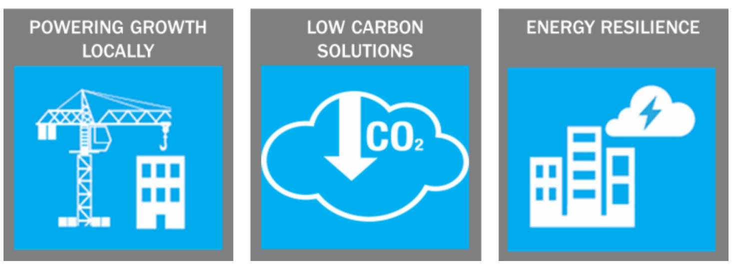
Port Lands Energy Plan

Guidelines for a Net Zero District



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TORONTO Environment and Energy Division

Executive Summary

The Port Lands is an area of Toronto's waterfront that is being planned to undergo regeneration and renewal over the coming decades. It is estimated that upon completion, there could be over two million square metres of gross floor area and between 18,000 to 25,000 residents and 25,000 to 30,000 employees.

Council directed, at its July 2014 Council meeting, for staff to report on guidelines for achieving net zero energy import in the Port Lands. This is consistent with the Council-approved updated environmental policies in the Official Plan, which supports initiatives that "contribute towards an energy neutral built environment".

This Energy Plan was developed to support the Port Lands Planning Framework. Regeneration and renewal in the Port Lands presents a unique opportunity to work towards net zero through more aggressive energy reduction targets and low-carbon energy solutions.

Zero Net Energy Import Definition

A net zero energy district is a place where no more energy is consumed than is supplied by non-fossil fuel sources to approach zero emissions. In practice this means:

1) Minimizing energy consumption;
2) Maximizing efficiency of energy conversion; and
3) Maximizing use of low-carbon/renewable energy sources at both the building-scale, as well as the black/district scale

While the priority is utilizing low-carbon energy sources from within the Port Lands (i.e. local), the word "net" recognizes that there will still be a connection to utilities and that energy imported from the electricity/natural gas grids will be offset by exports.

Regeneration and renewal activities with the objective of achieving net zero energy import in the Port Lands will assist in both addressing pressing environmental issues, as well as contributing to the City's ambitious greenhouse house reduction target of 80% below 1990 levels by 2050.

Guidelines for a Net Zero District

The Port Lands represent a unique opportunity in Toronto by way of its location, size, and character in that unlike most other areas in the city, regeneration and renewal in the Port Lands will include developing new, sustainable mixed use communities alongside a working port and industrial area, and upgrading and constructing new hard infrastructure (e.g. streets, water and sewers etc.) across the area to support the broad range of uses contemplated.

Approach

The approach involved first calculating energy use, demand and GHG emissions for different development estimates using current standards within the City to understand the potential future energy needs of the Port Lands. International precedents and approaches were also explored to inform current trends and practices.

Other unique opportunities, such as creating synergies with the Portlands Energy Centre and the geography of the Port Lands itself within Toronto's waterfront, were identified. Specific technologies that were then evaluated to understand their potential contribution towards achieving net zero in the Port Lands.

Guidelines rationale

The graph below summarizes and represents the rationale for a net zero district. It shows cumulative energy consumption (if built to today's energy standards) for the various development phases, along with wedges (dashed lines) representing the guidelines to achieve net zero energy. The size of the wedge reflects the magnitude of the contribution towards net zero.

Reduced energy consumption in buildings

- New buildings designed to meet strict energy standards can help reduce energy consumption by 18% (Toronto Green Standard Tier 2) to 33% (Waterfront Toronto Minimum Green Building Requirements V2.1). More aggressive approaches, such as those identified in Toronto's Zero Emissions Building Framework, would reduce energy consumption further. Deep retrofits to existing buildings, including heritage structures, would also reduce energy consumption.

- Codes and standards are expected to continue to steadily become more stringent, which will lead to incremental improvements in energy efficiency over time.

Low-carbon, local energy supply solutions

- Low-carbon solutions in buildings throughout the Port Lands can contribute approximately 10-15% of local energy supply towards net zero. The actual amount will vary based on the built form. For example, the contribution of solar PV will be much less (<5%) in the higher density Villiers Island, but much more (>25%) in the lower density East Port.
- Block- and district-scale energy sharing networks that leverage large-scale renewable energy sources can contribute 50-60% of the needed energy supply towards net zero. The contribution is significant given that these networks are most appropriate in high density developments, which tend to use the most energy and also have fewer opportunities for on-site solutions.
- Reducing water consumption, increasing solid waste diversion, and low-carbon transportation choices like walking, cycling and the use of public transit, can further reduce energy use and emissions. Since the Planning Framework already establishes an excellent mode split of 72% in favour of transit and active transportation, further transportation emissions reductions will come from uptake of electric vehicles over time.

Improved resilience to power outages

- Multi-unit residential buildings with backup power systems will ensure that residents can remain in their homes for extended periods of time during power outages.
- Recreation Centres can serve as Community Reception Centres for people displaced by power outages.

Decisions made early, particularly the new building designs and easements for thermal networks, are essential for achieving a net zero district. Improvements to codes and standards and existing buildings are likely to occur incrementally. Further, many building-scale solutions can be implemented subsequent to development occurring. However, ensuring substantially reduced energy consumption in buildings and thermal network development over time, requires upfront commitments.

Conclusion and Recommendations

Regeneration and renewal in the Port Lands presents a unique opportunity to achieve a net zero district. The scale of new development contemplated, supporting infrastructure investments, and the lakefront location, combine to create an opportunity not found elsewhere in Toronto. The two strategies necessary are reducing the energy consumption, while developing low-carbon local energy supply solutions at the building, block, and district scale.

The net zero guidelines provided in this report are qualitative, designed to highlight critical, early decisions needed to achieve a net zero district in the Port Lands over time. The recommendations also identify future follow-on work that will be necessary to better understand opportunities and challenges of realizing net zero energy import in the Port Lands.

Reducing energy consumption in buildings

1) Building on the success of the Toronto Green Standard and Waterfront Toronto's Minimum Green Building Requirements, establish require passive design requirements to further reduce energy consumption.

Building-scale renewable energy solutions

2) Explore opportunities for building-scale renewable energy solutions to address building energy consumption or demand that cannot be addressed through efficiency measures. Such solutions include, but are not limited to:
    a. Solar PV
    b. Wind
    c. Geothermal
    d. Biomass
    e. Lake water cooling
    f. Waste heat recovery

Block-scale energy networks

3) Identify, designate and reserve easements for energy networks, including rights of way for linear infrastructure.
4) During more detailed planning exercises, identify, designate and reserve strategically located small parcels (underground or above ground) for low-carbon energy solutions, which may include:
    a. Lake water cooling energy transfer stations
    b. Sewer heat energy transfer stations
    c. Solar PV systems
    d. Biomass combined heat and power plants
5) Create a framework for energy network implementation, including reference to business models (i.e. franchise, lease), easements, and reserved development parcels to attract private investment from energy developers for energy solutions towards a net zero district.

6) Explore opportunities and approaches that would encourage developers to invest in energy network-ready buildings, and building-scale energy plants designed to share energy with neighbouring buildings.

Resilience to climate change and other disruptions

7) Explore opportunities to strengthen resilience to power outages in multi-unit residential buildings, including, but not limited to:
    a. Powering additional loads such as domestic water pumps and elevators
    b. Creating refuge areas
    c. Backup power systems designed for at least 72 hours of continuous operation
8) Identify and designate community reception centres within the Port Lands

Low-carbon transportation

9) In accordance with direction emerging through the Port Lands and South of Eastern Transportation and Servicing Plan, ensure transit-supportive development and complete streets with high-quality pedestrian and cycling amenities to reduce reliance on the personal automobile;
10) Provide the necessary infrastructure and space allocation in buildings to support electric personal vehicles and car sharing fleets.

Water and wastewater

11) Encourage highest levels of water conservation through low-flow fixtures and water efficient appliances
12) Explore opportunities for grey water recycling systems within buildings to avoid using high quality and energy intensive drinking water for non-potable purposes (e.g. toilets flushing irrigation, etc.)
13) Explore opportunities for heat exchange with water infrastructure, including heat exchange with water supply mains and pumping stations, as well as heat recovery from sewage pumping stations, sewer lines, and buildings drains

Solid waste

14) Encourage highest levels of solid waste diversion consistent with the City's Long-term Waste Management Strategy

Innovation

15) Due to the long-range nature of the Port Lands Planning Framework, ensure continued flexibility such that innovations and emerging technologies, at the building, block, precinct and/or Port Lands scales, can be implemented over time and that would further contribute to the objective of achieving a Net Zero district.

Integration with other plans and studies

16) Ensure that other studies in the area which may be on-going or that are to come, consider the opportunities identified in this energy plan and integrate them towards a Net Zero district.

Follow-on work

Building on this Community Energy Plan, EED staff will work with City Planning and Waterfront Toronto to undertake a feasibility study to determine the optimal approaches for a low-carbon/renewable thermal energy network, including front-end engineering designs, business cases and implementation strategies. These analyses will include:

- Evaluation of potential low-carbon energy sources in and around the Port Lands, including estimates of magnitudes and associated emissions reductions
- Approximate locations for linear infrastructure and distributed energy centres, including potential co-location with other infrastructure (e.g. sewers, transit, parks)
- Life cycle costing for various engineering design options
- Delivery models that take into account development and infrastructure phasing
- Changes to relevant policies/regulations

Contents

Figure 1. The Port Lands. Located east of Toronto's Downtown core between the Inner Harbour and Leslie Street south of Lake Shore Boulevard.

1. Introduction

The Port Lands area (Figure 1 on the previous page) is being planned to undergo regeneration and renewal over the coming decades. It is estimated that upon completion, there will be:

- Approximately two million square metres of new gross floor area (GFA);
- Between 18,000 to 25,000 residents and 25,000 to 30,000 employees in new, mixed-use communities and employment areas; and
- Substantial investments in new transportation and servicing infrastructure

City Planning, with Waterfront Toronto, has been preparing the Port Lands Planning Framework (PLPF) to guide long-term regeneration and renewal. The Environment and Energy Division developed this Energy Plan in support of the PLPF.

1.1. Community Energy Planning (CEP)

The mandate for CEP was established by City Council's adoption in 2009 of the Power to Live Green: Toronto's Sustainable Energy Strategy, which defines CEP as follows:

> "CEP describes how energy is used in communities, and how its use affects the community including energy cost, energy security, and environmental impacts. Community Energy Plans show how designing for sustainable energy supports community objectives of greenhouse gas emissions reduction, local job creation and funds retained in community" (p. 19)[1].

The location, size, and character of the Port Lands presents a unique opportunity in that unlike most other areas of Toronto, regeneration and renewal here will include developing sustainable, mixed-use communities alongside a working port/industrial area, and upgrading and constructing new infrastructure (e.g. streets, water and sewers etc.) across the area to support the broad range of uses contemplated. Challenges and opportunities lie in the three main categories of growth, low-carbon solutions and resilience:

Powering Growth Locally

Energy conservation in new buildings through passive design, and in existing buildings through deep retrofits, is key to reducing energy use.

Low-carbon Solutions

Low-carbon energy supply at the building and block/district scale, as well as low-carbon transportation choices, help drive deep GHG reductions. Maximizing waste diversion and minimizing water use and wastewater production further reduce emissions.

[1] http://www1.toronto.ca/city_of_toronto/environment_and_energy/key_priorities/files/pdf/2009- 10_report.pdf

Energy Resilience

Backup power solutions for residential buildings and recreation centres can mitigate vulnerability to power outages associated with extreme weather and aging infrastructure.

1.2. Zero Net Energy Import

City Planning updated Council on the progress of the PLPF in July 2014, during which City Council directed staff, as part of the final report on the PLPF, to report on guidelines for zero net energy import and zero waste export[2]. This Energy Plan was developed to support work currently underway for developing the Port Lands Planning Framework. Council directed, at its July 2014 Council meeting, for staff to report on guidelines for achieving net zero energy import in the Port Lands.

1.2.1. Definition

A net zero energy district is a place where no more energy is consumed than is supplied by non-fossil fuel sources to approach zero emissions. In other words, energy consumption and low-carbon/renewable energy supply are equal. (Figure 2).

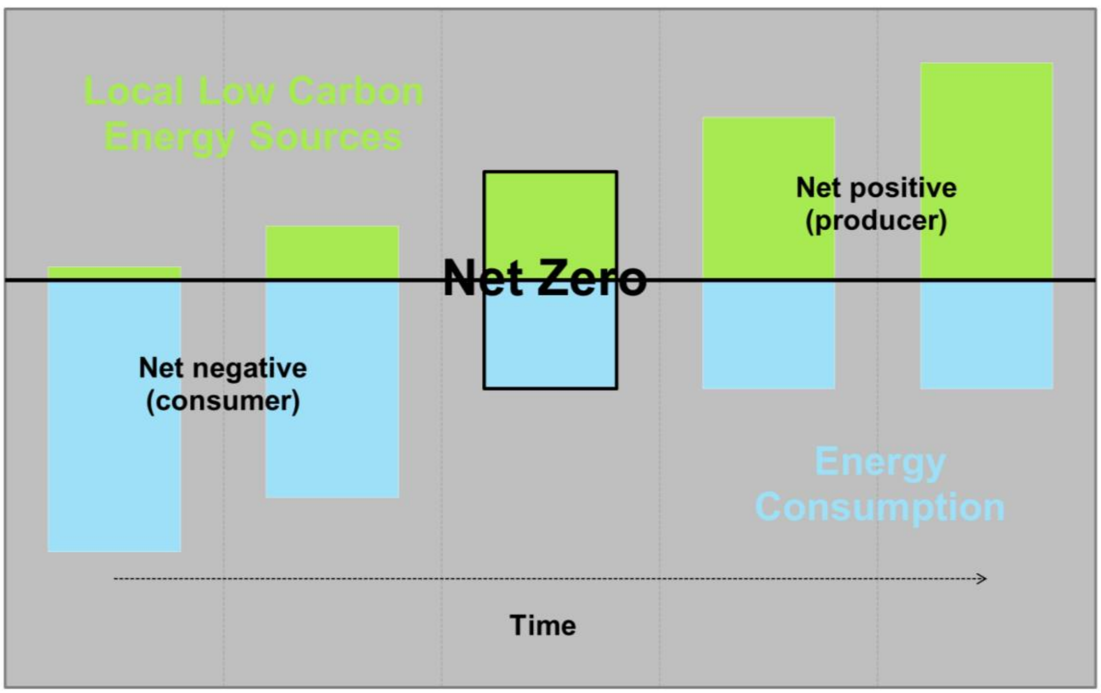

Figure 2. Conceptual illustration of net zero. Net zero is when energy consumption and low-carbon/renewable energy supply are equivalent. Over time, reducing energy consumption and increasing use of renewable energy sources, is key to achieving net zero. Furthermore, the more that energy consumption is reduced, the less energy needs to be supplied. In other words, very efficient buildings reduce the need for investment in energy infrastructure, which is not only a more cost effective approach, but also makes it easier to incorporate local, low-carbon solutions.

[2] http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2014.PG34.11

Therefore, not only is there a focus to identify energy sources from within the Port Lands area, such that it nets what is imported from utilities, but also to plan for low-carbon/ carbon neutral solutions at both the building scale and block/district scale over time (i.e. lake water cooling, sewer heat, biomass combined heat and power, solar farms, heat recovery).

1.2.2. Context

In this report, the interpretation of net zero as low-carbon, local energy solutions is in keeping with past City Council direction in city-wide sustainable energy strategies and current Council-approved environmental policies pertaining to "an energy neutral built environment" in the recently amended Official Plan[3]. Furthermore, this interpretation is consistent with the ongoing TransformTO initiative being led by the Environment & Energy Division, which will provide a path to an 80% reduction in greenhouse gas (GHG) emission levels by 2050 relative to 1990 levels[4].

For Toronto to achieve its goal of an 80% reduction in GHG emissions, any new, large district within Toronto should strive for zero-emissions new development. Achieving zero emissions in new buildings will make it easier to achieve the overall reduction target given the challenges associated with retrofits to existing buildings. This also holds true for the Port Lands - achieving net zero district-wide will be easier if new buildings are net zero.

[3] http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=f6ce5d0a02148410VgnVCM10000071d60f89RCRD
[4] www.toronto.ca/transformto

2. Guidelines for a Net Zero District

This Energy Plan provides an overview of background completed to understand potential energy consumption and approaches to achieving net zero and low carbon development as the Port Lands evolves and transforms over the coming decades.

Recommendations for guidelines have been identified to ensure that from the outset, any redevelopment contributes to net zero energy. Given the longer-term development horizon for the Port Lands, flexibility in implementation is required to respond to emerging technologies and approaches.

2.1. Approach

The approach involved first calculating energy use, demand and GHG emissions for different development estimates using current standards within the City to understand the potential future energy needs of the Port Lands.

Current trends and practices in developing net zero communities were informed by exploring existing and in-development precedents such as Edmonton's Blatchford Redevelopment project, which is targeting carbon neutrality and 100% renewable energy supply (page 16). Additional case studies of model sustainable communities can be found in Appendix 1.

Other unique opportunities, such as creating synergies with the Portlands Energy Centre and the geography of the Port Lands itself within Toronto’s waterfront, were identified. Specific technologies that were then evaluated to understand their potential contribution towards achieving net zero.

2.1.1. Guidelines rationale

Figure 3 summarizes and represents the rationale for a net zero district. It shows cumulative energy consumption (if built to today's standards) for the various development phases, along with wedges (dashed lines) representing the guidelines to achieve net zero energy. The size of the wedge reflects the magnitude of the contribution towards net zero. Although the chart indicates four discrete phases, development is expected to take place over 50 years and is contingent of market factors.

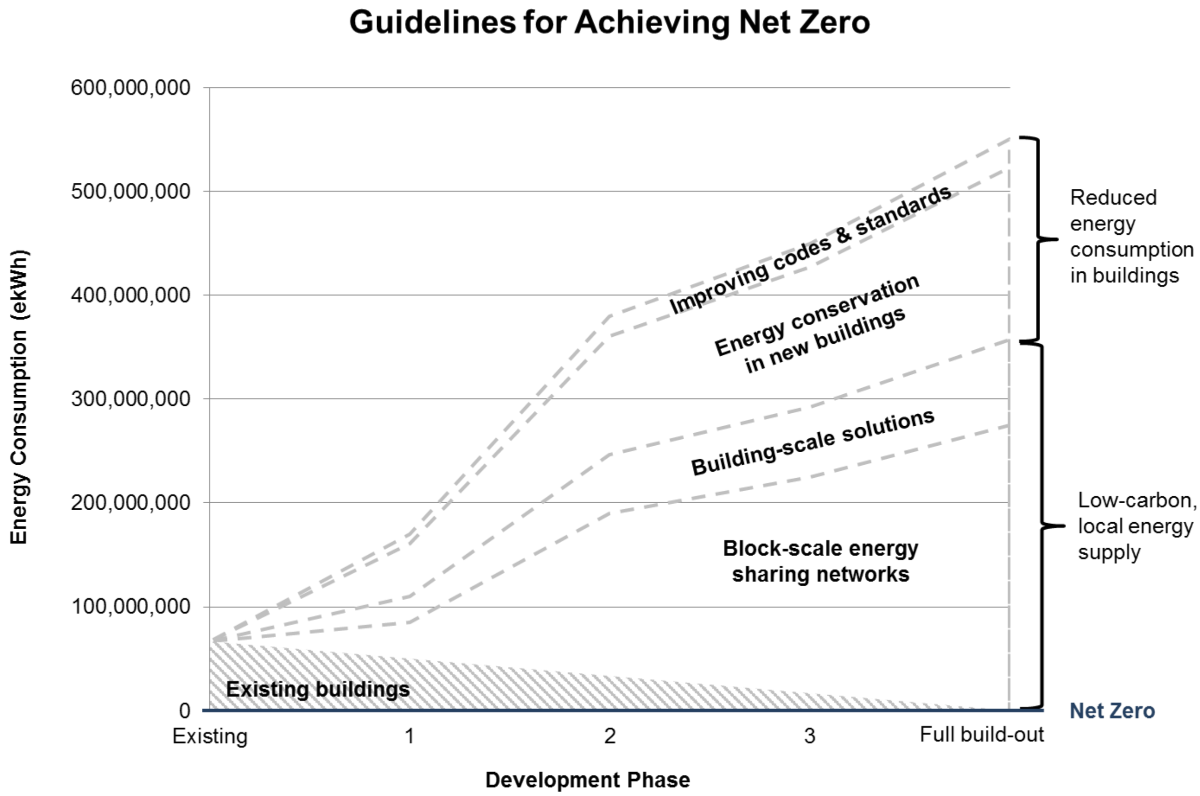

Figure 3. Estimated cumulative energy consumption of Port Lands' buildings over time.

Reduced energy consumption in buildings

Codes and standards are expected to continue to steadily become more stringent, which will lead to incremental improvements in energy efficiency over time. These include the Ontario Building Code, as well as, standards for mechanical equipment, construction materials and techniques, as well as, appliance standards like EnergyStar.

The key to significant reductions in energy consumption is new buildings designed to meet strict energy standards such as TGS Tier 2 and Waterfront Toronto MGBRs, which can help reduce energy consumption by 18-33%. In addition to this, passive design approaches would help maximize conservation. Deep retrofits to existing buildings, including heritage structures, would further reduce consumption.

Low-carbon, local energy supply solutions

Low-carbon solutions for individual buildings, such as rooftop solar PV or geo-exchange systems, can contribute approximately 10-15% of local energy supply towards net zero. However, the wide variety of the Port Lands' built form (existing and proposed) would mean that the actual amount per building would vary. For example, tall residential buildings with small roofs in Villiers would be limited to less than 5% of energy supplied by solar PV, while large warehouses in East Port could easily supply more than 25%.

Block- and district-scale energy sharing networks that leverage large-scale renewable energy sources, such as lake water-cooling and sewer heat recovery, have the potential to contribute over 50-60% of the needed energy supply towards net zero, especially in higher density areas such as the Lower Don Lands and Film Studio precincts

Beyond buildings, there will be numerous opportunities to reduce energy use and emissions in the Port Lands by reducing water consumption, increasing solid waste diversion, and through low-carbon transportation choices like walking, cycling, and use of public transit and electric vehicles.

Improved resilience to power outages

Although energy resilience is not a prerequisite for achieving net zero, it is critical to the sustainability of the Port Lands. Multi-unit residential buildings with backup power systems will ensure that residents can remain in their homes for extended periods of time. Recreation Centres can serve as Community Reception Centres for people displaced by power outages.

Summary

Avoiding locking-in significant energy use and emissions in the Port Lands will require upfront decisions, particularly with respect to the energy standards chosen for new buildings and space (e.g. easements, parking garages) for energy sharing networks. In other words, these decisions will be largely responsible for determining whether or not the Port Lands is a net zero district in 50 years.

Improvements to codes and standards and retrofits of existing buildings are likely to occur incrementally and they will not be substantial enough on their own to achieve net zero. Further, many building-scale solutions, such as solar PV systems, can be implemented after buildings are constructed.

Aggressive, low EUIs and energy sharing networks however, must be considered well in advance of development and then monitored over time to take advantage of opportunities to further reduce the EUI and expand the networks.

Case Study: Blatchford Redevelopment

Redevelopment of the 540-acre site of the former Edmonton City Centre Airport aims to create a 2 million m^2 mixed-use community for 30,000 residents and 10-12,000 employees over 25 years[5].

The lands are owned by the City and the Blatchford Redevelopment Office (BRO) functions as the Master Developer, similar to Waterfront Toronto. The BRO is tasked specifically with implementation, not policy, which is the City's role. Under this structure, the BRO was asked to deliver a sustainable neighbourhood through a financially sound approach.

The dual-mandate for Blatchford is to be carbon neutral AND use 100% renewable energy at full build-out.

Key strategies

- Conservation first – Reduce building energy consumption as much as possible through better than code building standards that increase in stringency over time
- Efficient energy delivery – Ambient Loop (District Energy Sharing System) is needed to leverage renewables; sharing between buildings is key
- 100% renewable energy – Geo-exchange and sewer heat recovery; Solar PV

The project team determined that the most cost-effective approach is to share energy amongst buildings via "ambient loop" (i.e. ambient temperature water) connected to low-carbon energy sources[6]. A geo-exchange borefield will be installed below a stormwater

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[5] http://blatchfordedmonton.ca/about/
[6] http://sirepub.edmonton.ca/sirepub/cache/2/w5fnpx20mgzrohu5djaujosi/47050903282017031204881.PDF

management pond during the initial phases of development. Later phases will take advantage of trunk sewer heat recovery. Over time, the ambient loop will act as a platform for various other renewable energy sources (e.g. solar thermal).

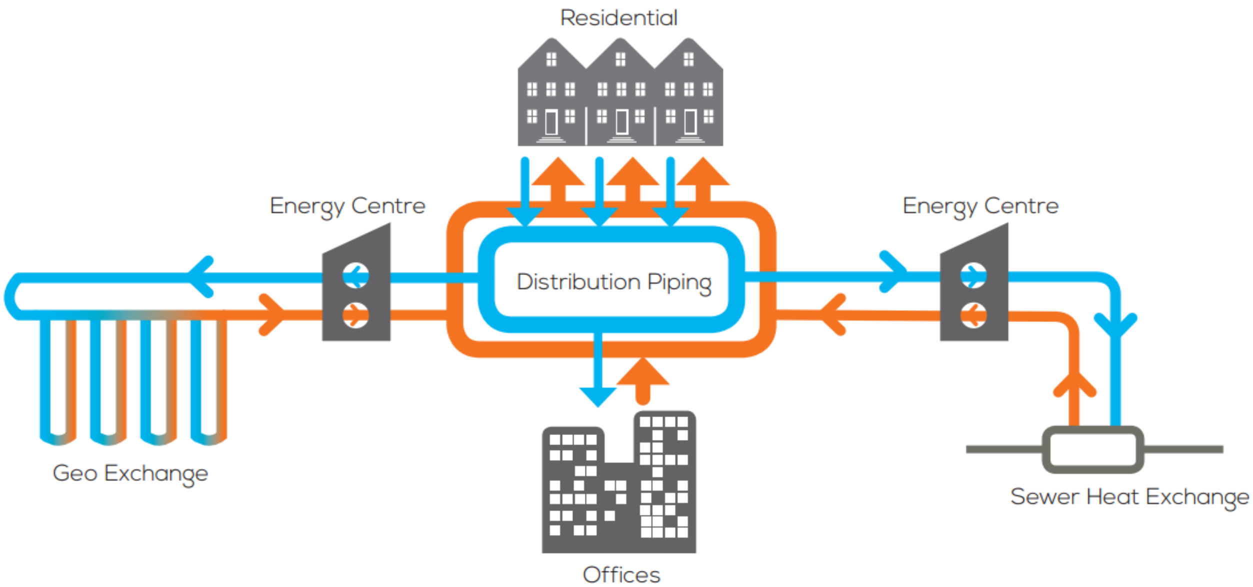


Illustration of the ambient loop concept for Blatchford

Opportunities beyond buildings:

- Transportation – Complete communities as well as a LRT and extensive pedestrian/cycling network will help reduce the carbon footprint associated with transportation.
- Water/Wastewater – Low Impact Development, green infrastructure, low- flow fixtures, and capturing rainwater for the irrigation of local gardens will help reduce water use and manage stormwater.
- Solid Waste – Energy from waste, particularly through digestion of organic materials, may be a future renewable energy source.

The City of Edmonton is currently in the process of selecting an interested partner to advance ambient loop development, which will be phased-in as building development and site servicing takes place. The strategy identifies the critical path decisions needed to meet the objectives, but it also allows for the flexibility needed to adapt to changing conditions and new technologies over the build-out period.

3. Energy & GHG Calculations

Energy consumption, demand, and resulting GHG emissions were calculated for development estimates provided by City Planning. The development estimates essentially consist of gross floor areas, anticipated uses (i.e. residential, commercial), and projected timing over a 50-year build-out period.

Energy and emissions were calculated using current minimum efficiency standards, Tier 1 of the Toronto Green Standard (TGS). In the next section, guidelines are provided for future discounting of energy and emissions relative to key factors, such as improvements to minimum codes and standards, and potential requirements above those future minimum codes and standards.

Calculating energy use and GHG emissions as if the building was built to today's energy standard allows us to effectively identify the anticipated impacts of future codes and standards and the level of requirements that need to go beyond them to achieve hyper-efficient buildings.

3.1. Inputs

Figure 4 below shows the expected total GFA for each land use within the four districts of the Port Lands. (See Appendix 2 for a summary of the development estimates). See Figure 1 for a map of the Port Lands showing the districts.

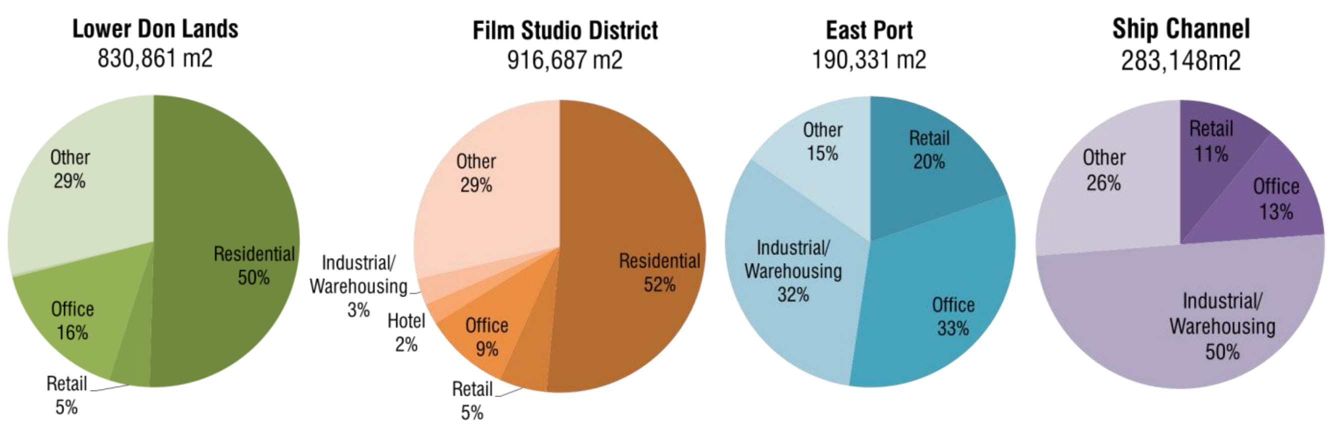


Figure 4. Total GFA for each use within each of the four districts of the Port Lands.

Overall, this would lead to a total of approximately 2,000,000 m^2 of GFA, most of which would be located in the Lower Don Lands and Film Studio District, and over 50% of which would be residential.

Given the size of the Port Lands, a 50-year full build-out is anticipated. Large-scale renewal is anticipated to occur in Villiers Island in the Lower Don Lands and portions of the Film

Studio District within the next 20-25 years. The balance of the Port Lands will see incremental redevelopment as opportunities and the market permits.

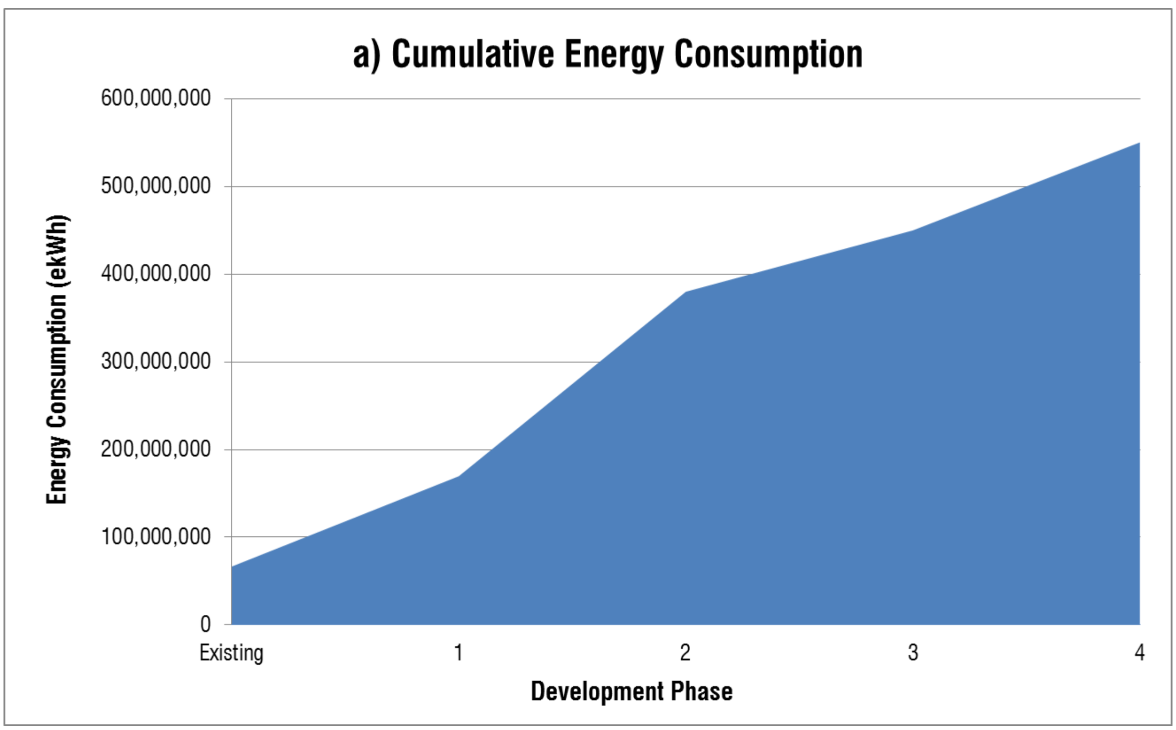
3.2. Methodology

Using the development estimates, we calculated the energy consumption, energy demand and GHG emissions for the Port Lands area by applying energy coefficients (i.e. multipliers) for various building types to the projected gross floor areas.

The approach in this Energy Plan consists of calculating energy and GHGs emissions using the efficiency standard available today and then in the following-section providing guidelines for future discounting of energy and emissions relative to key factors, such as future codes and standards, and requirements that go beyond code.

3.3. Outputs

Figure 5 (a-d) depicts energy calculations for the Port Lands should it be built-out to the current Toronto Green Standard (TGS), Tier 1, which requires new buildings to achieve a 15% improvement in energy performance relative to the Ontario Building Code. Specifically, it shows: a) Cumulative energy consumption over time; b) Energy consumption; c) Energy demand; and d) GHG emissions.



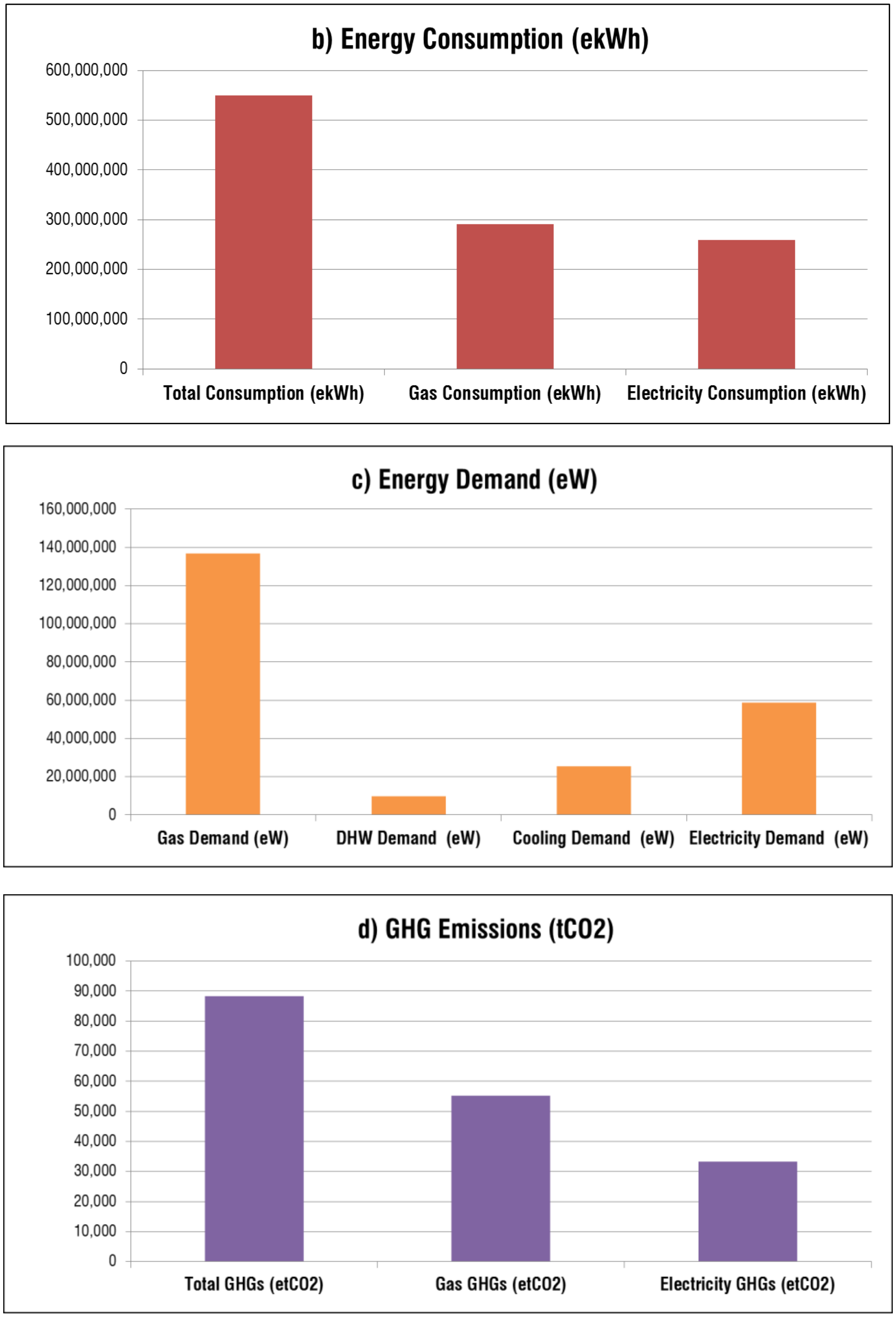


Figure 5. Energy and GHG calculations. Calculated energy outputs indicate the energy and GHG profile of a Port Lands built to today's minimum standards, recognizing of course that these standards will improve over time. Showing the calculations this way, particularly Figure 5.a), conveys the magnitude of the effort required to achieve net zero, especially that it requires certain early decisions as well as ongoing flexibility.

4. Achieving Net Zero

This section outlines key opportunities for achieving net zero and it provides examples and qualitative estimates of potential contributions.

4.1. Powering Growth Locally

Local energy solutions start with high levels of energy conservation. This includes retrofits to existing buildings, such as equipment replacement or envelope upgrades, as well designing new buildings with a focus on passive solutions. For the larger-scale regeneration areas, such as in the Lower Don Lands, much of the existing building stock will be redeveloped. In other areas, like the Film Studio District and South Ship Channel, vacant or underutilized lands are anticipated to redevelop and intensify. As such, this section focusses on opportunities for new buildings.

4.1.1. Energy conservation in new buildings

Based on current in-force standards[7], designing new buildings to achieve the voluntary TGS Tier 2 (which is a 25% improvement relative to the OBC) would reduce energy consumption by 18% as shown in the Figure 6. Electricity demand and GHG emissions (not shown) would be reduced by 16% and 21%, respectively.

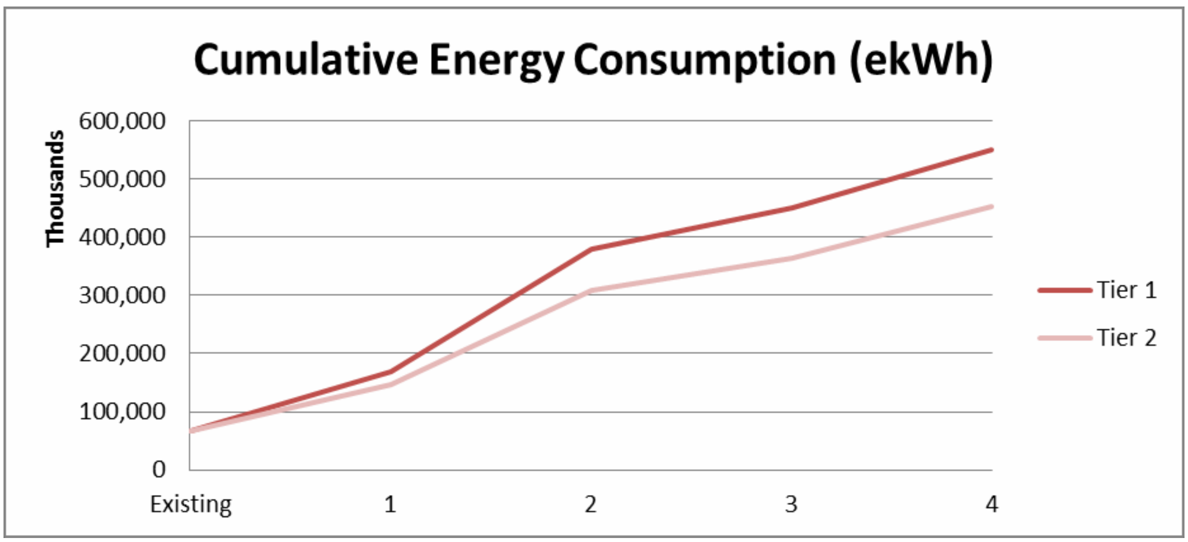


Figure 6. Energy savings associated with Tier 2 TGS.

Lands that would be redeveloped by Waterfront Toronto would also be subject to Waterfront Toronto's Minimum Green Building Requirements (MGBRs)[8]. Whereas the

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7 http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=f85552cc66061410VgnVCM10000071d60f89RCRD

8 http://waterfrontoronto.ca/nbe/wcm/connect/waterfront/21691f61-b2dc-4d59-a1d2-0e3fc92b2218/mgbr_v2_august_2012_1.pdf?MOD=AJPERES

Energy Use Intensity (EUI) of a typical TGS Tier 1 building would be approximately 200 $ekWh/m^2/year$, the current Version 2.1 of the MGBRs is closer to 135, equivalent to a 33% reduction in energy consumption on an annual basis.

While Waterfront Toronto's MGBRs would represent a significant improvement in energy consumption, there are a host of voluntary and mandatory energy codes in other jurisdictions worldwide, the most aggressive of which tend to be found in Western Europe. Integral Group completed a study in 2015 for the City of Toronto on global best practices in energy efficiency standards and Examples indicate that buildings should be approaching EUIs of at least 100 ekWh/m2/year[9], which would represent a 50% improvement compared to the typical Tier 1 building.

Toronto Green Standard Version 3.0

The next version (3.0) of the TGS is currently being developed by City Planning staff and is anticipated to be in-force early 2018. Under consideration are more aggressive energy use intensity targets, as well as new targets for thermal energy demand intensity and GHG emission intensity (Figure 7).

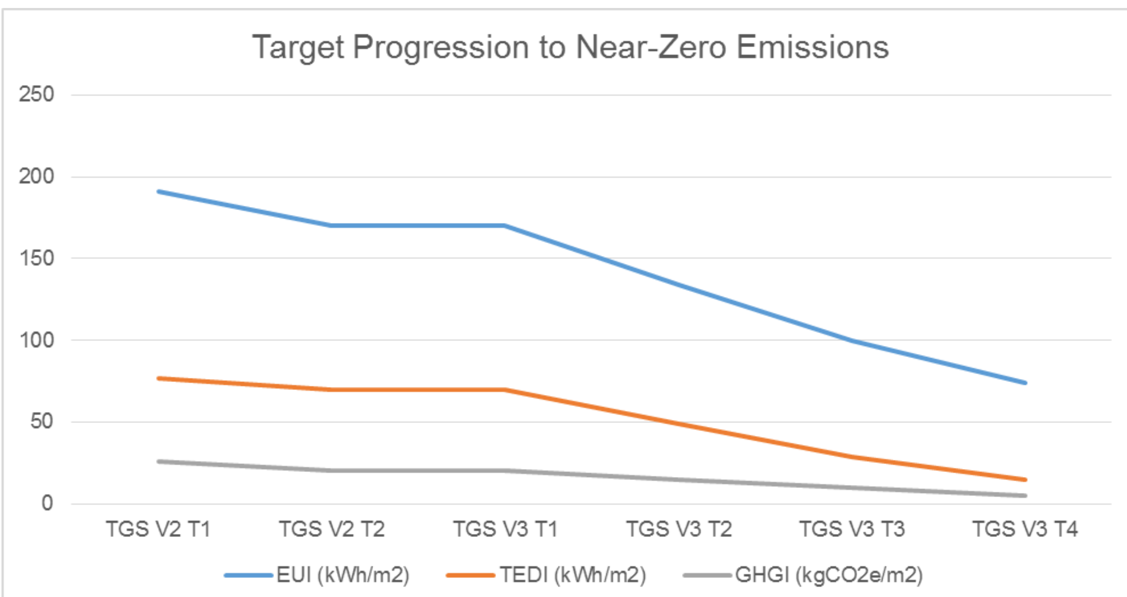

Figure 7. Toronto Green Standard Version 3 proposed targets.

In support of the City's 2050 emissions target, it is expected to establish a roadmap to zero emissions new development by 2030. The intent is to update the TGS every four years such that by 2030, TGS V3 T4 would be TGS V6 T1. Connection to low-carbon district energy systems and resilient design are also expected to be key components of TGS V3.

9 https://www1.toronto.ca/City%20Of%20Toronto/City%20Planning/Developing%20Toronto/Files/pdf/TGS/Global%20Best%20Practices%20in%20Energy%20Efficiency%20Policy%20July%2016%202015.pdf

4.2. Low-Carbon Solutions

Reducing energy consumption cannot alone achieve net zero – local energy supply must provide the required remaining energy. Further and as mentioned, this report also interprets zero net energy import to mean low-carbon solutions, ideally approaching zero emissions. The added benefit of deep consumption reductions is that when less energy is required overall, low-carbon/carbon neutral solutions can make a larger contribution to the energy supply.

4.2.1. Building-scale renewable energy

At the scale of individual buildings, there are several viable low-carbon energy supply options that can be integrated into buildings, including:

- Solar photovoltaic (PV) and solar thermal systems
- Geo-exchange systems
- Biomass boilers/combined heat and power (CHP)

Rooftop Solar PV

Figure 8 indicates the estimated solar PV potential for the Port Lands, assuming that 50% of the roof space is available and not considering other competing objectives such as biodiversity and providing green roofs, or constraints such as amenity space, shading etc.

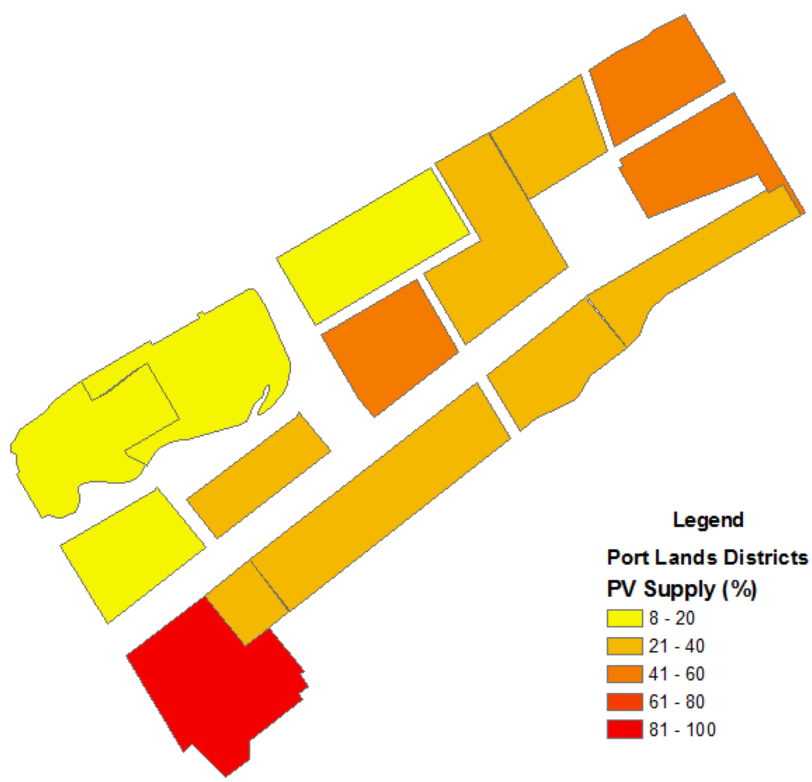

Figure 8. Estimated rooftop solar PV potential for each precinct/block in the Port Lands.

Actual contributions would vary from building to building given differences in massing. For example, given the expected density and building heights in the Lower Don Lands, solar PV potential is limited (more floors, but same roof space), but in the East Port or South Ship Channel, where there is substantial existing roof space and where new buildings will be of a larger scale, potential is much greater.

Advances in building-integrated PV (where the solar panels form part of the building envelope) will increase the potential for electricity generation over time.

Geo-exchange

Geo-exchange can potentially contribute a significant amount of thermal energy, but will also increase electrical demand due to the use of heat pumps. Currently, there is limited electrical capacity in the area. To achieve net zero, additional electricity would have to be generated locally to feed geo-exchange systems. Given that the Port Lands sits on lake-fill, the loops would need to be installed into bedrock to allow for efficient heat transfer. Further investigation, beginning with geotechnical studies, is necessary.

Biomass

Locally sourced biomass that replaces fossil fuels would contribute towards achieving net zero. In the Port Lands, using waste wood stored at nearby City of Toronto yards, or sugarcane crop residues shipped to the Redpath sugar refinery to replace natural gas could be a viable low-carbon biomass opportunity.

The economic feasibility of any biomass solution depends heavily on a sustainable fuel supply, however. Staff from the EED are currently investigating the potential use of waste wood (construction waste, downed trees, etc.) as a viable fuel source in Toronto. To identify specific opportunity in the Port Lands more detailed analysis will be needed.

Summary

Building-scale solutions could contribute 10-15% of low-carbon energy supply, potentially more depending on whether a nearby, stable biomass fuel source exists and what any future geotechnical studies reveal. Actual contributions will vary from building-to-building, but the average contribution will be limited due to technical and cost considerations. However, this assumes the application of current technology, which will become more efficient and less expensive over time, thus increasing contributions to energy supply.

4.2.2. Block- and District-scale Renewable Energy

Sharing energy at the block or larger scale has the potential to make a much more substantial contribution to low-carbon energy supply because it provides the platform necessary to cost-effectively incorporate large renewable energy sources, such as lake water-cooling and sewer heat recovery. A thermal network that connects buildings can take advantage of:

- Heat recovery from sources including sewers, power plants, industries, ice rinks
- Heat sinks such as Lake Ontario (e.g. Enwave's Deep Lake Water Cooling System)
- Efficient biomass combined heat and power plants

Figure 9 identifies several existing heat sources and sinks in the Port Lands, including the lake, industrial facilities, the Portlands Energy Centre and the Ashbridge's Bay Wastewater Treatment Plant. These opportunities require more detailed investigation, particularly heat recovery from existing facilities and the prospects for lake water-cooling.

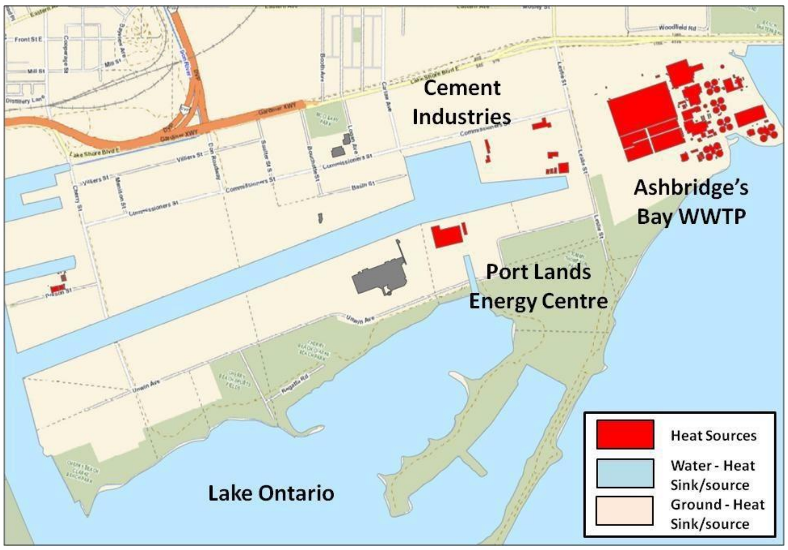

Figure 9. Existing heat sources and sinks in the Port Lands. In red are several facilities with heat recovery potential. This includes cement industries, the Portlands Energy Centre and the Ashbridges Bay WWTP. Lake Ontario is a major heat sink, which is an opportunity for lake water-cooling in the Port Lands.

Given the expected long-term redevelopment of the Port Lands, there may also be an opportunity for larger scale electricity generation from ground-mounted solar PV on vacant lands as an interim measure, until such a time as the lands redevelop.

Heat recovery from new facilities

New facilities such as data centres and ice rinks, owing to their substantial cooling requirements, often make excellent sources of waste heat as well. A 2009 report prepared for the City of Toronto by Halsall Associates found that the average data centre consumes the energy equivalent of 25,000 North American households, much of which is used to keep equipment cool year-round[10]. This generates significant waste heat, which can be recovered to heat nearby buildings.

The Port Lands Community Infrastructure Strategy has identified that an arena should be provided either in the East Port or south of the Ship Channel. Currently, Ports Toronto is

[10] City of Toronto Green Data Centre Case Study Report (May 15, 2009 report by Halsall Associates for the City of Toronto)

exploring leasing a portion of their site south of the Ship Channel for a two-pad hockey arena/skating centre. Again, year-round cooling of the ice produces substantial waste heat that can also be recovered. These and other opportunities will be studied further as more information is gathered.

Lake water cooling

Lake Ontario provides a nearby heat sink for cooling, which Enwave Energy Corporation takes advantage of to cool downtown office towers (Figure 10). The Deep Lake Water Cooling (DLWC) system currently cools approximately 2.5 million m^2 of GFA, equivalent in size to a fully built-out Port Lands. This cooling system reduces electricity consumption by 90% and electricity demand by 61 MW, which is roughly three times as large as the calculated 20 MW cooling demand for the fully built-out Port Lands[11].

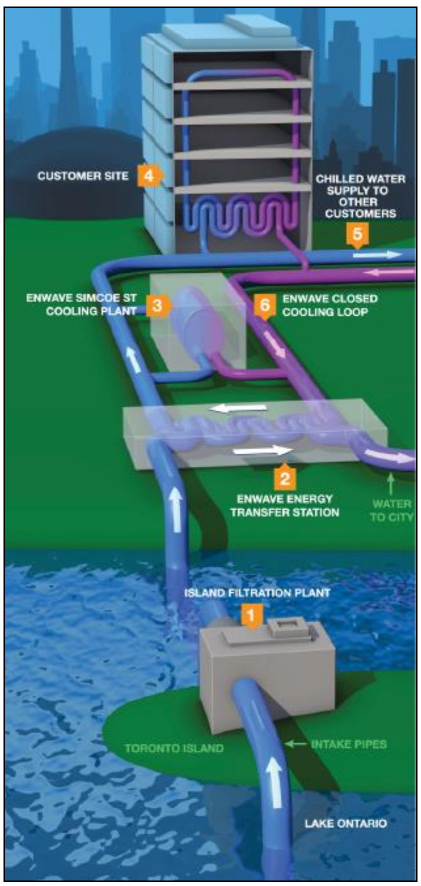

Figure 10. How the Enwave Deep Lake Water Cooling systems works.

1) Three intake pipes draw 4°C water from Lake Ontario at a depth of 83 metres. Water is then filtered and treated for the City's potable water supply.
2) At the Energy Transfer Station, the icy cold water is used to cool Enwave's closed chilled water supply loop through 36 heat exchangers.
3) During the colder months, chilled water bypasses Enwave's cooling plant and continues onto the customer's building.
4) At the customer's site, the water is used to provide comfort cooling for building occupants.
5) Enwave chilled water loop extends to other buildings.
6) Chilled water is returned to the Enwave Transfer Station to repeat the cycle.

Source: Enwave Energy Corp./Brookfield Inc.

Heat recovery from local power production

CHP is electricity generation and simultaneous waste heat recovery, which can be used to fully or partially satisfy space heating and/or domestic hot water needs. CHP can achieve efficiencies of 80-90% compared to 35-50% for a modern power plant (Figure 11).

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[11] Data courtesy of Enwave Energy Corporation

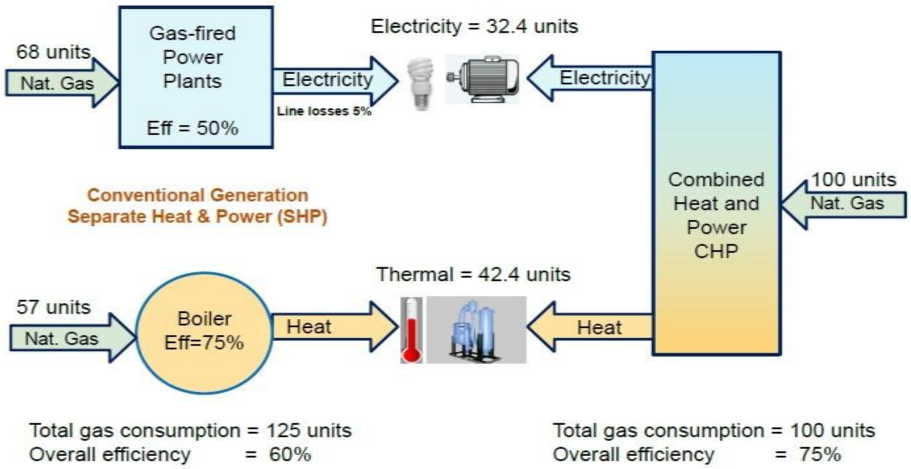

Figure 11. CHP versus conventional, separate heat and power. CHP uses less fuel to produce the same amount of heat and power when compared to separate power plants and boilers. Since CHP is more efficient overall, it is less carbon intensive as well (Source: "How CHP Systems Save Fuel and Reduce CO_2 Emissions" – June 24, 2015 presentation by Tim Short & Aqeel Zaidi to Ontario CHP

High efficiency CHP has double the efficiency and half the GHG emissions compared to the gas power plants used only to generate electricity. The implementation of small, load-displacing CHP has proven successful in several instances in Toronto, generating internal rates of return greater than 10%.

Heat can often be recovered from power generation and industrial activities for use in nearby buildings. The Portlands Energy Centre (PEC), which combusts natural gas to generate electricity, is an example of a power plant where excess heat could be recovered at the power plant stack and distributed through a thermal network.

The PEC has the capacity to heat approximately 300,000 m^2 of floor area[12], but it is not designed for this purpose and is located far from planned initial developments. As it approaches its end of life in 30 years or so, there may be an opportunity to reconfigure it as a CHP to heat nearby buildings that develop over time.

Low-carbon thermal energy networks

A thermal network is not a technology; it is a thermal energy distribution strategy for multiple buildings. Modern thermal energy networks are often co-located with other infrastructure such as parks, transit, and sewer lines (Figure 12) in order to access local renewable energy sources.

[12] http://www.toronto.ca/legdocs/2006/agendas/committees/pof/pof060620/it015.pdf

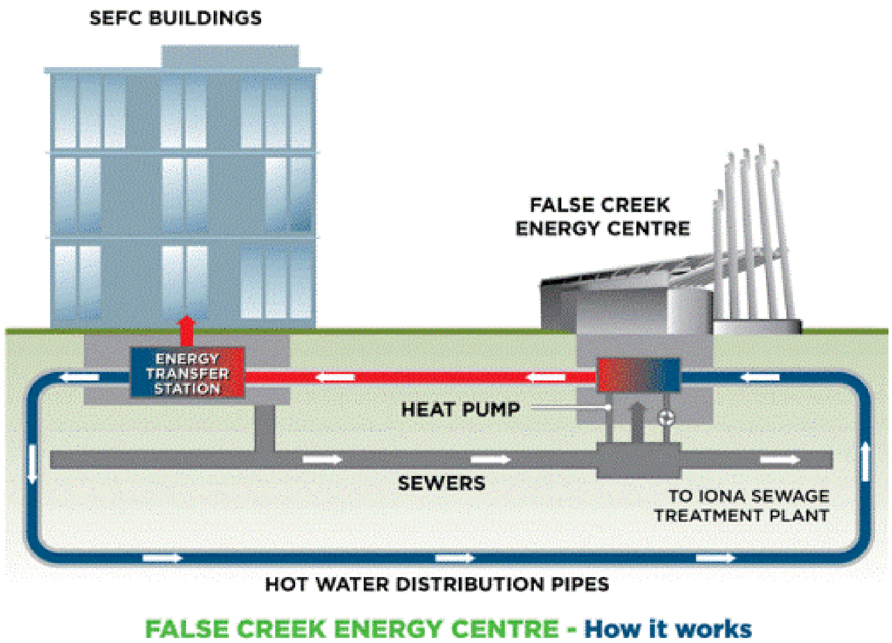

Figure 12. Sewer heat recovery at the False Creek Energy Centre, Vancouver, BC. The system uses heat pumps to extract heat from sewage before treatment. This provides 70% of the needed heat for connected buildings, with the remaining 30% from natural gas boilers, and reduces overall GHG emissions by 60%. With plans for new wastewater networks serving the Port Lands, sewage could also provide a significant and stable heat source. EED staff are currently working with Toronto Water to map out and quantify sources of low-carbon heat city-wide (Source: City of Vancouver)

Thermal networks are often designed with distributed energy centres in buildings and pipes crossing streets to connect development parcels/buildings. Critical to their success is attracting private investment from energy developers, just-in-time capital outlays, flexibility to grow the network over time, and buildings designed for connection.

This approach is being taken in the Etobicoke Civic Centre (ECC) Precinct – formerly the Westwood Theatre Lands – a brownfield being master planned by Build Toronto (Figure 13 on the following page). EED staff worked with Transportation Services to design a thermal energy network based on the interchange reconfiguration[13] and pipe installation at road crossings has been tendered by Engineering & Construction Services[14]. EED staff continue to work with Build Toronto to ensure new buildings, including the ECC, connect to the system[15].

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[13] http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=6084a0bdbd309510VgnVCM10000071d60f89RCRD

[14] http://www.toronto.ca/legdocs/mmis/2016/pw/bgrd/backgroundfile-98273.pdf

[15] http://buildtoronto.ca/wp-content/uploads/2016/12/ECC-RFSQ_CallDocument_Dec21.pdf

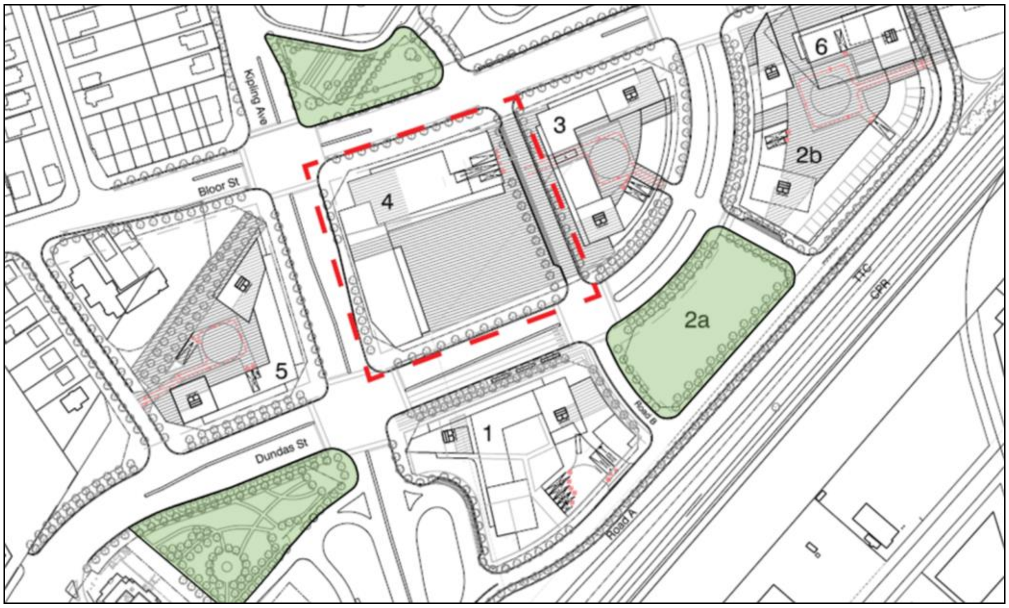

Figure 13. Master planning of the ECC Precinct is an opportunity for the City of Toronto to plan for a net zero district. By designing the new Etobicoke Civic Centre building for very low energy use (e.g. TGS V3), and using it as the anchor for a low-carbon thermal energy network, the ECC can become a net zero district. (Source: Etobicoke Civic Centre Design Competition - Stage 1 Request for Supplier Qualifications)

Strategic Partnership for Low-Carbon Thermal Network Development

The City of Toronto recently closed a Request for Proposals to obtain advice from the market place on partnership approaches to developing low-carbon thermal energy networks in Toronto[16]. The intent is to partner with one or two companies to accelerate and scale-up low-carbon thermal energy network development city-wide, including the Port Lands.

The emergence of energy developers presents an opportunity for strategic partnerships with these companies, where they take on the responsibility of designing, building, financing and operating the systems, and the City acts as a facilitator, policymaker, and champion.

Microgrids

Microgrids are the electrical version of thermal networks, distributing electricity to multiple buildings instead of water or steam. They are local grids, often connected to, but distinct from, the larger distribution network. In Toronto, their application has so far been limited mostly to sites with a single landowner (e.g. university and hospital campuses).

Connecting multiple buildings to a microgrid allows for increased penetration of distributed generation such as solar PV and CHP, especially in mixed-use areas. Furthermore, they can improve resilience if they are designed to operate independently from the distribution grid during a power outage.

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[16] http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2016.EX18.15

With requirements for new electrical infrastructure, regeneration and renewal in the Port Lands presents an opportunity to implement a microgrid. As corridors for thermal networks are considered, similar consideration should be given to opportunities for microgrid infrastructure.

Summary

It is projected that these block-scale solutions could contribute at least 50% of the energy supply required after aggressive energy conservation in buildings. Block-scale solutions will be essential to achieving a low-carbon energy supply in the Port Land. The size and cost of block-scale solutions, however, means that they cannot be implemented in advance of development; instead, physical space can be reserved for networks and energy centres so that capital can be deployed as needed.

4.2.3. Opportunities Beyond Buildings

Water consumption/wastewater production, solid waste management, and transportation choices account for much of the energy use and emissions not associated directly with buildings. Redevelopment and new municipal infrastructure will provide opportunities to reduce the carbon intensity of water, waste and transportation over time.

Water & Wastewater

Pumping and treatment of lake water requires a substantial amount of energy, thus producing emissions. In the Port Lands, pumping requirements are anticipated to be minimal given proximity to the lake, so the bulk of this energy will be electricity and gas consumption for sewage treatment at the Ashbridges Bay Wastewater Treatment Plant, as shown in Table 1.

Table 1. Ashbridges Bay WWTP Energy Use and Emissions (2012)

Operation Name	Address	Avg Hours /Week	Annual Flow (ML)	Electricity (kWh)	Natural Gas (m3)	Steam (GJ)	Chilled Water (GJ)	GHG Emissions (Kg)	Total Energy (GJ)	Energy Intensity (ekWh/ML)
Ashbridges Bay	1091 Eastern Ave / 9 Leslie	168	210,816	114,690,500	4,545,260	0	0	19,608,267	588,550	775.49

Source: City of Toronto Annual Energy Consumption & Greenhouse Gas Emissions Report (2012)[17]

The Port Lands and South of Eastern EA is considering a satellite treatment facility for a portion of the lands south of the Ship Channel. Should a facility such as this be constructed in the Port Lands, this would provide an opportunity for energy production

[17] http://www1.toronto.ca/City%20Of%20Toronto/Environment%20and%20Energy/Action%20Plans,%20Policies%20&%20Research/PDFs/2012_energy_consumption_GHG_emissions%20report.pdf

associated with black water treatment. Currently, provincial regulations are stringent with respect to satellite facilities and Toronto Water would be required to either guarantee to maintain and operate a private facility or cost of connecting these lands to the ABTP would need to be substantial to warrant a separate facility.

Reducing Energy Use from Water Treatment

As the electricity grid decarbonizes, emissions associated with water use are predominantly due to natural gas consumption, both at the treatment plant, as well as in buildings for domestic water heating. Therefore, opportunities to reduce gas use and associated emissions include, but are not limited to:

- Reducing hot water consumption – Low-flow kitchen and bathroom fixtures, as well as low flow appliances, can significantly reduce water use
- Reducing natural gas consumption – High efficiency boilers and solar thermal systems can reduce natural gas consumption for water heating; biogas can displace natural gas use altogether
- Reducing/offsetting wastewater treatment energy – Improved stormwater management and greywater recycling for non-potable uses or irrigation reduces the amount of water sent to treatment plants, thus reducing energy used for treatment

Solid Waste

Solid waste management, including collection, separation, processing and landfilling, has a large energy and carbon footprint: trucks emit carbon dioxide; transfer stations require electricity and natural gas to operate; and landfills emit large amounts of methane[18] (Figure 14 on the following page). Furthermore, the Green Lane Landfill that Toronto sends its garbage to is quickly reaching its maximum capacity.

[18] http://www.owma.org/Portals/2/Cover_Page_Image/OWMA%20GHG%20Report%20December%202015.pdf

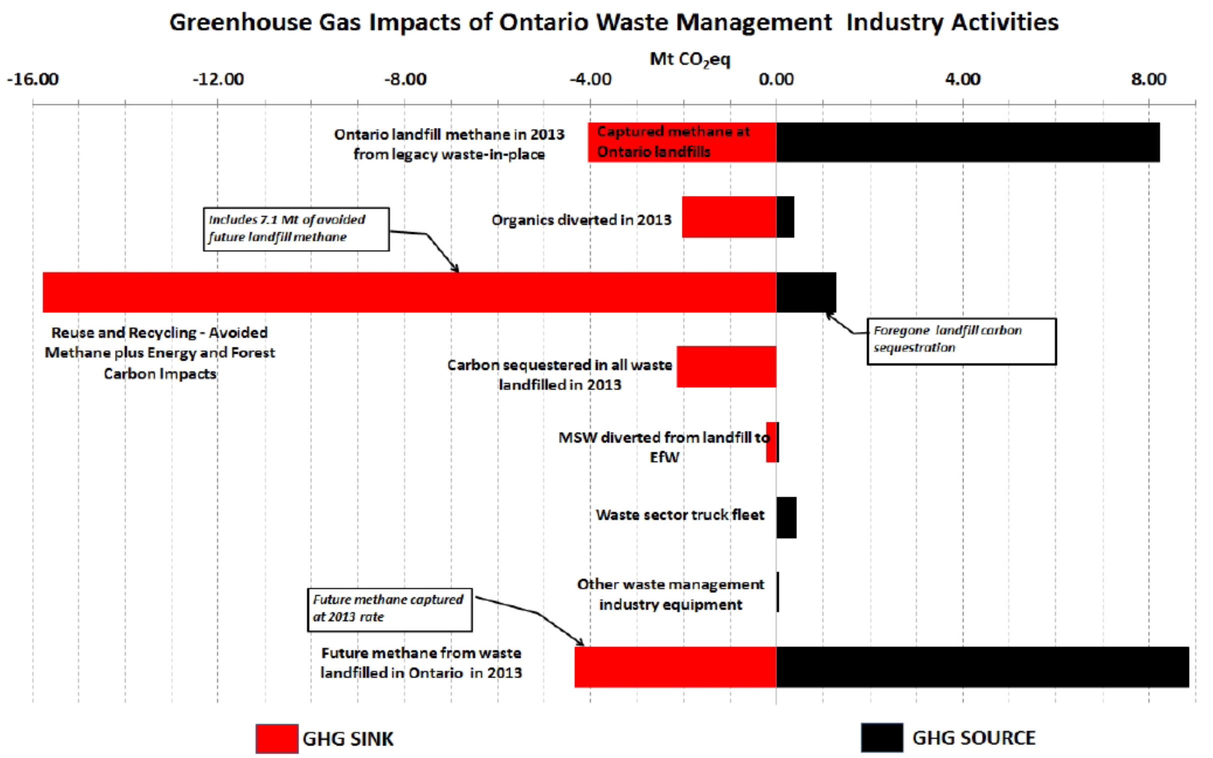

Figure 14. GHG Emissions and the Ontario Waste Management Industry in 2013 (Source: OWMA, 2015)**.**

City Council approved a Long-term Waste Management Strategy for the entire city in 2016[19]. The strategy provides a framework for solid waste management decisions in the future. It recommends various policies and programs, including how to manage any leftover garbage remaining after reusing, recycling, and composting.

Energy Recovery

Recovering the energy remaining in waste streams after first reducing, reusing and recycling as much as possible, is part of Toronto's Waste Hierarchy. Energy recovery will be a key aspect of achieving zero waste export from the Port Lands if this is pursued. Notwithstanding massive reductions in waste production, strategies will be required to manage the remaining waste streams within the area, and energy recovery is one possible opportunity to help avoid the landfill.

Transportation Choices

The Port Lands and South of Eastern Transportation and Servicing Master Plan is advancing a progressive transportation strategy for the area. The Environmental Assessment (EA) will identify the preferred street and transit networks. Additional, active

19 http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=b2fe8005b7ae7410VgnVCM10000071d60f89RCRD

transportation routes are also being explored by Waterfront and the City through ongoing planning. The City Planning Division developed Complete Street Principles to inform the EA, and conceptual cross-sections that balance and prioritize transit and active transportation have been developed.

Low-carbon transportation choices

A path towards low carbon transportation starts with planning for transit-supportive development such as mixed-use and complete communities (live/work/play) to reduce overall transportation demand through prioritizing walking and cycling, as well as transit, over private vehicle use.

Figure 15 shows travel modes for commuting downtown[20]. There is currently a 75% modal split downtown in favour of walking, cycling, and transit. A 72% mode split is contemplated in the EA currently underway based on different service being contemplated in different areas of the Port Lands.

Additional opportunities to increase the transit modal spit may result from future transit initiatives that are in proximity to the Port Lands, including the Downtown Relief Line, Smart Track and Metrolinx projects.

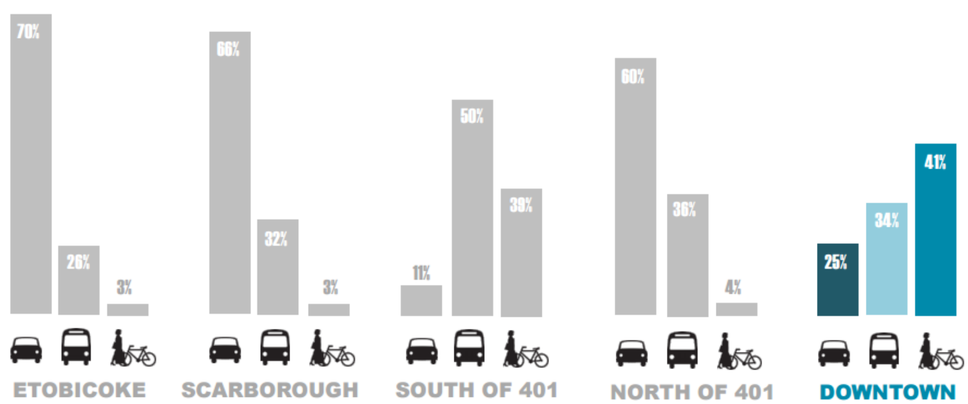

Figure 15. Modal Split of different areas of Toronto compared to Downtown
(Source: TOcore Overview Presentation - April 2015)

Increasing the modal split towards active transportation and transit has the following benefits:

- Walking and cycling are not only free of GHG emissions, but also promote healthy lifestyles.

20 http://www1.toronto.ca/City%20Of%20Toronto/City%20Planning/Core/File/pdf/Website_powerpoint_april212015.pdf

- Higher order transit (light rail, street cars) is powered by electricity which tends to be a low-carbon alternative to fossil fuel mobile fuels (diesel and gasoline)
- Planning for auto share and vehicles for personal transportation to be electric would further reduce fossil fuel use in the Port Lands, and can benefit the electric grid when used for storage.

For illustrative purposes, Figure 16 shows the different carbon intensities for various passenger travel options[21]. Considering that the Port Lands has and will continue to have significant truck use for commercial and industrial operations, prioritizing electric car sharing and personal vehicles is an important way to reduce the emissions contributions associated with vehicle use.

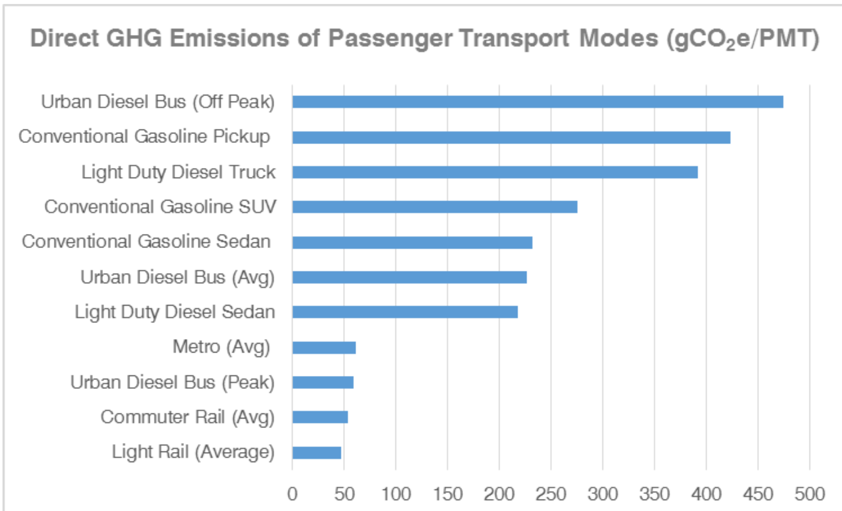

Figure 16. Direct GHG Emissions from various passenger transport modes in grams of carbon dioxide per passenger mile travelled. Considering only direct (i.e. operational) GHG emissions, single occupant vehicles are generally the most carbon intensive and public transport the least, except for diesel buses used during off-peak hours. Though based on US data, the relative intensities would be similar for Toronto. However, electrified rail transport would likely be less carbon intensive as Toronto's electricity supply is less carbon intensive than San Francisco's, New York's and Chicago's, which this data is based on. (Adapted from Chester & Horvath, 2009)

4.3. Energy Resilience

Resilience is a key aspect of energy planning that is independent of energy efficiency. Extreme weather events, which are expected to occur more frequently and be more intense in Toronto[22], have the potential to cause sustained, area-wide power outages as witnessed during the December 2013 ice storm. Therefore, no matter how efficient a

[21] http://www.its.berkeley.edu/sites/default/files/publications/UCB/2009/VWP/UCB-ITS-VWP-2009-2.pdf

[22] http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=b8170744ee0e1410VgnVCM10000071d60f89RCRD

building, it should have backup power systems designed to provide safety and a degree of comfort to occupants so they can remain in their building when grid power supply is disrupted.

4.3.1. Backup Power Guidelines for MURBs

Minimum codes for standby power systems in multi-unit residential buildings (MURBs) have not changed significantly in the last 30 years, so they are not typically designed to deal with area-wide (i.e. non-emergency) power outages. The EED engaged Hidi Rae Consulting Engineers to prepare business cases to improve MURB standby power systems, including retrofit opportunities for existing buildings and design guidelines for new buildings[23]. The report found that resilience can be improved in many MURBs at a low incremental cost. For example:

- Powering domestic water booster pumps and hot water boilers to provide hot and cold water to units can be done is most new MURBs with little added cost.
- Additional elevators can be powered to allow residents to move freely throughout the building.
- In both existing and new buildings, where it is cost-prohibitive to backup all systems, common areas such as lobbies or amenity spaces can be converted to refuge areas, which have heating, cooling and convenience electricity.

EED staff recently adapted the business cases report into "Minimum Backup Power Guidelines for MURBs"[24].

The report also recommended that natural gas generators (Figure 17 on the following page), though approximately 10-15% more expensive than diesel systems, are the preferred solutions for backup power because they offer indefinite run time (i.e. no refuelling) and are less prone to failure.

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23 http://www1.toronto.ca/City%20Of%20Toronto/Environment%20and%20Energy/Programs%20for%20Businesses/BBP/PDFs/City%20of%20Toronto%20Back-up%20Power%20Report.pdf

24 http://www1.toronto.ca/City%20Of%20Toronto/Environment%20and%20Energy/Programs%20for%20Businesses/BBP/PDFs/Minimum%20Backup%20Power%20Guideline_October%202016.pdf

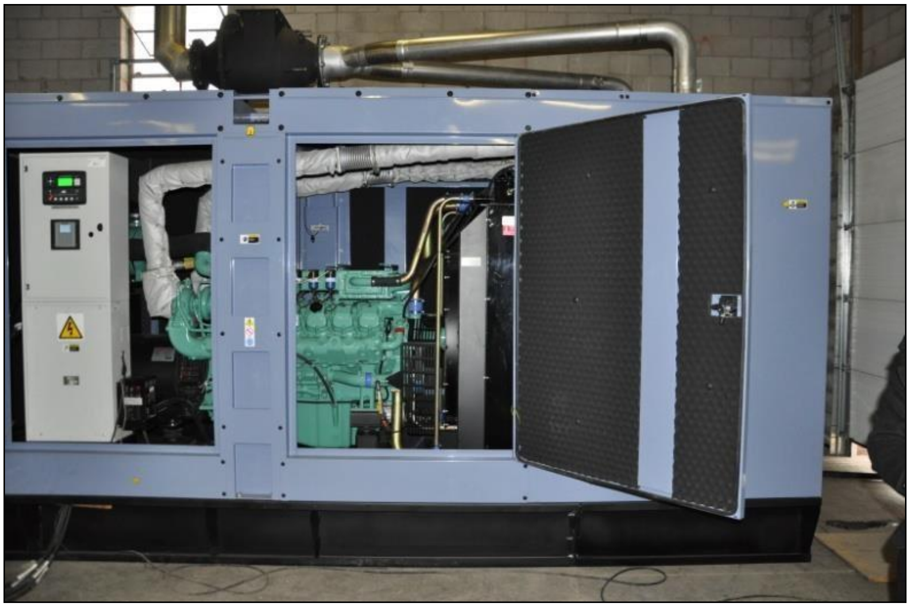

Figure 17. Packaged, 400 kW natural gas-fired generator. Natural gas-fired generators, such as the unit pictured above, are a proven technology that is commercially available. Though more expensive that typical diesel generators, they are more reliable and resilient.

Solar PV and other renewables, combined with energy storage systems, can also be used to provide zero-emission backup power to buildings. Over time, with the price of solar PV-generated electricity approaching grid parity and the cost of battery storage systems declining, such systems could be implemented to help strengthen resilience.

4.3.2. Community Reception Centres

City of Toronto Community Centres, as well as facilities run by other community organizations (e.g. YMCA), can greatly improve the resilience of a particular area by doubling as a Reception Centre for people displaced from their homes by power outages, especially during extreme weather events when shelter is essential.

Four Community Centres (one in each district of the city) have now been permanently designated as Reception Centres[25] and efforts are currently underway to upgrade/ augment standby power systems to allow for longer operation in the event that they are needed to receive displace individuals.

The Port Lands will include new communities with a minimum of two community centres proposed. Additional community infrastructure is proposed that could serve as Reception Centres in the event of a power outage. Subject to discussion with Parks, Forestry and Recreation staff, any new facilities in the Port Lands should be considered for designation for Reception Centres and provide shelter during sustained power outages.

25 http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=8151a394b236a410VgnVCM10000071d60f89RCRD&vgnextchannel=84a7e03bb8d1e310VgnVCM10000071d60f89RCRD

5. Conclusion

Regeneration and renewal in the Port Lands presents a unique opportunity to achieve a net zero district. The scale of new development contemplated, supporting infrastructure investments, and the lakefront location, combine to create an opportunity not found elsewhere in Toronto.

Achieving net zero relies on two key strategies: first, significant reductions in building energy consumption, particularly in new buildings; second, widespread deployment of local, low-carbon solutions at the building, block, and even district-scale. The chart below summarizes and represents the guidelines to achieve net zero, with the size of the wedges indicating the magnitude of the contribution.

Reduced energy consumption in buildings

- New buildings designed to meet strict energy standards can help reduce energy consumption by at least 30%. Deep retrofits to existing buildings, including heritage structures, would further reduce energy consumption.
- Codes and standards are expected to continue to steadily become more stringent, which will lead to incremental improvements in energy efficiency over time.

Low-carbon, local energy supply solutions

- Low-carbon solutions for individual buildings can contribute at least 10-15% of local energy supply towards net zero.
- Block- and district-scale energy sharing networks that leverage large-scale renewable energy sources can contribute over 50% of the needed energy supply towards net zero.
- Reducing water consumption, increasing solid waste diversion, and low-carbon transportation choices like walking, cycling and the use of public transit and electric vehicles can further reduce energy use and emissions.

Improved resilience to power outages

- Multi-unit residential buildings with backup power systems will ensure that residents can remain in their homes for extended periods of time during power outages.
- Recreation Centres can serve as Community Reception Centres for people displaced by power outages.

Summary

Decisions made early, particularly the initial EUIs chosen and easements for thermal networks, are essential for achieving a net zero district. Improvements to codes and standards and existing buildings are likely to occur incrementally. Further, many building-scale solutions can be implemented subsequent to development occurring. However, ensuring substantially reduced energy use in buildings and thermal network development over time, requires upfront commitments.

6. Recommendations

The net zero guidelines provided in this report are qualitative, designed to highlight critical, early decisions needed to achieve a net zero district in the Port Lands over time. The recommendations also identify future follow-on work that will be necessary to better understand opportunities and challenges of realizing net zero energy import in the Port Lands.

Reducing energy consumption in buildings

1) Building on the success of the Toronto Green Standard and Waterfront Toronto's Minimum Green Building Requirements, establish require passive design requirements to further reduce energy consumption.

Building-scale renewable energy solutions

2) Explore opportunities for building-scale renewable energy solutions to address building energy consumption or demand that cannot be addressed through efficiency measures. Such solutions include, but are not limited to:
    g. Solar PV
    h. Wind
    i. Geothermal
    j. Biomass
    k. Lake water cooling
    l. Waste heat recovery

Block-scale energy networks

3) Identify, designate and reserve easements for energy networks, including rights of way for linear infrastructure.
4) During more detailed planning exercises, identify, designate and reserve strategically located small parcels (underground or above ground) for low-carbon energy solutions, which may include:
    e. Lake water cooling energy transfer stations
    f. Sewer heat energy transfer stations
    g. Solar PV systems
    h. Biomass combined heat and power plants
5) Create a framework for energy network implementation, including reference to business models (i.e. franchise, lease), easements, and reserved development parcels to attract private investment from energy developers for energy solutions towards a net zero district.
6) Explore opportunities and approaches that would encourage developers to invest in energy network-ready buildings, and building-scale energy plants designed to share energy with neighbouring buildings.

Resilience to climate change and other disruptions

7) Explore opportunities to strengthen resilience to power outages in multi-unit residential buildings, including, but not limited to:
    d. Powering additional loads such as domestic water pumps and elevators
    e. Creating refuge areas
    f. Backup power systems designed for at least 72 hours of continuous operation
8) Identify and designate community reception centres within the Port Lands

Low-carbon transportation

9) In accordance with direction emerging through the Port Lands and South of Eastern Transportation and Servicing Plan, ensure transit-supportive development and complete streets with high-quality pedestrian and cycling amenities to reduce reliance on the personal automobile;
10) Provide the necessary infrastructure and space allocation in buildings to support electric personal vehicles and car sharing fleets.

Water and wastewater

11) Encourage highest levels of water conservation through low-flow fixtures and water efficient appliances
12) Explore opportunities for grey water recycling systems within buildings to avoid using high quality and energy intensive drinking water for non-potable purposes (e.g. toilets flushing irrigation, etc.)
13) Explore opportunities for heat exchange with water infrastructure, including heat exchange with water supply mains and pumping stations, as well as heat recovery from sewage pumping stations, sewer lines, and buildings drains

Solid waste

14) Encourage highest levels of solid waste diversion consistent with the City's Long-term Waste Management Strategy

Innovation

15) Due to the long-range nature of the Port Lands Planning Framework, ensure continued flexibility such that innovations and emerging technologies, at the building, block, precinct and/or Port Lands scales, can be implemented over time and that would further contribute to the objective of achieving a Net Zero district.

Integration with other plans and studies

16) Ensure that other studies in the area which may be on-going or that are to come, consider the opportunities identified in this energy plan and integrate them towards a Net Zero district.

Follow-on work

Building on this Community Energy Plan, EED staff will work with City Planning and Waterfront Toronto to undertake a feasibility study to determine the optimal approaches for a low-carbon/renewable thermal energy network, including front-end engineering designs, business cases and implementation strategies. These analyses will include:

- Evaluation of potential low-carbon energy sources in and around the Port Lands, including estimates of magnitudes and associated emissions reductions
- Approximate locations for linear infrastructure and distributed energy centres, including potential co-location with other infrastructure (e.g. sewers, transit, parks)
- Life cycle costing for various engineering design options
- Delivery models that take into account development and infrastructure phasing
- Changes to relevant policies/regulations

Appendix 1 – Model Sustainable Communities

Consideration was given to those (existing and planned) communities with local, low-carbon solutions, as well as a scale comparable to either the Port Lands, a precinct within the Port Lands, or a block within a precinct. The table summarizes the results from the review of key model communities.

The Blatchford redevelopment in Edmonton is a Canadian example of comparable size and context, which has a dual-mandate for carbon neutrality and 100% renewable energy. Most of the information pertaining to this community was obtained through a phone call with the Blatchford Redevelopment Office.

Model Sustainable Communities

Scale	Community	Description	Comparison	Key Strategies
Port Lands	**Blatchford**	217 hectare former airport in Edmonton, being redeveloped into mixed-use community	Smaller, with less planned density and expected population, but similar total GFA	Low EUI in buildings, ambient district energy sharing system, 100% RE
	Hammarby Sjöstad	250 hectare industrial harbour outside Stockholm revitalized for Olympic bid	Slightly smaller, but similar population and unit count	Aggressive low EUI in buildings + thermal network with WWTP heat recovery and CHP
	HafenCity	157 hectare industrial harbour in Hamburg – population intensification	Half the size, but similar residential population and total GFA	Aggressive low EUI in buildings + thermal networks with high renewable fractions
Precinct	**West Village at UC Davis**	52 hectare, planned net zero development for students, faculty, staff	Similar land area as *Lower Don Lands*, but mostly low-rise residential	Advanced building envelopes + hybrid solar systems (Almost net zero – 87%)
	Vauban	38 hectare residential redevelopment of former military barracks outside Freiburg	Similar land area as *Film Studio District*, but mostly low-rise residential	Aggressive low EUI in buildings + extensive solar PV
Block	**La Cité Verte**	9.3 hectare residential redevelopment of heritage buildings in Quebéc City	Similar land area as *South River* block, but much less dense	Biomass district heating + underground vacuum-based waste collection
	Dockside Green	6.1 hectare brownfield development on Victoria waterfront – LEED Platinum	Similar land area and total GFA as blocks in *Turning Basin District* north of Commissioners Street	On-site WWTP and biomass CHP

Hammarby Sjostad

- Industrial harbour outside of Stockholm, Sweden, that was revitalized for 2004 Olympic bid
- 250 hectare mixed-use development
- By 2017:
    - 28,000 residents (12,000 units);
    - 10,000 employees (200,000 m^2 commercial GFA)
- Predominantly mid-rise built form
- Overarching goal is to demonstrate modern urban development based on ecological principles

Key strategies

- Aggressive, low EUI: 72 $ekWh/m^2$ avg. building performance
    - Approx. 46% reduction in emissions and water consumption from BAU
- Thermal network with CHP and multiple energy sources
    - Waste incineration
    - Heat re-use from local wastewater treatment
    - Household waste digestion
- Extensive rooftop solar PV
- Underground vacuum solid waste collection

HafenCity

- Industrial harbour in central Hamburg, Germany, being revitalized to accommodate population growth without consuming more land
- 157 hectare mixed-use development
- By 2025:
    - 12,000 residents; 45,000 employees
    - 2.32 million m^2 GFA (approx.. 50% office space)
- Mostly mid- and high-rise built form
- Goals include contributing to Hamburg's emissions reduction targets and exemplifying sustainable development

Key strategies

- Building performance standard called the "Ecolabel" (sets CO_2/energy consumption levels)
    - Benchmarked to Germany's EnEv2009; Passivhaus required for residential construction
- West precinct: **Thermal network with CHP**, geothermal, solar thermal and pilot fuel cell project (92% renewable);
- East precinct: Thermal network with decentralized production including **biomass CHP**, biomethane fuel cells, gas CHP, and geothermal
- Extensive solar PV

West Village at UC Davis

- Greenfield development to house, students, faculty and staff of UC Davis, California
- 52 hectare low-rise residential development
- 3,000 residents (600 units); 4,000 m^2 commercial GFA; 500 single-family homes
- Largest planned net zero community in the United States

Key strategies

- High performance building envelope including:
  - Advanced roofing;
  - Sunshades; and
  - Substantial exterior insulation
- Air-water heat pumps, with potential for future ground source heat pumps
- Solar PV/thermal hybrid systems
- Planned biogas digester for electricity
- Planned local wastewater treatment
- Currently near net zero – occupant behaviour led to more energy use than expected

Vauban

- Revitalization of aging, former military barracks outside of Freiburg, Germany
- 38 hectare low-rise residential development
- 5,000 residents (1,400 units/600 dormitory rooms); 600 employees
- Co-operatively planned district based on triple bottom line approach to development

Key strategies

- Very aggressive, low EUI:
    - 65 kWh/m^2 maximum (thermal);
    - 42 Passivhaus units (15 kWh/m^2 heat); and
    - 100 Energy Plus units
- Biomass CHP (80:20 ratio of wood pellets to gas)
- 500 m^2 of solar thermal panels
- 2,500 m^2 solar PV panels
- Piloting organics/sewage digestion for biogas
- Grey water treatment for non-potable uses

La Cite Verte

- Residential redevelopment of part of former convent in Quebec City, Canada
- 9.3 hectare low-rise residential development
- 800 units; 6,700 m^2 commercial GFA
- Main objectives were to reuse and retrofit existing heritage buildings in order to minimize demolition energy consumption as well as develop new, eco-friendly buildings

Key strategies

- All buildings are connected to a thermal network, with the heat provided by wood pellet combustion
    - Boilers are located in the basement of the development
    - The pellet storage silo is integrated with one of the buildings
- Underground vacuum-based solid waste collection
    - First system in Canada

Dockside Green

- Waterfront brownfield redevelopment in Victoria, Canada
- 6.1 hectare mid-rise residential development
- 2,500 residents; 120,000 m^2 total GFA
- First LEED Platinum community in the world

Key strategies

- All buildings are connected to a thermal network supplied by a waste wood gasification plant
- On-site wastewater treatment plant
    - Potential to recover heat and gasify residual biosolids to heat new buildings
- Reclaimed water from the treatment plant is used for non-potable needs

Appendix 2 – Inputs & Outputs for Energy Calculations

This page summarizes the development projections (i.e. "inputs") prepared by City Planning, and the corresponding energy calculations (i.e. "outputs") used to establish the baseline energy consumption, demand and emissions.

Summary: Development Projections

GFA (m2) by Use	Existing	New	Total
Residential	0	891,190	891,190
Retail	0	154,036	154,036
Office	50,134	268,526	318,660
Hotel	0	21,135	21,135
Industrial/Warehousing	82,464	149,867	232,331
Other*	42,174	561,502	603,676
TOTAL	**174,771**	**2,046,256**	**2,221,027**
GFA (m2) by Precinct	**Existing**	**New**	**Total**
Lower Don Lands	8,502	822,360	830,861
Film Studio District	27,053	889,634	916,687
East Port	98,006	92,325	190,331
Ship Channel	41,211	241,937	283,148

***Other includes Film Studio, Flex, and Destination uses**

Summary: Energy Calculations

Energy by End Use (TGS Tier 1)	**Existing**	**New**	**Total**
Total Consumption (ekWh)	**66,682,236**	**483,510,427**	**550,192,663**
Gas Consumption (ekWh)	36,470,544	254,462,397	290,932,941
Electricity Consumption (ekWh)	30,194,007	229,048,029	259,242,036
Gas Demand (eW)	20,911,261	115,998,434	136,909,695
DHW Demand (eW)	639,046	8,988,743	9,627,789
Cooling Demand (eW)	3,310,330	22,190,539	25,500,869
Electricity Demand (eW)	7,775,801	50,962,759	58,738,560
Total GHGs (etCO2)	**12,104**	**76,280**	**88,384**
Gas GHGs (etCO2)	7,396	47,708	55,104
Electricity GHGs (etCO2)	4,708	28,572	33,280
Energy by End Use (TGS Tier 2)	**Existing**	**New**	**Total**
Total Consumption (ekWh)	**66,682,236**	**385,525,225**	**452,207,462**
Gas Consumption (ekWh)	36,470,544	190,437,983	226,908,527
Electricity Consumption (ekWh)	30,194,007	195,087,242	225,281,248
Gas Demand (eW)	20,911,261	85,288,868	106,200,129
DHW Demand (eW)	639,046	4,993,746	5,632,792
Cooling Demand (eW)	3,310,330	18,878,915	22,189,244
Electricity Demand (eW)	7,775,801	42,262,327	50,038,128
Total GHGs (etCO2)	**12,104**	**57,888**	**69,992**
Gas GHGs (etCO2)	7,396	34,200	41,597
Electricity GHGs (etCO2)	4,708	23,688	28,395