towards a Green Economy, 2011
Activity #5: Increase the amount and quality of walking and cycling	The City of Calgary has over 550 Km of pathways and over 260 km of on-street bicycle routes among the	14% of all daily trips are made by walking/cycling. The CTP recommends that	*Walkable*, *transit-supportive* built environment patterns have been associated	Source: (Calgary Transportation Plan, 2009[xiv])

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
infrastructure and encourage its use	most extensive in Canada and the US.	this increase to 20-25% of all dally trips.	with higher amounts of active transport and more physical activity overall. Less *walkable*, vehicle-dependent built environments have been correlated with higher body weights, obesity, and their associated chronic diseases. *- Dr. Larry Frank, The Built Environment and Health: A Review*	
Activity #7: Work with insurance companies to develop pay-as-you-drive insurance and promote it to citizens	Pay as you go insurance is in place in about 39 states in the US. A number of Canadian provinces are looking into it as well.	For the US, a pay as you go program could reduce gasoline demand by 11.4 billion gallons (9.1%) driving would decline by 8 percent, reduction would reduce carbon dioxide emissions by 2 percent and oil consumption by about 4 percent nationwide.	For the US, PAYG could increase social welfare by $19.3 billion per year. It could save society the equivalent of about $50 billion to $60 billion a year by reducing driving-related harms.	Source: (Parry, nd. [xv]) Source: (Brookings Institute, 2009[xvi])
Activity #8: Consider parking supply restrictions, and toll roads or congestion pricing for vehicles	The city of London has been the most successful at reducing traffic in the core with the London Congestion Charge.	Reduced congestion in central London by 30% in one year (Feb. 03 to 04). An estimated 19.5% decrease in CO_2 emissions.	Initial capital cost $480 M, Operating Cost $692 M, Operating revenue $1,746 M (USD – 2002-2010)	Source: UNEP, Towards a Green Economy, 2011
Goal #3: **Reduce the energy use in industrial facilities through energy efficiency and a focus on industrial developments with**				

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
lower energy use. Anticipated Target: **8% below the Reference Case by 2044**				
Activity #1: Consider supporting industrial energy management systems	BC Hydro Energy Manager Program works with organisations to implement an energy management program that ensures optimization of energy dollars while incorporating a culture of energy conservation.	Panorama Mountain Village saved $515 K in utilizing their snowmaking equipment more efficiently.	Provides an Energy Management Assessment, develops a strategic Energy Management Plan	Source: BC Hydro, 2013[xvii]
Activity #2: Consider encouraging, incenting and eventually requiring energy audits of industrial	See activity #1 C3 currently operates an industrial energy efficiency assessment program in partnership with Alberta innovates.		Assessment targets industrial based companies of less than 300 employees with energy expenditures between $175K and $5.5 M. $25K or 50% of the cost of the assessment is available.	Source: http://industrialenergy.c-3.ca/
Activity #3: 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	There is very little information on industrial facilities benchmarking energy use. Two industry associations have: The Canadian Electricity Association (CEA) and Canadian Cement Industry (based upon a NRCan – CIPEC Report)	Cement Industry: The study determined that the overall energy efficiency of the cement sector was relatively good, with a median **energy efficiency index** (EEI) value of 76, compared with a theoretical best practices plant with a value of 100. The relatively high level of overall energy efficiency is attributed to facilities and	The cement manufacturing industry realized an 11 percent increase in energy efficiency per tonne of cement produced between 1990 and 2006 and a corresponding reduction in greenhouse gas (GHG) intensity of 6.4 percent.	Source: NRCan, 2007[xviii]

City of Edmonton	Action by other cities:	GHG Reductions	Economic Benefits	Comments
		organizations that are already actively engaged in energy management programs. CEA: Developed an annual reporting process under their ECR program since 2009 this reporting has been consolidated including the development of a sustainability index.	Priority spills remain a major concern and have increased by 32.5 percent relative to the baseline. Use of SF6 in electrical equipment, while small, also contributed to the decline in performance both in 2010 and 2012.	Source: Canadian Electricity Association, 2013[xix]
Activity #4: Consider working with the provincial government to provide incentives for energy efficiency upgrades and eventually increase regulations that will further motivate energy efficiency upgrades	Policy Initiative			
Activity #5: Assess the feasibility, benefits and disadvantages of working to have future industrial development in Edmonton focus on facilities with low to moderate energy use.	No information on a policy such as this found in the literature. There was considerably more information about establishing manufacturing that supports renewable energy and sustainable activities.			

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
Goal #4: **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.** Anticipated Target: **7% below the Reference Case by 2044**	Distributed energy boils down to two basic strategies: The first is to harvest as much power as possible locally, close to where it is consumed, from small-scale, low-carbon sources. The second is to wring the maximum amount of useful work out of every unit of energy available. The overarching goal is to create resilient, self-reliant cities prepared for the economic and political volatility ahead in the 21st century. (Source: Scientific American, June 2010)[xx]			
Activity #1: Support companies providing distributed energy services	City of Toronto	Combined Heat and Power system with a district energy system can bring benefits such as improved electricity supply reliability and efficiency, lowered energy cost, increased profits to local companies, and reduced environmental impact through the reduction of emissions like NOx and CO_2	If development patterns that have been observed since 2006 continue, each 1 MW of capacity added to a constrained Central Toronto power grid will facilitate $131 million in construction and 745 construction jobs. A key component of distributed energy system is energy security – being able to be independent of the grid in catastrophic events, i.e. hurricane Sandy and the 2013 Calgary floods	Source: (Beck et.al, 2012)[xxi]
Activity #2: Remove regulatory barriers to distributed generation	See Wade Canada[xxii]			
Activity #3: Provide incentives for	May cities and utilities are providing incentives for small	CHP – can reduce GHG from a standard		

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
distributed generation	solar and wind. The California Public Utilities Commission (CPUC) issued a decision creating the Self-Generation Incentive Program (SGIP) to offer financial incentives to their customers who install certain types of distributed generation facilities to meet all or a portion of their energy needs, up to 1.5 MW.	electricity generation station by 50%	California offers: for PV 50% of maximum project cost, plus $4.50/W – Size from 30kW to 1MW) Fuel cells operating on renewable fuel 40% of maximum project cost plus $2.50/W. Micro-turbines, combustion engines and small gas turbines with heat recovery 30% of maximum project costs and $1.00 /W Note: Program started in 2004 and just ended in June 2012.	Source: Energy Solutions centre[xxiii]
Activity #4: Design new neighbourhoods to take advantage of free heat from the sun	The state of Minnesota has developed a set of guidelines for solar ready homes. The City of Vancouver has developed a passive solar home guideline.	In Minnesota's climate, a SHW system can be designed to supply 75% of a household's hot water. A passive design can reduce total energy demand for space heating and cooling to less than15 kWh / m2 /	• $1,000 for a two-story residential building • $5,000 to $7,500 for a three-story mixed-use building • Estimated Cost for Retro-fitting Existing Structures to Incorporate Solar Ready Requirements • $5,000± for a two-story residential building • $20-30,000 for a three story mixed-use building	Source: Lunning Wende Associates, 2010[xxiv] Source: The City of Vancouver, 2009[xxv]

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
		year.		
Activity #5: Require all new buildings with solar access to be built 'solar-ready'	City of Vancouver has adopted a policy that all new homes be solar ready. (Green homes Program) BC has also established a Solar Hot Water Ready Regulation.			Source: Compass Resource Management, 2009[xxvi] Source: Solar, BC 2013[xxvii]
Activity #6: Eventually require on-site energy generation on larger new buildings	Colorado became the first U.S. state to create a renewable portfolio standard (RPS) by ballot initiative when voters approved Amendment 37 in November 2004. The original version of Colorado's RPS required utilities serving 40,000 or more customers to generate or purchase enough renewable energy to supply 10% of their retail electric sales. **Distributed Generation Carve-out for IOUs** IOUs must also have a certain percentage of their retail sales come from either wholesale distributed generation (DG) or retail DG**, regardless of technology type, according to the following schedule: • 1% of its retail electricity sales in 2011 and 2012; • 1.25% of its retail electricity sales in 2013 and 2014 • 1.75% of its retail		On-site renewable energy generation systems can reduce local government energy costs by decreasing susceptibility to fossil fuel price volatility, which can lead to higher prices for grid-based electricity. This allows local governments to better anticipate and plan for future energy expenditures (U.S. EPA, 2004; AWEA, 2007). In 2003, Auburn, New York installed a geothermal system to heat and cool its historic City Hall at an installed cost of approximately $1 million, comparable to the cost of a conventional heating and cooling system. The geothermal system, which was installed in a way that blended with the historic building's internal and external architecture, is expected to save approximately $250,000 in operating and maintenance costs	Source: US Department of Energy, 2013[xxviii] Source: USEPA, 2008[xxix]

City of Edmonton	Action by other cities:	GHG Reductions	Economic Benefits	Comments
	electricity sales in 2015 and 2016; • 2% of its retail electricity sales in 2017-2019; and • 3% of its retail electricity sales in 2020 and each following year.		(including energy costs) over its lifetime due to expected increases in conventional energy prices (Energy Vortex, 2003).	
Activity #7: Require district energy in new developments where it is economic	The literature research has not found an example of a mandatory program. The development of district energy is driven by feasibility and support cooperation by municipalities, higher levels of government and utilities.			
Goal #5: **Increase the energy efficiency of buildings (new and existing) through capacity building, incentives and regulations.** Anticipated Target: **5% below the Reference Case by 2044**				
Activity #1: Work with energy retailers to provide customers a way to compare the energy use of their building to that of similar buildings	A number of US utilities have moved to provide on-line access of utility bills and energy use with a minimum of 12 months data for free. This service is available for			Source: National Action Plan for Energy Efficiency, 2008)[xxx]

City of Edmonton	Action by other cities:	GHG Reductions	Economic Benefits	Comments
	residential and commercial customers. A service such as this is usually offered in a situation that a utility goes to a visible time of use meter. The Nova Scotia government is considering time of use pricing, but there is no indication so far that bills and energy data will be on-line. A total of 10 utilities have included benchmarking for sub-tenants on one overall account. There is no mention of benchmarking residential properties of equal size with energy use. The most common benchmarking is that utilities may state overall average use for residential customers. The best commercial opportunity for benchmarking may be through BC Hydro's commercial services energy management program. The City of San Francisco in 20011 has made it mandatory that all non-residential building over 10,000 sq. feet must be benchmarked and reported using the Energy Star Portfolio Manager. Building owners or their representatives must annually electronically share a brief report of key benchmarking results with the Department of Environment, and tenants. This report is an "Annual		Benchmarking the energy performance of a building provides information essential to minimizing the single largest controllable cost center in building operations: energy use. Benchmarking your building's energy performance data is one way to show that buildings in San Francisco are among the most efficient in the world	Source: The City of San Francisco, 2013[xxxi] City of San Francisco Environment Code: Existing commercial buildings energy performance, 2013.[xxxii]

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
	Energy Benchmark Summary", and is based on data from the prior calendar year. Annual energy benchmarking reports are not required for unoccupied buildings or new buildings the certificate of occupancy triggers the start of reporting.		– in other words, it helps attract buyers and tenants who value low cost of operations and environmental performance. Also, benchmarking improves the competitiveness of commercial buildings in the city, supports the local economy – particularly jobs related to energy efficiency, reduces greenhouse gas emissions, conserves resources, and enhances electricity reliability.	
Activity #2: Support the adoption of visible meters in homes	One of the key concerns about smart meters (largely) and less so with in home visible meters is a perceived lack of privacy and that the utility will invade the homeowner's privacy. This has been expressed as Nova Scotia and BC move into smart metering. The UK Government is proposing the installation of home smart meters in every home by 2019. The organization Consumer Focus, conducted research into the various type of meters proposed to provide advice and direction to the Government on the best unit to be considered, given the diversity of users – including the elderly, the visually or dexterity impaired. The study informed on the unit not the	Domestic energy consumption is still largely invisible to millions of users and this is a prime cause of much wastage. Feedback on consumption is necessary for energy savings.	Immediate direct feedback could be extremely valuable, especially for savings from daily behaviour in non-heating end-uses. In the longer term and on a larger scale, informative billing and annual energy reports can promote investment as well as influencing behaviour. Savings have been shown in the region of 5-15% and 0-10% for direct and indirect feedback respectively.	Source: Consumer focus, 2012[xxxiii] Source: University of Oxford, 2006[xxxiv]

City of Edmonton	Action by other cities:	GHG Reductions	Economic Benefits	Comments
	acceptance.	NRCan report on pilot project they conducted show savings ranging from 5 – 20%	The same NRCan report stated savings could range from $150 to $350 per year.	Source: NRCan, 2008[xxxv]
Activity #3: Support companies providing energy efficiency services for buildings	Policy - through education and awareness.			
Activity #4: Support building energy management systems	Policy - through education and awareness.			
Activity #5: Support and eventually require energy labelling of buildings at time of sale.	Separate report			
Activity #6: Support and eventually require building retrofits at time of sale	Although no local government was found to require energy retrofits at the point of sale. Incenting buyers to "add" an energy assessment to their traditional home inspection could set the stage, if paired with a Local Improvement Charge. LICs are financing payment obligations included on a			Source: Suzuki, 2011[xxxvi]

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
	property owner's tax bill as a surcharge until they are completely paid off. On sale, an outstanding LIC obligation remains with the property.			
Activity #7: Put in place a voluntary green building checklist and eventually require it	The Toronto Green Standard (TGS) is a two-tier set of performance measures with supporting guidelines related to sustainable site and building design for new private and public development. The standards are designed to work with the regular development approvals and inspections process. As of January 31, 2010 new planning applications are required to document compliance with Tier 1 environmental performance measures. Applicants who also choose to meet Tier 2, a voluntary higher level of environmental performance, may be eligible for a Development Charge Refund.(20% of the Development Charges paid to the City).	No data was found on the program results.		Source: City of Toronto, 2013[xxxvii]
Activity #8: Monitor the provincial and federal governments' efforts to continue to increase energy efficiency requirements in the building code	Policy and municipal operations to communicate with other levels of government			
Activity #9: Consider engaging facilities with large amounts of waste	City of London Ontario conducted an integrated	If the City of London implements all identified building and		Source: Canadian Urban Institute,

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
heat to see if this heat could be used elsewhere	energy mapping strategy. C3 is currently by NRCan to develop a waste heat energy map of the Alberta Industrial Heartland (Fort Saskatchewan area.)	personal transportation improvements identified in the Ultra High Efficiency Scenario evaluated for London it is anticipated that the city can reduce its energy use by 14,600,000 GJ (32%) and reduce emissions by 700,000 tonnes CO_2/yr. compared with Business as Usual.		2011[xxxviii] Note: A similar study has been done for Hamilton, Guelph, and Barrie, Ontario. The CUI has also conducted a study for Calgary in 2008[xxxix]
Goal #6: **Reduce the amount of gasoline and diesel used in the vehicle fleet through capacity building, incentives and regulations.** Anticipated Target: **4% below the Reference Case by 2044 (dependent on changes to the electricity grid)**				
Activity #1: Encourage the adoption of fuel efficient vehicles	Although the federal government regulates fuel efficiency levels, local governments can support the use of fuel efficient vehicles. The State of Utah has developed a Clean fuel vehicle decal for their license plate which permits single occupancy drivers to use the High Occupancy Lanes (HOV) in the state and in Salt Lake City they can park for free at any meter or city			Source: City of Salt Lake City, 2013[xl]

City of Edmonton	Action by other cities:	GHG Reductions	Economic Benefits	Comments
	parking lot. The requirement for the plate is fuel economy of 41 MPG or better or an EOP Pollution score of 8 or more. The majority of vehicles are electric, natural gas or hybrid. A number of other States have developed similar special designations.			
Activity #2: Support fleet fuel management programs	The City of Chicago's Departments of Business Affairs and Consumer Protection (BACP) and Department of Environment announced the Green Taxi Incremental Cost Allowance Program ("Green Taxi Program") and encourage taxicab owners to take advantage of this program.		Hybrids can be reimbursed for $2,000. That is the maximum allowed by the federal government under this program. CNG or propane powered vehicles can be reimbursed for up to 100% of the implemental cost, which is typically between $9,000 and $14,000. Electric vehicles are not qualified under this program.	Source: City of Chicago, 2013[xli]
Activity #3: Support companies providing electric vehicles, natural gas vehicles, biofuels and associated services	As part of its ongoing effort to improve air quality, the City of Chicago is working with the Chicago Area Clean Cities (CACC) coalition and the Metropolitan Mayors Caucus to promote the use of alternative fuel vehicles—vehicles powered by "clean" fuels such as compressed natural gas, E85 (85% ethanol, 15% gasoline), propane and biodiesel—in Chicago area fleets. Through two grants from the federal Congestion Mitigation and Air Quality Improvement			

City of Edmonton	*Action by other cities:*	*GHG Reductions*	*Economic Benefits*	*Comments*
	Program, the City and its partners are also creating the infrastructure to support these vehicles by building up to 25 private alternative fueling stations			
Activity #4: Encourage, incent and eventually require the electrification of loading spaces, truck stops and garages	City of Anaheim, Plug in Electric Vehicle Incentives. Solar Colwood (Victoria, BC), is offer incentives for businesses to install electric vehicle charging stations.		Anaheim Public Utilities is offering a Plug-in Electric Vehicle Charger Rebate to customers who install a Level 2 (240-Volt) plug-in electric vehicle (EV) charger. Through this program, Anaheim Public Utilities will reimburse customers for out-of-pocket expenses up to $1,500 per charger. Eligible expenses include the charger purchase price, and installation costs. In addition to the $1,500 rebate, we will waive the City's permit application fees related to the installation of the EV charger. Level 2 charging system = 33% of the installed cost up to $2,000. A level 2 charging system powered by solar PV = 33% of the installed cost up to $4,000.	Source: City of Anaheim, 2013 [xlii] Solar Colwood, 2013[xliii]

SPECIFIC CASE STUDIES

The following are short case study examples related to many of the themes covered in the City of Edmonton Energy Transition Plan. Many provide specific examples of GHG savings and economic benefits to the cities portrayed in the case study. We did find however, two papers that provide an interesting counter point about smart growth, which is provided not as the definitive view on the subject but an interesting consideration of the complexity of the urban development and density.

Using development cost charges to finance smart development
Development Cost Charges (DCC's) are the most common means of financing growth-related infrastructure. (BC Climate Action Toolkit, 2013)[xliv]

They are one time charges that local governments can levy on most new subdivision and building at the time of approval. DCC's shift financial responsibility for providing capital costs for off-site infrastructure, including sewer, water, storm drainage, roads, and parkland, from the general tax base to the developers of new growth requiring the infrastructure.

However, DCCs cannot be used to pay for ongoing maintenance and operating costs for new infrastructure. Local governments are authorized to collect DCCs under the Local Government Act (see Division 10 - Section 932).

DCCs are one way for local governments to encourage climate-friendly development. A good DCC schedule provide financial incentives for development with lower infrastructure capital costs. In other words, development that is higher density, centrally located, and energy efficient would pay lower DCCs.

Local governments are authorized to collect DCCs under the Local Governments Act (see Sections 932 – 37.1). Amendments made to the Local Government Act in2008 expanded local government authority regarding DCCs by enabling local governments to waive or reduce DCCs for, for- profit affordable rental housing, small lot subdivisions designed to result in low greenhouse gas emissions, and developments designed to result in a low environmental impact.

The requirements that a development must meet in order to receive a waiver or reduction must be clearly stated in the DCC bylaw.

COMMUNITY EXAMPLES:

- City of Maple Ridge process for qualification
- Kelowna - DCC bylaw contains six different density categories for residential developments, based on units per hectare.
- Penticton – DCC bylaw specifically for low-environmental impact development. Eligible developments may receive a 50% or 100% reduction of DCC. Proposed developments are evaluated using a Sustainability Checklist to determine eligibility for DCC reductions.
- Sooke – DCC bylaw, used specifically in Town Centre Revitalization Zone, provides a multi-year DCC reduction for eligible development, such as LEED certified and not-for-profit housing.

- City of Surrey Centre: Building a Vibrant Downtown - Incentives: Surrey's Economic Investment Zones

Urban density and local sustainability – a case study in Finland (Saynajoki, et. Al, 2013) [xlv]

The authors of this paper challenge the concept that in regions that require space heating for part of the year, high-density residential areas with high-density buildings have an inherent advantage of lower energy use, in that they have a reduced area of external wall and less indoor space per person. In addition, conventional wisdom holds that dense cities have great potential for limiting the use of motor vehicles and their associated GHG emissions. Thus there seems to be remarkable potential to reduce the carbon footprints of the many millions people moving to cities for the first time, who are able to live in well-built, energy-efficient apartments, with efficient appliances that are well served by public transport.

However, the authors make the point that environmental sustainability of high urban density can be challenged. Although higher urban density may correlate with the increased carbon-efficiency of transportation and housing services, consumption-centred lifestyles in the cities tend to repeal the benefits achieved. Recent research has demonstrated that, in several cases, management and planning strategies that aim to increase urban density seem to counteract environmental objectives for regional GHG emission reductions. Cities and towns can be regarded as the demand and consumption centres of the global economy, and also as the hot spots of waste generation.

The authors also point to social sustainability, that high urban density is not necessarily something that is desirable to populations. They cite; according to Bramley and Power (2009), compact urban areas worsen neighbourhood problems and dissatisfaction, despite improving access to services. In addition, a study by McCulloch (2012) shows a negative relationship between housing density and neighbourhood satisfaction that is largely independent of individual and household characteristics. Families with young children especially would prefer to live in neighbourhoods with lower housing densities (McCulloch, 2012). According to Vallance et al. (2005), density-centred urban planning is not always well received by local residents and can have unintended effects on everyday life and the symbolism of places and spaces.

The authors also caution that the desired and often referenced benefit that dense urbanization fueling economic growth can also be challenged. Since manufacturing jobs are not located in the dense core of cities, transportation demands to support these jobs often goes in reverse to the service and professional jobs that draw individuals to the core from the suburbs.

Findings:

The main finding of the study is that even though higher urban density is promoted as an environmentally, socially and economically sustainable use of land, increases in construction and consumption are actually likely to water down the carbon-efficiency gains that could possibly be achieved in the case area by density-centred policies. It is also found that the area's strategy of pursuing increased urban density has had negative social impacts.

Table 4 - Carbon footprint of various areas in Finland

Area		Population	Density (per km^2)	Private consumption (annual per capita / €)	Carbon footprint (annual per capita)	Distribution of carbon footprint		
						Housing	Transport	Personal
1	Helsinki downtown core	165,000	10,000	20,200	14.7 t CO_2e [1)]	6.3 t	1.6 t	6.8 t
2	Helsinki metropolitan area	930,000	1,400	17,600	12.5 t CO_2e [2)]	6.6 t	1.6 t	4.3 t
3	**Extended case area**	**69,000**	**20**	**13,800**	**11.1 t CO_2e** [3)]	**6.5 t**	**1.9 t**	**2.7 t**
4	Tampere	206,000	340	15,000	10.9 t CO_2e [3)]	5.5 t	1.9 t	3.5 t
5	Cities in Finland	3,210,000	–	15,200	10.9 t CO_2e [2)]	5.9 t	1.8 t	3.2 t
6	Finland	5,400,000	20	14,300	10.2 t CO_2e [3)]	5.4 t	1.8 t	3.0 t
7	Semi-urban areas in Finland	860,000	–	13,800	9.9 t CO_2e [2)]	5.2 t	2.1 t	2.6 t
8	Rural areas in Finland	1,120,000	–	12,200	9.0 t CO_2e [2)]	4.7 t	2.1 t	2.2 t

Land Use and Driving: The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions (ULI, 2010)[xlvi]

This paper summarizes and analyses three publications: Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions, 2009; Growing Cooler: The Evidence on Urban Development and Climate Change, 2008 and Diving and the Built Environment: Effects of Compact Development on Motorized Travel, Energy Use and CO_2 Emissions.

Key points:

- The key to successful compact development is a land use pattern that has a high quality pedestrian network and a variety of land uses within walking distance of each other. Compact development also allows drivers to park once—for example, in a shopping district—and take care of many errands and activities without getting in their cars again. Since most trips of all modes are not work or work-related trips, compact development makes destinations like church, school, and shops more convenient to access with limited vehicular trips.

- Each study settles on different estimates of the actual reductions in Vehicle Miles Travelled (VMT) for compact development versus typical suburban development. *Moving Cooler* finds that compact suburban development reduces VMT by 20 percent and urban development reduces VMT by up to 60 percent. *Growing Cooler* concludes that, in comparison to sprawling development patterns, compact development reduces VMT by 20 to 40 percent. And *Driving and the Built Environment*, after an extensive review of published research, concludes that doubling residential density reduces VMT by 5 to 12 percent, or by as much as 25 percent when combined with other changes.

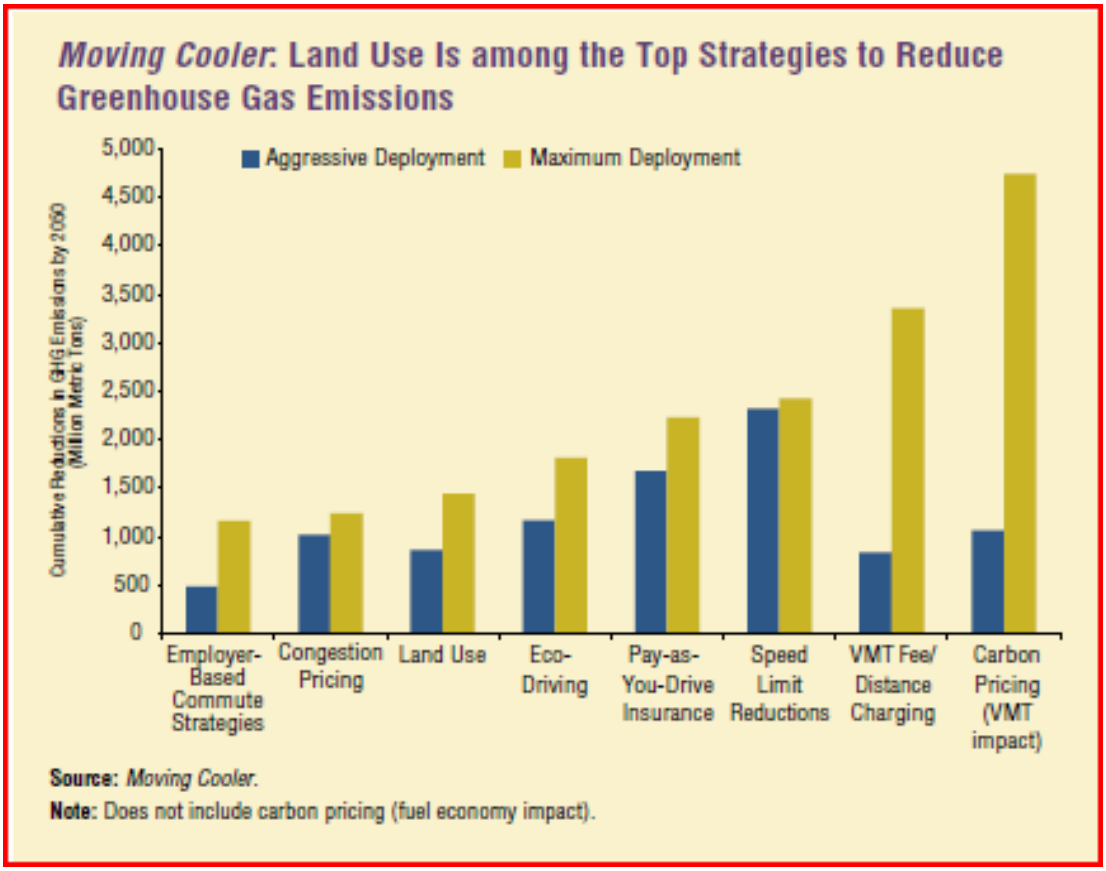
- Compact development is not simply another term for “density.” For the purposes of modeling, however, the studies define the residential density component of compact development to *average* in the range of 11 to 15 dwelling units per net acre. There are many ways to build this average density. Compact residential development could consist of townhouses, apartment buildings, and single-family houses on small lots in a wide variety of combinations.

- Market studies show that the demand for compact development is growing. For example, the U.S. Environmental Protection Agency has documented continuing trends toward center city investment, finding that many cities have doubled or even tripled their capture of regional residential construction since 2000. In addition, market preference research for “generation Y” (people in their 20s) showed that 77 percent plan to live in

the urban core, and one-third will pay more to live near shops, work, and entertainment. The strong urban preference of generation Y suggests very high demand for urban housing types.

- What are the obstacles to compact development? These are largely institutional, regulatory, and financial. On the institutional side, government fragmentation and sectorial silos can stymie attempts to build in more compact ways, because this type of development is more complicated than other types. Regulatory barriers include exclusionary zoning, large minimum lot sizes, engineering standards for street design and parking, and other impediments to change. Financial challenges include reluctance on the part of lenders to participate in more complicated mixed-use projects; compact development can also be more expensive to build than other kinds of development, and may require the integration of transit and other expensive infrastructure.

- Compact development's potential to reduce driving and greenhouse gas emissions is significant, although improvements in vehicle and fuel technology will also be needed to reach GHG reduction targets by 2050. Despite needed policy and regulatory reforms, increasing market demand for compact development means advancing it will be "worth the effort."



Three *Driving and the Built Environment* Scenarios: Reduction in Annual VMT in 2050

Land Development Scenarios to 2050	New and Replacement Housing	Density of New Residential Development	Percent Reduction of VMT for Households in New Compact Development	Percent Reduction of Total VMT from Baseline
Baseline	62–105 million units	Base assumes the density of residential development from the 1990s continues	Not applicable	Baseline
Moderate	Same as base	25% is twice as dense as base	12%	**1.3–1.7%**
Aggressive	Same as base	75% is twice as dense as base	25%	**8–11%**

Three *Moving Cooler* Land Use Scenarios: Reduction in Annual VMT in 2050

	Distribution of Residential Growth			
Scenarios	**Rural and Suburban**	**Compact Suburban**	**Urban**	**Percent Reduction in Total VMT from Baseline**
1990s Development Pattern	66%	21%	13%	Baseline
Aggressive Deployment	36%	31%	33%	7.7%
Maximum Deployment	10%	49%	41%	12.6%

Compact Suburban: 5 to 12.5 dwelling units per acre. Urban: Greater than 12.5 dwelling units per acre.

Moving Cooler's Compact Development Strategies: Cumulative Greenhouse Gas Reductions (in million metric tons) by 2050

Strategy	Aggressive Deployment	Maximum Deployment
Land Use	865	1,445
Nonmotorized Transport Strategies		
Pedestrian	171	227
Bicycle	117	176
Public Transportation Strategies		
Transit Fare Measures	34	78
Increased Frequency, LOS, Extent	72	168
Urban Transit Expansion	281	575
Parking Strategies		
CBDs and Regional Activity Centers:		
On-Street Parking Pricing	41	42
New Tax/Higher Tax on Free Private Parking	18	31
Urban Parking Restrictions	189	359
Residential Parking Permits	20	48
Sum of All Compact Development Strategies	**1,808**	**3,149**

Note: According to the U.S. Environmental Protection Agency, 1 million metric tons is approximately equal to annual greenhouse gas emissions from 190,000 U.S. passenger vehicles.

City of Calgary Cost for infrastructure based upon urban design (UNEP, 2011)

The following table illustrates the cost of infrastructure based upon dispersed and compact and densely clustered scenario as part of *PlanIt Calgary – the Municipal Development Plan.*

Table 5 – cost of infrastructure based upon densification models (City of Calgary)

Total Cost in (Cdn $ billion)				
	Dispersed Scenario	***Recommended Direction***	***Difference***	***% Difference***
Road capital cost	17.6	11.2	6.4	-36
Transit capital	6.8	6.2	0.6	-9
Water and wastewater	5.5	2.5	3.0	-54
Fire stations	0.5	0.3	0.2	-46
Recreation centres	1.1	0.9	0.2	-19
Schools	3.0	2.2	0.9	-27
Total	***34.5***	***23.3***	***11.2***	***-33***

Capacity and infrastructure cost of different transportation systems (UNEP, 2011)

The following table illustrates the capacity/costs for various modes of transportation infrastructure based upon US construction.

Table 6 – Transportation infrastructure cost by mode

Transportation Infrastructure	*Capacity (Persons/hour/day)*	*Capital costs (US$/km)*	*Capital cost/ capacity*
Dual-lane highway	2,000	10 – 20 M	5,000 – 10,000
Urban street (car use only)	800	2 – 5 M	2,500 – 7,000
Bike path (2m)	3,500	100,000	30
Pedestrian walkway/pavement (2m)	4,500	100,000	20
Commuter rail	20,000 – 40,000	40 – 80 M	2,000
Metro Rail	20,000 – 70,000	40 – 350 M	2,000 – 5,000
Light Rail	10,000 – 30,000	10 – 25 M	800 – 1,000
Bus Rapid Transit	5,000- 40,000	1 – 10 M	200 – 250
Bus Lane	10,000	1 – 5 M	300 - 500

SPECIFIC INITIATIVES - ENVIRONMENTAL AND ECONOMIC BENEFITS

Table 7 below is drawn from a number of sources and reflects more specific projects and their estimated environmental, economic and social benefits. Not all sources were able to provide all three benefits.

Table 7 – Survey of municipal actions and estimated benefits

Initiative/project	*Environmental*	*Economic*	*Social*
	Benefits (unless noted are in US$)		
Increased density (savings on purchase of cars and fuel) (UNEP, 2010)		$19 B/yr	
Bogota, Columbia Bus Rapid Transit over metro rail savings (UNEP, 2010)		$2.02/per passenger	
London congestion charge (UNEP, 2010)	19.5% decrease in GHG's	$1,746 M Revenue	
Tokyo Water system (leak prevention) (UNEP, 2010)	20% saving of water	$16.7 M (Electricity) $172.4 M (Leakage prevented)	
Germany's 2006 building retrofit program (UNEP, 2010)			150,000 construction jobs created
Chicago Urban tree program (UNEP, 2010)		$9.2 M (air cleansing value) Benefits 2 times the value	
City of Chicago – Energy Savers Retrofits 11,050 apartment units in 314 buildings (CofChicago, 2013)[xlvii]	13.9 Tonnes GHG emissions	Leveraged $10 M	Created more than 400 jobs
City of Chicago – Construction begins on affordable housing retrofits and Renewables. (CofChicago, 2013)			1,170 units
City of Chicago – Taxi fleet achieves 416% increase in fuel efficiency and alternative fuel vehicles. (CofChicago, 2013)	3,500 (51%) of vehicles in Chicago's taxi fleet are hybrid fuels (regulation)		
City of Chicago - Solar installers trained on streamlined zoning and one-day expedited permitting process. (CofChicago, 2013)		Depart of buildings has reduced solar permit fees and clarified zoning.	
Antioch, California – Energy Efficient Lighting Retrofit Program. Replace 8,725 high pressure sodium lamps in streets and parks with induction lighting. (SCI, 2012)[xlviii]	1,825 Tons of GHG avoided/yr	$4.6 M Cost $531.3 K Savings/yr	

Initiative/project	*Environmental*	*Economic*	*Social*
	Benefits (unless noted are in US$)		
Austin Green Business Leaders. With the use of a scorecard, businesses adopted sustainable practices in business – combined rebates and incentives, businesses would receive awards based upon their actions.(SCI, 2012)		31 businesses have completed scorecards, 135 are actively participating. $10 K grant from ICLEI	
Polway, California – New construction (infill) affordable housing rental project, 56 units (22 units /acre). (SCI, 2012)	Zero energy home, solar PV system, storm-water collection, recycled and low VOC materials used. 95% reduction in the carbon footprint over conventional construction	$15.8 M development cost $108 K for greening	Resident education was provided to every tenant. Tenants are very engaged in the complex and enjoy the walkability to other community services
Solar Beaverton, Oregon. Renewable energy program. 258 homeowners have installed solar systems. (SCI, 2012)	87.5 Tons of GHG avoided. 2,187 Tons over 25 years	Streamlined permitting process	Created 12 full time jobs

OBSERVATIONS

- Based upon our research, there appears to be a strong relationship between sustainability actions, stronger economic performance and an enhanced quality of life. Based upon observations from a number of cities across North America – higher levels of energy efficiency, increased number of “green buildings”, increased access to sustainable transportation options such as public transit and higher levels of water conservation will reflect in the city having:
    - Higher employment
    - Higher GDP per capita
    - Reduced crime
    - Higher levels of educational attainment
    - Lower levels of perceived stress (improved metal health)
    - Higher investment in new commercial and institutional buildings.

- One of the most complex areas that challenge the advancement of sustainability for cities is the land use planning models. Densification does cause scores related to crime, stress to actually increase. The key appears to be to not just densify the city core, but also along major travel corridors, shopping and commercial nodes, and maybe not with just the densest urban forms of housing but rather a mixture that support all demographics of needs (such as families).

- Based upon literature reviewed, the strategic actions planned by the City of Edmonton are consistent with other cities. Not all cities have taken as comprehensive an approach, but larger cities with more resources generally have a similar comprehensive program.

- A number of cities reviewed have done extensive pre-plan development which included extensive citizen engagement about themes and aspects of the plan. This approach appears to have ensured generally broad support when investments are required in program delivery.

- Cities that either volunteered to participate or have been evaluated in some of the national or international assessments of sustainable cities are demonstrating comprehensive actions. The Mercer and Siemens rankings are among the most comprehensive, because they do incorporate quality of life and relative satisfaction of citizens. It is unknown if these ranking of sustainable cities fosters a degree of happiness among citizens as no polls have been conducted with citizens on how they feel about a city ranking. Intuitively however, it would instill a considerable amount of pride, so long as it was broadly known.

- While it is good to develop plans and construct detailed action plans, as this literature review indicates, there were few examples found of comprehensive reporting and evaluation of the program. The City of Chicago, Vancouver, Portland and Toronto appear to be leaders.

- One action area that was found to be least promoted and is overlooked but has a profound aspect to the social well-being of its citizens, is the need to maintain areas of open space and treed parklands. In the discussion of densification, maintaining green spaces must remain a priority.

ANNEX A: CORRELATION ANALYSIS

LINKING SUSTAINABILITY AND ECONOMIC AND SOCIAL PROSPERITY

INTRODUCTION

Many cities are looking toward low-carbon, sustainable development strategies. These strategies are sometimes presumed to be tangential to, or in conflict with, economic growth and social development. Many sustainability policies, programs and projects, however, can generate cost savings from increased productivity and more efficient use of resources, such as energy and water. These savings provide cities with an opportunity to support staff and expand services. Beyond immediate cost savings, sustainability initiatives can also provide long-term economic benefits, including job creation or retention, increased property values, and conditions that attract and retain residents and businesses.

In addition, sustainable cities have characteristics that can have a variety of positive social effects. Mixed land use and increased density (i.e., more people and dwelling units in a given area) have been linked with promoting increased social interactions and a sense of neighborhood and community. Sustainable transport options promote cycling and walking, and so human health. Public spaces in cities such a parks, community gardens, urban forests and recreational areas, not only sequester carbon but can also reduce stress and promote health. Urban greenery can increase property values and has been linked to increased retail success in areas with mature tree canopies, where consumers show a willingness to shop longer and spend more (CNT, 2010).

Clearly, there are sound reasons to presume that a low-carbon, sustainable development plan is mutually supportive of, and not otherwise in conflict with, economic growth and enhanced quality of life. But is this synergistic relationship supported by empirical observations. Is an environmentally sustainable city also prosperous and a good place to live? Are such cities livable places? The goal of this Annex is to examine these questions using city-level data.

METHODOLOGY

To test for the presence and significance of a link between a low carbon, sustainable city and its economic prosperity and overall livability we analyze the relationship between a range of environmental, economic, and social indicators using statistical correlation. Statistical correlation is a technique that reveals if two variables are related. For example, the price of a good and demand for that good are related variables; when the price of the good decreases demand will tend to increase and vice versa. Hence, price and demand are related in the sense that a change in one variable is accompanied by a change in the other variable. When a change in one variable is accompanied by a change in the other variable, the two variables are said to be correlated.

Statistical correlation is measured by the coefficient of correlation (ρ). The estimated value of ρ tells us something about the relationship between two variables:

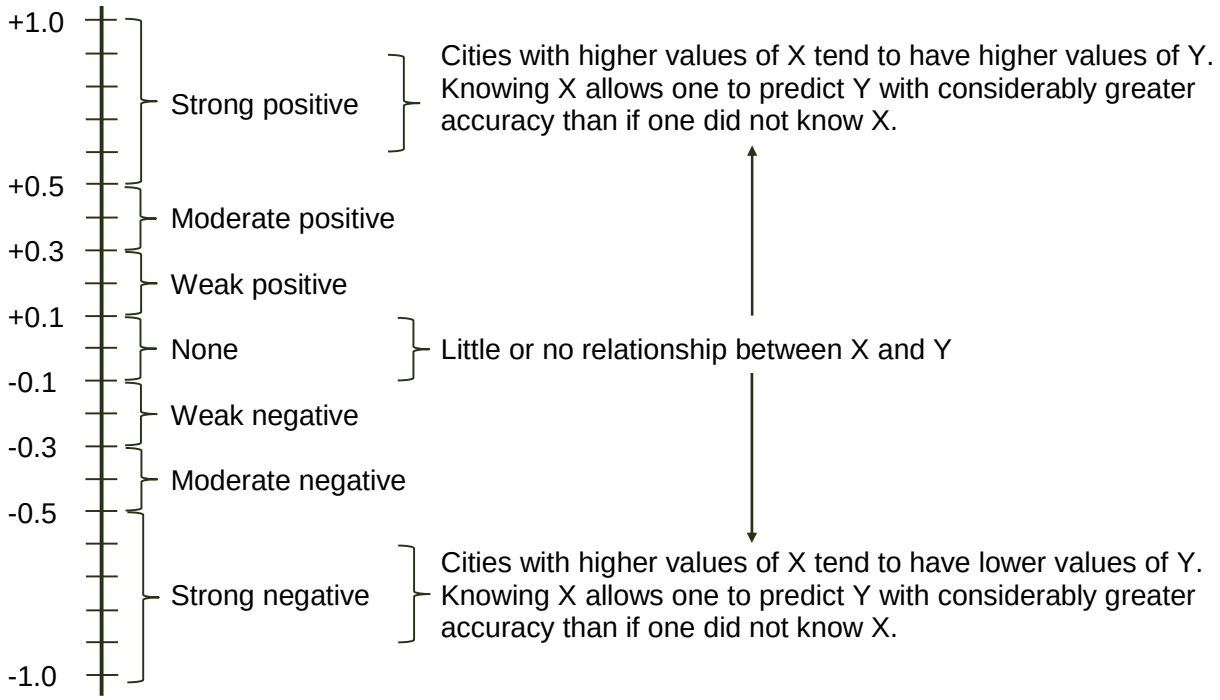
- Is the relationship is positive or negative?
- What is the strength of the relationship?

In the case of price and demand, for example, the change in one variable that accompanies a change in the other variable occurs in the opposite direction. This indicates that price and demand are negatively correlated.

The numerical value of ρ ranges between negative 1.0 and positive 1.0, and reveals the strength of the linear relationship between two variables, X and Y. The sign of ρ (+ or -) indicates the direction of the relationship. In general:

$\rho \cong +1.0$	$\Rightarrow$	Very strong positive linear relationship between X and Y. Y increases as X increases or X increases as Y increases.[2]
$\rho \cong 0.0$	$\Rightarrow$	No linear relationship between X and Y. Y does not tend to increase or decrease as X increases, or vice versa. X and Y are independent and not related.
$\rho \cong -1.0$	$\Rightarrow$	Very strong negative linear relationship between X and Y. Y decreases as X increases or X decreases as Y increases.

The closer the numerical value of ρ is +1.0 or -1.0, the greater is the strength of the relationship between two variables. For the purpose of our analysis we have adopted the following rules of thumb:



While estimated values of ρ tell us something about the relationship between different environmental, economic, and social indicators, two caveats should be noted:

[2] Note that statistical correlation makes no distinction between X and Y. Reversing the roles (x-axis and y-axis) of X and Y does not change the numerical value of the coefficient of correlation.

- The coefficient of correlation only measures a linear relationship. Even if the numerical value of ρ is close to zero, it is still possible that a weak, moderate or strong non-linear relationship exists between two variables; and
- The coefficient of correlation says nothing about cause and effect. A specific value of ρ tells us whether X and Y are related, as well as the strength of that relationship. However, it does not tell us if a change in X causes the change in Y or vice versa. The presence of strong statistical correlation does not prove causation because it does not account for confounding variables (i.e., other determinants of the selected dependent variable).

DATA SETS

To test for the presence of a link between low carbon, sustainable cities and economic and social development using correlation analysis city-level data covering a range of environmental, economic, and, social indicators is needed. Two sources of environmental indicators were used:

- The State of World's Cities report; and
- The Green City Index project.

The State of the World's Cities report was developed by the United Nations Human Settlements Programs (UN-Habitat) (Moreno et al, 2013). The objective of the report was to examine how cities can generate and distribute equitably the benefits and opportunities associated with increased prosperity, while simultaneously taking into account, economic wellbeing, social cohesion, and environmental sustainability. A new holistic approach to characterizing prosperity was developed (the City Prosperity Index) to help cities measure progress towards an economically, socially, politically and environmentally prosperous urban future. The City Prosperity Index is composed of five separate indices covering: productivity, quality of life, infrastructure, environmental sustainability, and equity. This data set was used to test for statistical correlation between the environmental sustainability index[3] and each of the productivity[4] and quality of life[5] indices across global cities. The indicator data set is provided in Table 1, Appendix A.

The Green City Index project was conducted by the Economist Intelligence Unit and sponsored by Siemens (Summer and Bachfield, 2011). The project aimed to measure and analyze the

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[3] The environmental sustainability index is made of four sub-indices: air quality (PM), CO_2 emissions, energy, and indoor pollution.

[4] The productivity index measures the "city product", which is composed of the variables capital investment, formal and informal employment, inflation, trade, savings, exports and imports, and household income and consumption. The city product represents the total output of goods and services (value added) produced by a city's population during a specific year.

[5] The quality of life index is a combination of four sub-indices: education, health, safety and security, and social capital and public space. The sub-index education includes literacy, primary, secondary and tertiary enrolment. The sub-index health includes life expectancy, under- five mortality rates, HIV/AIDS, morbidity, and nutrition variables.

environmental performance of global cities, including 27 major US and Canadian cities. Cities were chosen to represent a number of the most populous metropolitan areas in the United State and Canada. The overall objective was to provide stakeholders with a tool to help cities learn from one another with regards to the environmental challenges they face. Each city was evaluated based on 31 indicators organized across nine categories: CO_2, energy, land use, buildings transport, water, waste, air, and environmental governance. For example, each city's energy category score was based on observations of:

- Electricity consumption per unit of US$ GDP (TJ per $US million); and
- Electricity consumption per person (GJ per person).

Each city's buildings category score was based on observations of the rate of LEED certified buildings (silver, gold or platinum) per 100,000 persons. Scores for the other categories are based on similar measurable indicators. Full details of the 31 indicators and weighting system to derive aggregate scores is provided in Summer and Bachfield (2011). Cities are ranked against each other to indicate their relative position in each category and overall (there is an overall Green City Index). In-depth city profiles, outlining the individual city's strengths, challenges and ongoing environmental initiatives are also provided to highlight key findings as well as to provide context for the assigned scores and rankings. The category scores for 27 major US and Canadian cities is provided in Table 2, Appendix A. This data set was used to test for statistical correlation between category scores and select economic and social indicators obtained for each of the 27 cities. The analysis was performed separately for the US cities and the Canadian cities (Calgary, Ottawa, Toronto, Vancouver, and Montreal); primarily to reflect differences in the data collected by Statistics Canada and the US Census Bureau (e.g., we were able to identify data on many social indicators for the Canadian cities that were not available for the US cities). The full set of identified economic and social indicators for the Canadian cities and the US cities is provided, respectively, in Table 3 and Table 4, Appendix A.

RESULTS

Figure 1 contains scatter plots examining the relationship between the UN-Habitat environmental sustainability index and productivity index (panel a) and environmental sustainability index and quality of life index. In both cases the data point for individual cities fall within an upward sloping football pattern, which suggests a positive relationship between both indices and the environmental sustainability index. Cities with higher scores on the environmental sustainability index tend to have higher scores on the productivity index. The numerical value of the coefficient of correlation (ρ = +0.49) suggests a "moderate" association between the two indices. Similarly, cities with higher scores on the environmental sustainability index tend to have higher scores on the quality of life index. The numerical value of the coefficient of correlation (ρ = +0.51) suggests a "strong" association between the two indices.

Figure 2 summarizes the results of the statistical correlation analysis for the US cities using the Green City Index data set. Note that results are not provided for all economic and social indicators for which data was originally collected (e.g., median family income and overall health percentile ranking, in Table 4). Where both the sign of the coefficient of correlation was inconsistent across all indicators in terms of what we would expect in theory and the strength of

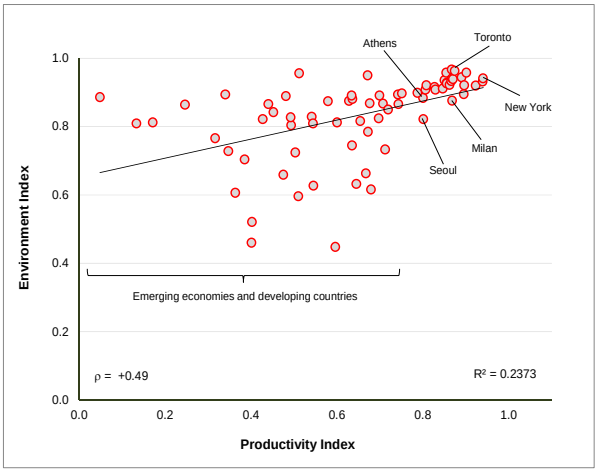
the relationship was “none” or “weak”, we excluded that indicator from the analysis. It is evident from Figure 2 that a moderate to strong relationship is observed between the environmental sustainability of a city and how it performs on select economic and social indicators. That is, cities that have higher levels of environmental sustainability (as captured by the overall green city index score) also tend to have:

- Higher rates of employment;
- Lower rates of unemployment;
- Higher GDP per capita;
- Lower rates of violent crimes;
- More graduates (higher levels of educational attainment); and
- Improved mental health (e.g., lower levels of stress, anxiety).

As stated above, the coefficient of correlation only measures a linear relationship. To test for the presence of non-linear relationships we generated scatter plots to see what functional form of trend line best fit the data. In most cases the best fitting trend line is non-linear (see Figure 4, Appendix B). This suggests that the relationships between environmental sustainability and economic and social prosperity may be even stronger across the 22 US cities in the sample.

Figure 1 Global Cities: Link Between Environmental Sustainability and Productivity and Quality of Life

(a) environmental sustainability index and productivity index



(b) environmental sustainability index and quality of life index

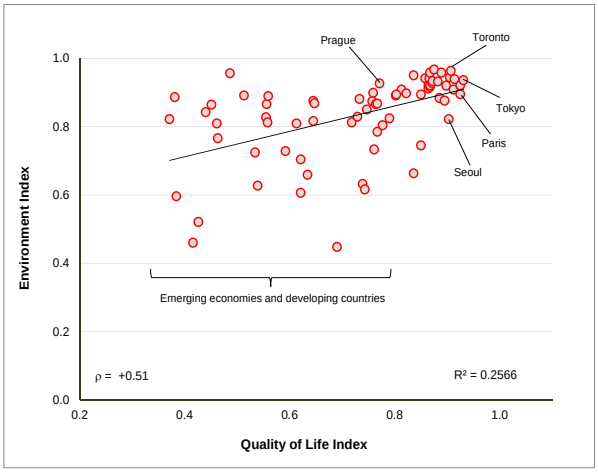


Figure 2 US Cities: Link Between Environmental Indicators and Economic and Social Indicators

	Economic and social indicators US cities					
	Employment rate, %	Unemployment rate, %	GDP per capita, $US	Murders, rate per 100,000	Educational attainment bachelors degree, %	Mental health, percentile ranking
Overall green index score						
Strong	+	-	+	-	+	
Moderate						+
Weak						
None						
CO_2 score						
Strong						
Moderate	+	-	+		+	
Weak				-		
None						+
Energy score						
Strong	+	-				
Moderate			+	-		+
Weak					+	
None						
Land score						
Strong	+		+			
Moderate		-			+	
Weak				-		+
None						
Buildings score						
Strong		-	+		+	
Moderate	+			-		+
Weak						
None						
Transport score						
Strong						
Moderate	+	-	+	-	+	+
Weak						
None						
Water score						
Strong			+			
Moderate	+	-		+	+	+
Weak						
None						
Waste score						
Strong	+			-		
Moderate		-	+		+	
Weak						+
None						
Air score						
Strong			+			
Moderate	+			-	+	
Weak		-				
None						+

Note: A "+" denotes a positive relationship; a "-" denotes a negative relationship.

Figure 3 summarizes the results of the statistical correlation analysis for the five Canadian cities contained in the Green City Index data set. As with the US results, coefficients of correlation are not provided for all economic and social indicators for which data was originally collected (see Table 3). Indeed, we are only confident in the associations between five economic and social indicators and four indicators of environmental sustainability (water, energy, buildings and the overall green city index score). The analysis is limited by the fact that the Green City Index data set only includes five Canadian cities. The results provided in Figure 3 suggest that cities with higher levels of environmental sustainability, higher levels of energy efficiency, and greater penetration of "green" buildings will also tend to have:

- Lower levels of perceived stress among citizens;
- A greater sense of community among citizens; and
- Higher levels of investment in new commercial and institutional buildings.

Furthermore, cities with higher levels of energy efficiency and water conservation will also tend to have higher levels of GDP per capita, which is what theory would suggest is an outcome from improved resource efficiency. For the purpose of illustration, scatter plots for the energy index scores are provided in Figure 5, Appendix B.

Figure 3 Canadian Cities: Link Between Environmental Indicators and Economic and Social Indicators

	Economic and social indicators Canadian cities				
	Unemployment rate, %	Non-residential building construction, $CDN millions per capita	GDP per capita, $US	Perceived life stress, quite a lot (15 years and over), %	Sense of belonging to local community, somewhat strong or very strong, %
Overall green index score					
Strong		+		-	+
Moderate					
Weak					
None	+		+		
Energy score					
Strong		+	+	-	+
Moderate					
Weak					
None	+				
Buildings score					
Strong		+		-	+
Moderate					
Weak	+		+		
None					
Water score					
Strong	+		+		
Moderate				-	+
Weak		+			
None					

Note: A "+" denotes a positive relationship; a "-" denotes a negative relationship.

CONCLUSIONS

The evidence examined supports the presumption that a low-carbon, sustainable development plan is mutually supportive of, and not otherwise in conflict with, economic growth and enhanced quality of life. An environmentally sustainable city is likely also to be a prosperous, livable place. Cities with higher levels of environmental sustainability tend to be more economically productive and provide residents with a higher quality of life.

In the context of Edmonton's Energy Transition Plan, observations from 27 major urban centers across North America suggest that cities with higher levels of energy efficiency, reduced GHG intensity, increased penetration of "green" buildings, greater availability of sustainable transport options, and higher levels of water conservation, will tend to have:

- Higher (lower) rates of employment (unemployment);
- Higher GDP per capita;
- Lower rates of violent crimes;
- More graduates (higher levels of educational attainment);
- Lower levels of perceived stress among residents (improved mental health);
- A greater sense of community among citizens; and
- Higher levels of investment in new commercial and institutional buildings.

Interestingly, cities which scored well on sustainable land use (i.e., densification, compactness) only showed a weak association with quality of life (the social indicators on crime and mental health). This is not surprising, as densification and compactness are also associated with crowding, increased noise, concerns over security, and less personal space and privacy.

Although it cannot be proven on the basis of statistical correlation, higher levels of GDP per capita, lower unemployment rates, lower rates of violent crime, lower levels of perceived stress, and a greater sense of community logically seem to be "effects" of higher levels of environmental sustainability. Whereas, in contrast, higher levels of investment in new commercial and institutional buildings and the presence of more graduates logically seem more likely "causes" of higher levels of environmental sustainability. It could be argued that the economic prospects and quality of life that a sustainable city offers attracts more graduates who have greater capacity to choose where they live.

Overall, the evidence suggests that it is actually a combination of economic, environmental, and social factors – and not solely economic prosperity - that produce a higher quality of life, and create conditions that attract and retain residents and businesses.

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APPENDIX A: DATA SETS

Table 1 City Prosperity Index: Productivity, Quality of Life, and Environmental Indices

Country	City	Productivity Index	Quality of Life Index	Environment Index
Austria	Vienna	0.939	0.882	0.932
United States	New York	0.940	0.866	0.941
Canada	Toronto	0.874	0.907	0.963
United Kingdom	London	0.923	0.898	0.920
Sweden	Stockholm	0.896	0.925	0.921
Finland	Helsinki	0.890	0.905	0.944
Ireland	Dublin	0.901	0.867	0.958
Norway	Oslo	0.870	0.914	0.939
France	Paris	0.895	0.925	0.895
Japan	Tokyo	0.850	0.931	0.936
Australia	Melbourne	0.867	0.875	0.967
New Zealand	Auckland	0.854	0.889	0.958
Netherlands	Amsterdam	0.866	0.872	0.933
Switzerland	Zurich	0.868	0.858	0.941
Denmark	Copenhagen	0.855	0.871	0.928
Belgium	Brussels	0.862	0.864	0.922
Spain	Barcelona	0.829	0.912	0.908
Italy	Milan	0.868	0.895	0.876
Poland	Warsaw	0.846	0.864	0.911
Portugal	Lisbon	0.827	0.867	0.916
Hungary	Budapest	0.808	0.867	0.921
Greece	Athens	0.800	0.885	0.884
Czech Republic	Prague	0.855	0.771	0.926
Republic of Korea	Seoul	0.801	0.903	0.822
Russia	Moscow	0.806	0.813	0.908
Mexico	Guadalajara	0.787	0.759	0.899
Brazil	São Paulo	0.742	0.803	0.894
Kazakhstan	Almaty	0.751	0.822	0.897
China	Shanghai	0.671	0.836	0.950
Romania	Bucharest	0.707	0.767	0.867
Mexico	Mexico City	0.743	0.764	0.866
Turkey	Ankara	0.699	0.802	0.891
Jordan	Amman	0.697	0.790	0.824
Thailand	Bangkok	0.719	0.747	0.850
Colombia	Bogotá	0.672	0.767	0.785

Source: Moreno et al (2013)

Country	City	Productivity Index	Quality of Life Index	Environment Index
Colombia	Medellín	0.600	0.718	0.812
Ukraine	Kyiv	0.579	0.757	0.874
Viet Nam	Hà Noi	0.712	0.761	0.733
Armenia	Yerevan	0.635	0.850	0.745
China	Beijing	0.667	0.836	0.663
South Africa	Cape Town	0.628	0.645	0.875
Indonesia	Jakarta	0.636	0.733	0.881
South Africa	Johannesburg	0.654	0.645	0.816
Philippines	Manila	0.676	0.647	0.868
Egypt	Cairo	0.679	0.743	0.616
Morocco	Casablanca	0.634	0.513	0.891
Honduras	Tegucigalapa	0.541	0.729	0.829
Moldova	Chisinau	0.340	0.850	0.894
India	Mumbai	0.645	0.739	0.632
Kenya	Nairobi	0.481	0.559	0.889
Cambodia	Phnom Penh	0.544	0.613	0.809
Mongolia	Ulaanbaatar	0.493	0.777	0.804
Guatemala	Guatemala City	0.440	0.556	0.866
Cameroon	Yaoundé	0.492	0.555	0.827
India	New Delhi	0.596	0.690	0.448
Côte d'Ivoire	Abidjan	0.452	0.440	0.842
Nepal	Kathmandu	0.385	0.621	0.704
Bangladesh	Dhaka	0.545	0.539	0.627
Uganda	Kampala	0.512	0.486	0.956
Nigeria	Lagos	0.475	0.634	0.659
Ghana	Accra	0.347	0.592	0.728
Bolivia	La Paz	0.363	0.621	0.606
Ethiopia	Addis Ababa	0.503	0.534	0.724
Senegal	Dakar	0.510	0.384	0.596
Zimbabwe	Harare	0.246	0.451	0.864
United Republic of Tanzania	Dar es Salaam	0.427	0.371	0.822
Zambia	Lusaka	0.316	0.463	0.766
Niger	Niamey	0.402	0.426	0.521
Mali	Bamako	0.401	0.416	0.460
Madagascar	Antananarivo	0.171	0.558	0.812
Guinea	Conakry	0.133	0.461	0.809
Liberia	Monrovia	0.048	0.381	0.886

Source: Moreno et al (2013)

Table 2 Green City Index: North American Cities

	Green city indicator scores								
	Overall	CO_2	Energy	Land use	Buildings	Transport	Water	Waste	Air
Canadian cities									
Calgary	64.8	75.4	62.5	57.8	56.0	50.8	94.1	58.8	50.8
Ottawa	66.8	86.0	56.9	75.0	28.2	65.4	84.9	66.2	76.7
Toronto	68.4	81.6	77.8	54.3	53.4	47.1	83.5	78.6	79.2
Vancouver	81.3	91.4	80.1	74.1	77.2	66.6	86.6	69.0	95.1
Montreal	59.8	80.1	33.8	57.7	36.4	65.3	47.2	63.7	79.5
US cities									
San Francisco	83.8	81.1	81.8	66.6	85.6	67.0	87.4	100.0	91.9
New York City	79.2	89.4	53.8	93.0	68.7	76.6	88.8	53.1	89.2
Seattle	79.1	84.7	69.8	56.2	98.2	59.8	83.3	83.1	80.5
Denver	73.5	76.0	86.0	53.3	68.8	60.7	85.6	51.9	79.0
Boston	72.6	79.0	82.4	74.9	62.1	50.2	91.8	54.7	74.3
Los Angeles	72.5	86.5	77.8	45.3	53.5	42.9	81.7	81.9	88.7
Washington DC	71.4	80.8	69.4	66.9	79.3	52.0	67.3	44.8	78.9
Minneapolis	67.7	40.2	76.5	80.1	37.0	63.9	88.2	72.6	57.0
Chicago	66.9	58.5	75.9	56.0	51.3	64.7	82.2	55.2	70.3
Philadelphia	66.7	78.4	72.5	67.7	29.5	47.2	70.4	57.6	82.9
Sacramento	63.7	67.6	49.0	44.4	41.7	56.0	76.3	72.2	89.1
Houston	62.6	32.1	71.0	56.8	66.4	53.6	80.5	59.5	49.3
Dallas	62.3	77.5	65.8	43.1	49.6	54.4	78.7	41.8	67.4
Orlando	61.1	52.2	64.2	54.5	42.3	49.4	81.0	58.0	66.4
Charlotte	59.0	59.8	55.7	64.6	26.2	40.8	84.8	40.9	69.5
Atlanta	57.8	57.0	44.8	36.7	66.7	47.6	71.7	29.6	78.2
Miami	57.3	90.1	61.5	59.2	26.7	51.2	78.2	28.4	57.8
Pittsburgh	56.6	38.8	67.6	50.7	78.5	51.2	71.6	25.5	40.1
Phoenix	55.4	66.3	72.9	49.6	26.7	38.0	77.4	40.5	65.2
Cleveland	39.7	1.2	68.0	28.1	16.7	47.9	56.1	22.2	60.0
St Louis	35.1	10.9	50.2	38.0	33.8	44.4	77.0	26.6	29.5
Detroit	28.4	43.8	27.3	35.8	18.1	37.5	38.8	-	37.4

Source: Summer and Bachfield (2011)

Table 3 Select Economic and Social Indicators for Canadian Cities in the Green City Index

	Canadian cities				
	Calgary	Ottawa	Toronto	Vancouver	Montreal
Selected economic and social criteria					
Unemployment rate, %	4.6%	6.6%	8.8%	7.0%	8.1%
Mean total income (couple & single parent), $CDN	93,410	97,010	69,740	68,970	69,150
Housing Starts per capita	12,841	6,026	48,105.0	19,027.0	20,591.0
GDP per capita, $US	50,200	38,500	45,000	37,500	31,500
Retail Sales per capita, $CDN	19	32	11	12	13
Non-residential building construction, $CDN millions per capita	1.0	0.6	1.0	1.5	0.9
Preceived health, very good or excellent, %	66%	65%	61%	61%	60%
Life Satisfaction, satisfied or very satisfied, %	95%	94%	92%	91%	93%
Perceived mental health, very good or excellent, %	77%	73%	73%	68%	74%
Perceived life stress, quite a lot (15 years and over), %	24%	32%	24%	22%	29%
Sense of belonging to local community, somewhat strong or very strong, %	61%	51%	67%	66%	55%
Total, all criminal code violations (excluding traffic), rate per 100,000 population	4,122	4,117	3,818	6,868	5,448
Total violent criminal code violations, rate per 100,000 population	676	635	5,448	1,353	1,094

Source: Statistics Canada (2013)

Table 4 Select Economic and Social Indicators for USA Cities in the Green City Index

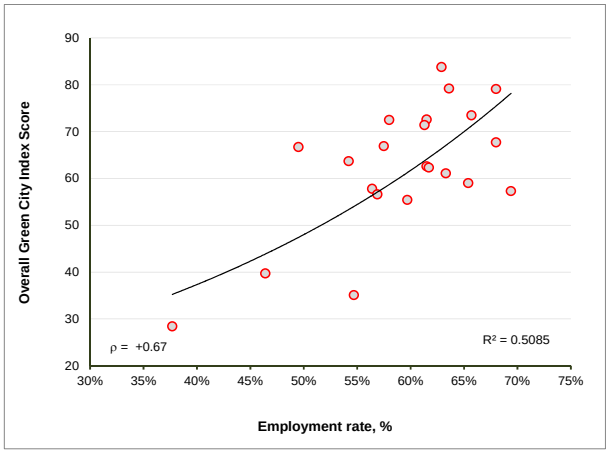
	Economic and social indicators							
	Employment rate, %	Unemployment rate, %	Mean family income, $US	GDP per capita, $US	Murders, rate per 100,000	Educational attainment bachelors degree, %	Mental health, percentile ranking	Overall health, percentile ranking
US cities								
San Francisco	62.9%	7.7%	86,713	60,300	5.9	18%	97	91
New York City	63.6%	6.8%	560,544	56,900	6.4	21%	12	38
Seattle	68.0%	4.3%	89,361	54,900	3.1	33%	48	71
Denver	65.7%	5.1%	58,593	49,200	3.6	25%	71	20
Boston	61.5%	6.5%	64,546	57,100	11.3	23%	65	67
Los Angeles	58.0%	8.1%	52,966	47,200	7.6	24%	8	81
Washington DC	61.3%	7.1%	71,208	60,500	21.9	23%	100	83
Minneapolis	68.0%	6.5%	59,498	50,200	9.6	30%	93	6
Chicago	57.5%	9.1%	52,101	45,400	15.2	25%	81	4
Philadelphia	49.5%	9.4%	45,769	46,200	19.6	14%	61	77
Sacramento	54.2%	9.5%	54,296	36,700	7.0	18%	32	85
Houston	61.5%	6.6%	47,329	48,000	11.8	18%	36	34
Dallas	61.7%	6.3%	42,699	48,900	11.3	18%	75	12
Orlando	63.3%	10.5%	67,378	41,800	7.5	21%	4	10
Charlotte	65.4%	8.1%	60,798	57,700	7.6	29%	53	30
Atlanta	56.4%	9.7%	61,658	42,200	17.3	29%	67	1
Miami	69.4%	4.6%	34,572	39,500	15.4	17%	20	26
Pittsburgh	56.9%	5.9%	50,922	39,400	17.6	16%	89	73
Phoenix	59.7%	7.6%	53,906	37,300	7.6	17%	35	55
Cleveland	46.4%	11.2%	31,159	41,400	19.0	9%	16	65
St Louis	54.7%	9.0%	39,483	37,600	6.0	16%	57	32
Detroit	37.7%	14.4%	31,017	40,300	34.5	8%	1	95

Source: United States Census Bureau (2013) and United States FBI (2010)

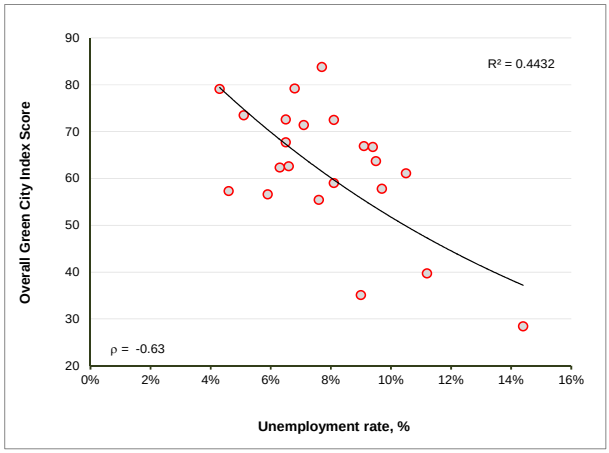
APPENDIX B: RESULTS – SCATTER PLOTS

Figure 4 US Cities: Link Between Overall Green City Index and Select Economic and Social Indicators

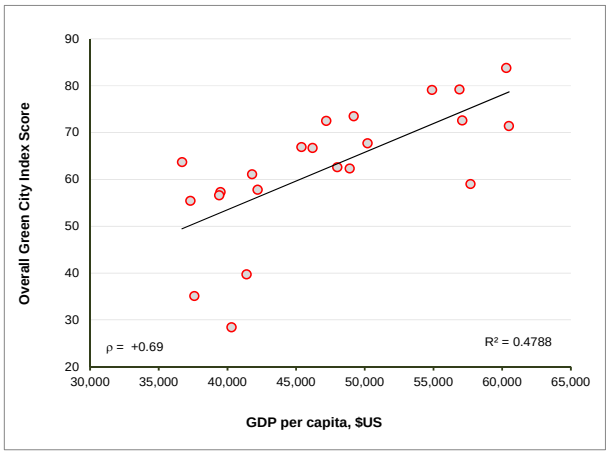
(a) Green City Index vs. Employment Rate



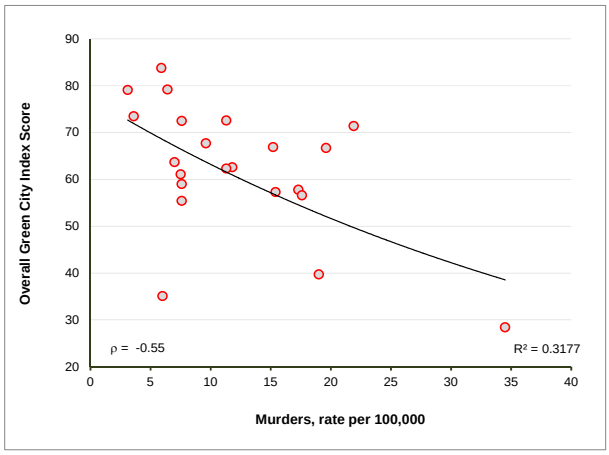
(b) Green City Index vs. Unemployment Rate



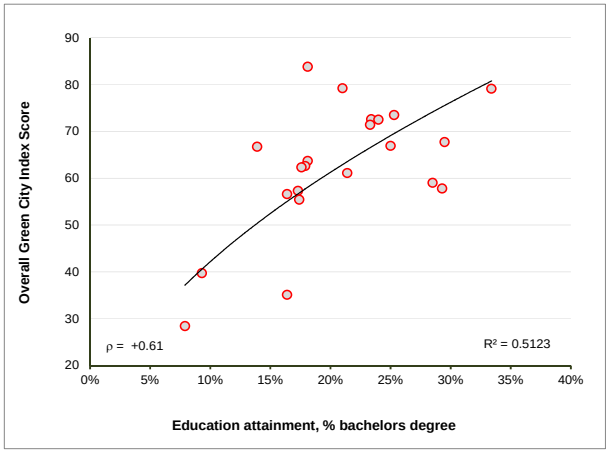
(c) Green City Index vs. GDP per Capita



(d) Green City Index vs. Murder Rate



(e) Green City Index vs. Educational Attainment



(f) Green City Index vs. Mental Health

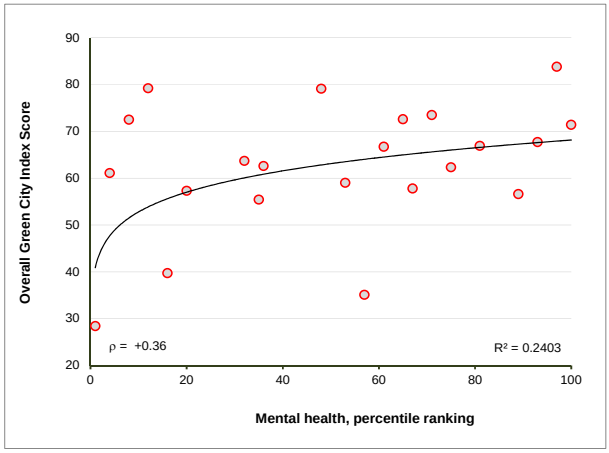
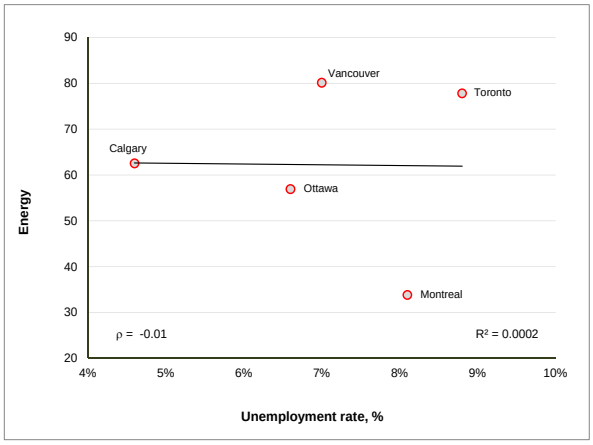
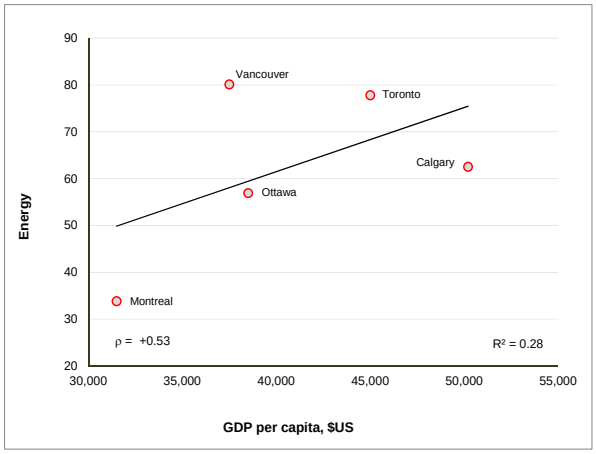


Figure 5 Canadian Cities: Link Between Energy Index Score and Select Economic and Social Indicators

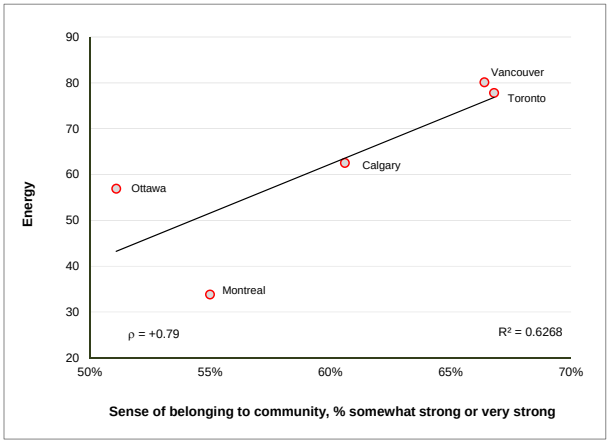
(a) Energy Index vs. Unemployment Rate



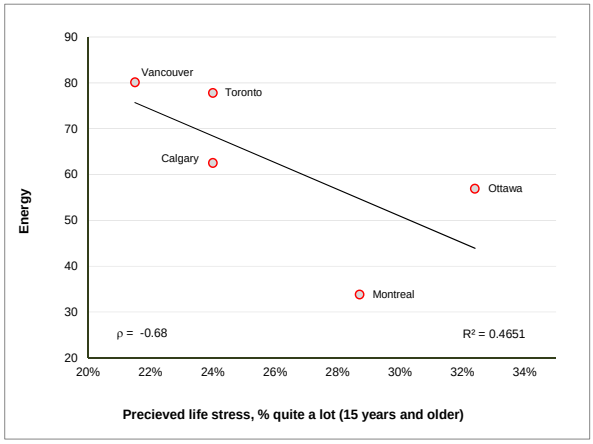
(b) Energy Index vs. GDP per Capita



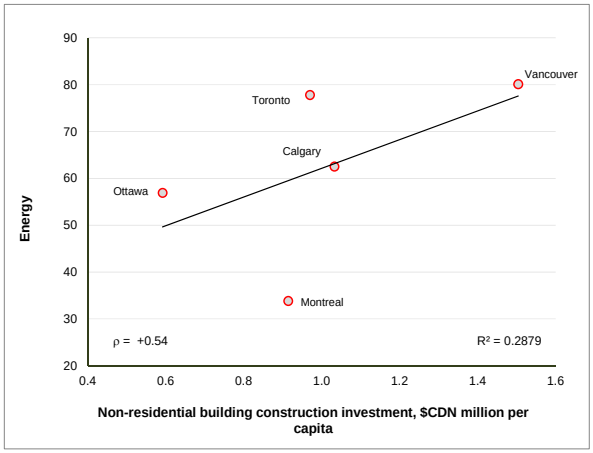
(c) Energy Index vs. Sense of Community



(d) Energy Index vs. Perceived Life Stress



(e) Energy Index vs. Non-residential Building Construction Investment



GLOSSARY OF TERMS

(Source: Unless otherwise referenced- NRCan, 2013)

BIOMASS:

Includes wood waste and pulping liquor. Wood waste is a fuel consisting of bark, shavings, sawdust and low-grade lumber and lumber rejects from the operation of pulp mills, sawmills and plywood mills. Pulping liquor is a substance primarily made up of lignin and other wood constituents and chemicals that are by-products of the manufacture of chemical pulp. It can produce steam for industrial processes when burned in a boiler and/or produce electricity through thermal generation.

CARBON DIOXIDE (CO2):

A compound of carbon and oxygen formed whenever carbon is burned. Carbon dioxide is a colourless gas that absorbs infrared radiation, mostly at wavelengths between 12 and 18 microns. It behaves as a one-way filter, allowing incoming visible light to pass through in one direction, while preventing outgoing infrared radiation from passing in the opposite direction. The one-way filtering effect of carbon dioxide causes an excess of the infrared radiation to be trapped in the atmosphere; thus it acts as a "greenhouse" and has the potential to increase the surface temperature of the planet (see Greenhouse Gas).

COGENERATION:

The simultaneous production of electric power and another form of useful energy (such as heat or steam) from the same fuel source. The heat or steam (that would otherwise be wasted) can be used for industrial process or other heating and/or cooling applications.

CITY:

A city is a social, ecological and economic system within a defined geographic territory. (UNEP, 2012)

ECONOMIES OF SCALE:

Occurs when there are advantages to large-scale production for a firm. Long-run average costs fall as production levels increase, reducing the per unit cost of the output.

ELECTRICITY:

A form of energy emanating from electric charges at rest or in movement.

ENERGY EFFICIENCY:

This term refers to how effectively energy is being used for a given purpose. For example, providing a similar (or better) level of service with less energy consumption on a per unit basis is considered an improvement in energy efficiency.

ENERGY INTENSITY:

The amount of energy used per unit of activity. Examples of activity measures are households, floor space, passenger-kilometers, tonne-kilometers, physical units of production and constant dollar value of gross domestic product.

ENERGY SOURCE:
Any substance that supplies heat or power (e.g. petroleum, natural gas, coal, renewable energy and electricity).

ENERGY STAR® QUALIFIED PRODUCT:
As an international symbol of energy efficiency, the ENERGY STAR mark helps consumers identify which appliances on the market are the most energy efficient in their class. Administered in Canada by Natural Resources Canada, the ENERGY STAR symbol is used mainly to identify products offering premium performance levels in energy efficiency. The ENERGY STAR symbol can be found on product packaging, literature and advertising and on the products themselves. In some cases, you may also find it on the EnerGuide label. The following criteria are used to determine if an appliance qualifies for the ENERGY STAR mark.

A standard-size **refrigerator** must exceed the minimum energy performance standard established by the Government of Canada by at least 10 percent in 2003, and at least 15 percent in 2004. A standard-size **freezer** must, in 2003, exceed these standards by at least 10 percent. Compact refrigerators and freezers must exceed these same standards by at least 20 percent.

A standard-size **dishwasher** must exceed the minimum energy performance standards established by the Government of Canada by at least 25 percent in 2003. Only standard-size dishwashers can qualify for the ENERGY STAR mark.

A **clothes washer** must use from 35 to 50 percent less water and at least 50 percent less energy per load than conventional washers.

A **television** must use 3 watts or less when turned off, i.e., use 75 percent less energy than conventional televisions, which consume up to 12 watts when turned off.

A **video cassette recorder** must use 4 watts or less when turned off, i.e., use 70 percent less energy than conventional video cassette recorders, which consume up to 13 watts when turned off.

A **DVD player** must use 3 watts or less when turned off, i.e., use 75 percent less energy than conventional DVD players, which consume up to 10 watts when turned off.

A **system stereo** must use 2 watts or less when turned off, i.e., use 70 percent less energy than conventional stereo systems, which consume up to 7 watts when turned off.

A **room air conditioner** must exceed the minimum energy performance standards established by the Government of Canada by at least 10 percent in 2003. A **central air conditioner** must exceed these standards by 20 percent.

A **forced-air furnace** must have an annual fuel utilization efficiency rating of 90 or higher. A f**urnace (boiler) with hot water or steam radiators** must have an annual fuel utilization efficiency rating of 85 or higher.

A **furnace (boiler) with hot water or steam radiators** must have an annual fuel utilization efficiency rating of 85 or higher.

FLUORESCENT LIGHTING**:**
A lighting unit that emits light by the excitation of a gas (such as neon) enclosed within a sealed tube or bulb. The terms "neon tube", "neon" and "fluorescent tube" are all used to designate the source of fluorescent light.

FOSSIL FUEL:
Any naturally occurring organic fuel, such as petroleum, coal and natural gas.

FUEL:
Refers to gasoline, fuel mixtures, diesel and propane, and to fuels used on farms. Vehicles that use a fuel other than gasoline represent only a small percentage of private vehicles.

GEOTHERMAL SYSTEM:
A geothermal system is a heat exchanger that uses the earth or ground water or both as sources of heat in the winter and as the "sink" for heat removed from the building in the summer. The system provides heat by removing it from the earth through a liquid, such as ground water or an antifreeze solution, which is upgraded by the heat pump and transferred to indoor air. The system provides cooling by reversing the process.

GIGAJOULE:
One gigajoule equals 1 x 10^9 joules (see Petajoule).

GREEN CITIES:

Green cities are defined as those that are environmentally friendly. (The greening of cities requires some or preferably all of the following:
(1) controlling diseases and their health burden;
(2) reducing chemical and physical hazards;
(3) developing high quality urban environments for all;
(4) minimising transfers of environmental costs to areas outside the city; and
(5) ensuring progress towards sustainable consumption (Satterthwaite 1997).

GREENHOUSE GAS (GHG):
A greenhouse gas absorbs and radiates heat in the lower atmosphere that otherwise would be lost in space. The greenhouse effect is essential for life on this planet, since it keeps average global temperatures high enough to support plant and animal growth. The main greenhouse gases are carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs) and nitrous oxide (N_20). By far the most abundant greenhouse gas is CO_2, accounting for 70 percent of total greenhouse gas emissions (see Carbon dioxide).

GREENHOUSE GAS INTENSITY:
The amount of greenhouse gas emitted per unit of energy used.

HEATING DEGREE-DAY (HDD):
A measure of how cold a location was over a period, relative to a base temperature. In this handbook, the base temperature is 18.0°C and the period is one year. If the daily average temperature is below the base temperature, the number of heating degree-days for that day is the difference between the two temperatures. However, if the daily average temperature is equal to or higher than the base temperature, the number of heating degree-days for that day is zero. The number of heating degree-days for a longer period is the sum of the daily heating degree-days for the days in that period.

HEATING DEGREE-DAY INDEX:
A measure of how relatively cold (or hot) a year was when compared with the heating degree-day (HDD) average. When the HDD index is above (below) 1, the observed temperature is colder (warmer) than normal. The HDD normal represents a weighted average of the 1951-1980 HDDs observed in a number of weather stations across Canada. Its value, which varies from year to year because of the flow of population, was 4476 HDDs in 2004.

HOUSING STOCK:
The physical number of dwellings is referred to as the housing stock. As opposed to the number of households, which refers to the number of occupied dwellings, housing stock includes both occupied and unoccupied dwellings.

KILOWATT-HOUR (KWH):
The commercial unit of electricity energy equivalent to 1000 watt-hours. A kilowatt-hour can best be visualized as the amount of electricity consumed by ten 100-watt bulbs burning for an hour. One kilowatt-hour equals 3.6 million joules (*see* Watt).

LOCAL IMPROVEMENT CHARGES (LIC):

LICs are financing payment obligations included on a property owner's tax bill as a surcharge until they are completely paid off. On sale, an outstanding LIC obligation remains with the property.(Suzuki, 2011)

PETAJOULE:
One petajoule equals 1 x 10^{15} joules. A joule is the international unit of measure of energy – the energy produced by the power of one watt flowing for a second. There are 3.6 million joules in one kilowatt-hour (*see* Kilowatt-hour).

PETROLEUM:
A naturally occurring mixture consisting of predominantly hydrocarbons in the gaseous, liquid or solid phase.

PRIMARY ENERGY USE:
Represents the total requirement for all uses of energy, including energy used by the final consumer (*see* Secondary energy use), non-energy uses, intermediate uses of energy, energy in transforming one energy form to another (e.g. coal to electricity), and energy used by suppliers in providing energy to the market (e.g. pipeline fuel).

RETROFIT:
The improvement in the energy efficiency of existing energy-using equipment or the thermal characteristics of an existing building.

SECONDARY ENERGY USE:
Energy used by final consumers for residential, agricultural, commercial, industrial and transportation purposes.

SECTOR:
The broadest category for which energy consumption and intensity are considered within the Canadian economy (e.g. residential, commercial/institutional, industrial, transportation, agriculture and electricity generation).

URBAN AREA:
An area having a population of at least 1000 inhabitants and a population density of at least 400 inhabitants per square kilometre, as determined in the previous census.

WATT (W):
A measure of power. For example, a 40-watt light bulb uses 40 watts of electricity (*see* Kilowatt-hour).

ADDITIONAL RESOURCES:

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