# Sustainable Integrated Urban & Energy Planning, the Evolving Electrical Grid and Urban Energy Transition

Prepared by:

**The Centre for Urban Energy**

**Ryerson University**

**Birendra (Bob) Singh, Pallavi Roy, Thierry Spiess, Bala Venkatesh**

## This White Paper assesses the following:

**Part 1:** Introduction into the **new paradigm of energy planning**

**Part 2: Drivers** of change and their **impact** on **urban** and **energy planning** and on the urban electrical distribution system

**Part 3:** Key considerations in developing an **integrated urban** and **energy plan**

**Part 4: Transformation** of urban **electrical distribution** utilities

**Part 5:** The role of **solar generation** and **energy coop** in integrated urban energy plan and their potentials in Toronto

**Part 6:** Lessons learned from some mega cities

**Part 7: Toronto's** experience in sustainable urban energy planning

**Part 8: Conclusion** and **recommendations** for all stakeholders

# Executive Summary

As cities often experience the negative impacts of climate change more intensely compared to their hinterland, they frequently are more ambitious in tackling these issues and are considered catalysts for change, resilience and innovation. Today, municipalities around the globe are striving to improve the livelihood of their inhabitants by producing and integrating renewable energy; aiming to reduce their carbon footprint; transitioning to distributed electrical power systems, promoting and developing sustainable transportation, etc. Electric transportation is being viewed as a means to reducing vehicular emissions, however, the electricity used to power electric vehicles needs to be generated from low carbon intensive sources. Responsible for more than 70 % of global energy-related $CO_2$ emissions, cities represent the single greatest opportunity for tackling climate change [1]. Also with advent of electric cars and trains in cities, the burden on infrastructure will further intensify. It is thus ever more crucial to recognize the importance of the city as a catalyst, an incubator and key player in addressing the challenges of the 21st century. The most effective way in realizing a city's potential is to integrate and coordinate energy planning, on a local, regional and provincial scale, with traditional urban planning while incorporating more citizen control.

The purpose of this White Paper is to examine the current considerations in sustainable urban and energy planning and the role of evolving electrical distribution systems as a key player in achieving transition. It focuses on the drivers of change and their impact on urban and energy planning and on the urban electrical distribution system. Considerations in developing an integrated urban and energy plan (such as environmental externalities, vulnerability, customer choice, etc.), as well as Toronto's experience are explored here. Among other recommendations, this paper emphasizes the role of solar generation, Community Energy Plans and energy co-ops in bridging urban planning and energy planning. Energy co-operatives and other local models of ownership of energy projects are a great way to increase private investment and strengthen local economies and may even serve as a model for the future of energy planning on a broader scale.

Urban and energy planning has moved beyond providing the basic necessities and societal needs to become aware of the new paradigms of sustainability, resilience and distributed energy. The synergy created by the need for electrical grid resiliency in light of extreme weather, incentives for developing more and more renewables, and an influx of new cost-effective technologies for integration and control are pushing the envelope especially in urban areas. The collective impact of today's drivers has been nothing less than a transformation of the electrical utility business.

Raising awareness for integration of urban and energy planning to all stakeholders is the first step towards achieving success in the area of integration of urban and energy planning. The following suggestions aim at furthering the integration of urban planning and energy planning in a more holistic fashion.

- Electricity planning must make an early entry into urban planning and be integrated at the land-use planning stage similarly to water, gas and heat.
- Currently, the electrical (regional and distribution) planning processes in Ontario do not consider community energy planning, energy coops as well as distributed energy on marginalized land for instance.
- Energy planning needs to be undertaken in partnership with communities and key stakeholders where these groups are meaningfully involved in contributing to the overall success. Thus, coming from the bottom, community energy plans can be a key element filling a much needed gap in the top down approach to energy planning in Ontario.
- Currently, community energy plans appear more like a (high-level) strategy document rather than a planning document. While they should remain that way, they also need to contain more specific programs and roadmaps that can be integrated with local, regional and even provincial energy plans.
- Encouraging decentralized production and distribution of energy is a good way to increase the resilience of the energy/electricity supply to adverse weather phenomenon and also to boost local economies.
- Toronto has great potential for Solar Energy, yet the overall installed capacity remains low. System barriers need to be removed to increase urban solar PV and Thermal energy.

- While microFIT-scale Urban solar projects will play a significant role in providing distributed electricity in the future, augmented considerations must be given to larger projects as well, making use of the city's vacant and underutilized lands for the generation of renewable energy.
- A common language is needed to unify all sorts of planners.

We are experiencing a paradigm shift, which is seeing the integration of energy generation, distribution, conservation, housing and city planning. Urban planning and energy planning being two separate entities is a thing of the past. We put forward suggestions for organizations carrying out urban planning and energy planning, more specifically electricity planning at different levels, to enable us to move towards a sustainable energy future with maximum efficiency and speed. The seamless integration of the two, urban and energy planning, needs to be seen as a necessity and, therefore, it is paramount to recognize this shift now and act upon it. It will not be easy, onr will it be achieved by urban and energy planners alone, but by a collaborative effort by players of different backgrounds and expertise, such as humanities, arts, economics and environmentalists. Ontario has made a great many strides in becoming one of North America's energy leaders, and protector of the natural landscape (see greenbelt) and is thus in a position to tackle these challenges, now and it the future. It would be detrimental to our image and our economy if there would be no vision for the holistic and seamless union going forward of these two vital planning strategies.

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Toronto Hydro-Electric System Limited (THESL)
Quality Urban Energy Systems of Tomorrow (QUEST)
TREC Renewable Energy Cooperative (owns SolarShare, Windshare and Lakewind co-ops)
Sustainability Ontario of Community Energy Co-op Inc.
Green Energy Co-op of Ontario (GECO)
Zooshare
Enbridge

Throughout this work, there were many meetings and discussions with members of the Environment & Energy Division of the City of Toronto. We would like to recognize their interest and willingness to participate in our project and for this we express our special thanks to them.



## Objective and Audience

The objective of this White Paper is to make policy setters, regulators, municipalities, energy service providers including utilities and academia aware of current issues, challenges and suggestions in the area of urban development planning and its interface with urban energy planning, more specifically electricity planning, to ensure a seamless integration of the two and to achieve a sustainable future.

# Table of Content

## List of Figures



## List of Tables

# Part 1: Introduction

Urbanization is a global phenomenon resulting in an ever-increasing concentration of individuals, economic activity, and resource requirements changing towns into cities and cities into mega-cities. According to a United Nations report, between 2007 and 2025, the urban population in developing countries is expected to grow at 2.27% per year and in developed countries at 0.49% per year (UN, 2008, Table 1.1). The Greater Toronto Area (GTA) is projected to be the fastest growing region of the province. Its population is expected to increase by almost 3 million, or 45.8 per cent, to reach over 9.4 million by 2041. The GTA's share of provincial population is projected to rise from 47.6 per cent in 2013 to 52.9 per cent in 2041 (Ministry of Finance, Ontario Population Projections 2013-2041). This translates into an ever greater Peak demand of the Province from 24,275 MW Peak in 2015 to 29,944 MW Peak in 2032 (IESO, 2013).

According to the United Nation's World Urbanization Prospects (2014), it is estimated that by 2050 about 80% of the global population will live in cities. As many cities are subject to expansion barriers due to space constraints, urban densification (e.g. smart growth) is expected to sharply increase, increasing consumption density for energy and other needs in these areas. The pace at which consumption density is increasing can exceed the time required to plan, obtain approval, design and construct the infrastructure needed to meet the new requirement (or future demand). This has the potential to overburden the existing infrastructure in cities in the short-term leading to their premature failure. In the longer term, delays in getting the required infrastructure for services in place, could result in the slowing down of economic development (i.e., industries moving away), and citizen dissatisfaction. It is worth noting however, that getting approval to build additional infrastructure for services or even upgrading the existing ones in cities where severe space constraints already exist would be a formidable task.

With the advent of smart in-home devices including computers as well as increased automation of commercial and industrial processes, customers are redefining the reliability and power quality of electricity supply. There is a definite shift in customer expectation towards zero tolerance for electricity supply interruptions in urban areas. Consistent with increasing urban population density with the construction of ever taller high-rises, electrical utilities see higher load densities often exceeding the capacity of the existing electrical supply infrastructure in the area. As mentioned, urban space constraint being a key factor, new ways must be found to meet the service needs including the electrical needs of these dense areas.

With mounting concerns about greenhouse gases (GHGs) and their harmful effects, no longer can we risk our future by continuing to follow our traditional carbon-laden path for energy supply in different sectors of economy. Triggered by high GHG levels, many regions of the world have already begun to experience the perils of climate shift in the form of global warming and extreme weather. Since cities consume 75% of the world's resources while occupying only 2% of the earth's surface area (Madlener and Sunak, 2011), they are also the dominant cause of carbon release into the environment. Hence, urban energy planning and urbanization management will be pivotal for creating the right framework conditions for a sustainable energy future (Madlener and Sunak, 2011). It is imperative therefore that new and efficient ways to supply energy to growing urban areas be found. Additionally, large cities can serve as a test ground and prime target locations for innovative thoughts and ideas in energy efficiency and energy security projects. Since energy is the backbone of all developments such as mobility of humans or goods, civil infrastructure, and buildings, transformation therefore must begin with large cities.

"Today, urban planning can be described as a technical and political process concerned with the welfare of people, control of the use of land, design of the urban environment including transportation and communication networks, and protection and enhancement of the natural environment" (McGill University, 2015). Thus urban planning concerns itself with developing and managing the physical infrastructure, social, economic, environmental and energy needs of a city. –While planning for energy is integral to the overall urban planning process, because of the need for detailed specific expertise, procurement and delivery of such big-ticket items as electricity and gas are handled by separate agencies. In Ontario normally, electricity is procured and distributed by municipally owned agencies whereas gas by a totally separate national gas company.

# Part 2: Drivers of urban planning and energy planning and their impact

Current drivers for urban planning and energy (in particular, electricity) planning as well as their future trends are investigated in this section. These drivers will bring about changes and innovation in the outcome of urban planning and energy planning. However, the pace of change and innovation will not be the same for all drivers as it will depend on each driver's relative impact and profile, which in turn determine the level of R&D effort devoted to it to bring about innovation. For example, in the past decade, significant effort has been dedicated to the reduction of GHG emissions, where effort still continues, and only recently, much attention has been put on climate change and extreme weather, a by-product of GHG emission. Given below are the drivers and trends for urban planning and energy planning.

## 2.1 Space Constraints due to Urbanization

Toronto is not immune to the global phenomenon of urbanization. High rises taller than ever before are being built in Toronto. Currently there are over 130 high-rise buildings under construction in Toronto, the most in all of North America (CBC News, 2014). NYC is a rather distant second with 92. Montreal has 25. Since Toronto is one of the most multicultural cities of the world, most if not all those immigrating to Canada prefer to live, raise a family and work in Toronto. What's more, Toronto was recently ranked as the best city to live in by the Economist (January 2015). Toronto is growing rapidly – over 50,000 condominium units have been added south of Bloor Street since 2000 (Better Building Partnership, 2015). In particular, Toronto is growing vertically, as development is occurring predominantly through intensification of built-up areas as a means to curb urban sprawl and prevent the need for extending infrastructure such as roads, public transportation and utilities ever farther.

This urban intensification, occurring in all major Ontario cities, is mandated by the Places to Grow Act of 2005 for the Greater Golden Horseshoe that aims at preserving pristine yet vulnerable habitats like the Green Belt, the Oak Ridge Moraine or the Niagara Escarpment.

*"The most obvious example of the positive role of urban density is transportation, one of the major components of energy and emissions intensity. For example, in Toronto, transportation emissions per capita are almost four times higher in low-density areas than in high-density areas" (WWF, n/a, p.5)*

***Trend*** *– Taller high rises and more energy efficient designs for buildings and individual dwellings. Energy utilities have been giving priority to compact and modular design for new infrastructure in cities for quite some time and the going forward trend is towards more of the same even if it means introductions of a totally new technology with monitoring and control to ensure supply reliability.*

## 2.2 Ageing Infrastructure

A direct reflection of the high rate of urbanization is higher load density for new construction and therefore putting strain on water, sewer and energy (electricity, gas) infrastructure, which, in many

instances, is already to its capacity due to past growth. It would be worth noting that the existing water, sewer and energy infrastructure in Toronto is not new and would require increased maintenance cost to simply function or if a decision is made to replace, outright replacement at a much higher capital cost.
Toronto Hydro estimates that 40 % of all power outages in Toronto occurred due to aging equipment (see figure 1 & 2). Seeing that the city has some of the highest outage~~s~~ interruptions per customer anywhere in the world, continual refurbishment of its infrastructure not only increases the electrical system's resilience but overall customer satisfaction.

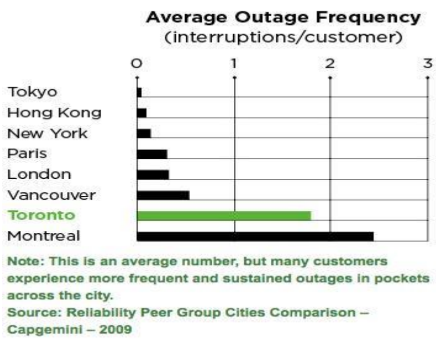


*Figure 2 Average outage frequency*

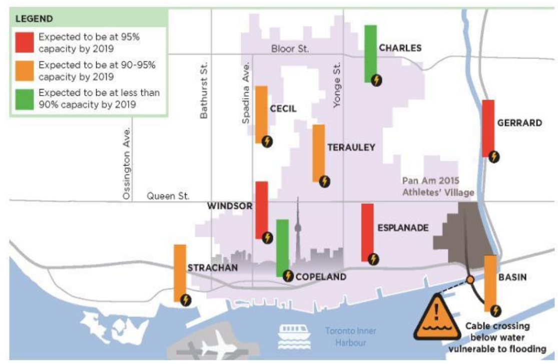


*Figure 1 Capacity of system*

*Source: Toronto Hydro (http://www.torontohydro.com/SITES/CORPORATE/LEARNMORE/Pages/Toronto'sGrid.aspx)*

***Trend*** *– With ageing infrastructure and rising maintenance cost, planning needs to place emphasis on the accuracy of modeling & the optimization of options. The focus still is to get the most out of the existing assets as long as it is economical to do so. Energy utilities are incorporating more and more real-time monitoring on the existing distribution assets and loading them to higher levels (i.e., taking calculated risk) to derive most benefit out of existing assets.*

### 2.3 Climate Change and GHG Reduction

Perhaps one of the most critical issues facing the world today is climate change and its impact on both the natural and built environment, like a city's infrastructure. Extreme weather related events of the past decade or so attest to the seriousness of the issue and its repercussions on sewer systems, grids and transportation etc. Under the auspices of the Kyoto Protocol, many jurisdictions of the world have established definite emission targets, which they endeavor to meet. Jurisdictions have established initiatives that are wide ranging in scope: eco-friendly designs for buildings/residential units, building resilient cities, elimination of coal or its decarbonisation prior to its use in any carbon-led industry, use of renewables such as wind and solar in the electricity industry, shift towards electric mobility of goods and people, etc.
One of the key drivers of building resiliency has been the insurance industry that has seen many fold jump in insurance claims in the last decade. Projections indicate this trend to continue unless concrete steps are taken to reduce emissions and to improve infrastructure resiliency. Ontario has seen its share of extreme weather and its crippling impact on the infrastructure in the past couple of decades.

***Trend*** *- The focus has moved from simply raising awareness and gathering information on climate change to "let us take prudent steps to reduce emission and to improve resiliency of the infrastructure." Significant effort is being devoted and progress is being made on all different fronts. Ontario has been leading the way in Canada by* *shutting down all coal fired generation and agencies at different levels of government replacing or planning to replace vehicles to eco-friendly fuels.*

### 2.4 Technology

Technological developments continue at an astounding pace. In fact, the pace is so fast that the affected industries are having a difficult time coping with it. Furthermore, in our context, the growth in technology is on all fronts affecting all players: customers, electricity generators, transmitters and distributors. While concerns exist with respect to reliability of new technologies because of a lack of enough performance history, the benefits of new technologies cannot be overlooked. For example, through the use of new technologies, electricity distributors can, among other things, improve reliability, asset utilization levels, and efficiency as well as maximize integration of renewables in the grid whereas electricity consumers can better manage their electrical bills through load control and can be a partner in effecting solutions to grid problems. The emerging technology of energy storage, which can be utilized by electricity distributors and consumers alike for a multitude of benefits, seen as a game-changer in the electrical utility industry. Utilities are engaging in pilot projects to test out some of the new technologies on the market.

***Trend*** - *The fast pace of technology development is expected to continue with advancements in energy storage systems and increasing levels of automation as well as controls with the use of state-of-the-art information and communications technologies. This is expected to occur on both sides, energy users and energy providers, with increasing levels of distributed controls, resulting in net-zero developments and micro-grids. Real-time grid control, data security and control would be of increasing challenge.*

### 2.5 Public Choice & Participation

A key shift in the areas of urban development planning and urban energy planning has been from an expert-driven activity to one that allows far greater public engagement and participation. Public engagement and partnerships, therefore, are seen as a cornerstone in novel planning approaches which can empower communities and result in more options to choose from, greater public acceptance of the option chosen as well as better overall design of urban projects. Participatory planning as it is termed, however, is not without caveats. It has to be properly planned and executed so that it is meaningful and socially inclusive of all groups representing the community.

***Trend*** - *Increasing levels of customer participation in planning and operation of the electrical grid is anticipated. Availability of of controls would allow customers to participate in providing solutions to electrical grid problems or issues such as low/high voltages and overloads.*

*Table 1 Current Drivers and Driver trends*

| | Current Drivers | Driver Trends |
|---|---|---|
| Urban Planning | Space constraints – high rises | Space efficiency – taller high rises, more energy efficient designs |
| | Ageing Infrastructure – decisions to replace or repair (maintain) | Increased focus on optimization of options and expenditures. Debate whether to replace or repair |
| | Climate Change & GHG reduction – awareness & info gathering | Resilient infrastructure/city: Electric mobility; use of renewable energy for space/water heating; factoring in environmental externalities in economics |
| | New eco-friendly designs for commercial buildings and residential units | Move towards optimized eco-friendly and more resilient designs |
| | Public Choices & Participation | Increased public participation in planning & design; offering hybrid solutions; incentivize public response & partnerships |
| | New Technologies | Use of new technologies for more compactness & modularity (see Toronto's Copeland Station) |
| | | |
| Electrical Utility Planning | **Current Drivers** | **Drivers Trends** |
| | Space constraints – compact & modular design | Use of new technologies for more compactness & modularity (see Toronto's Copeland Station) |
| | Ageing Infrastructure – focus on optimization | Real-time monitoring and increased focus on optimization studies |
| | Extreme weather & GHG reduction | GHG reduction – yes, integration of renewables; extreme weather – learning and developing strategy; factoring in environmental externalities in economics |
| | Public Choices & Participation | Increased costumer control and partnerships in formulating options (even for power system needs) and delivering value to costumer |
| | New Technologies – pilot projects in new technologies to deliver value | Targeted rolling our of new technologies; increased automation to deliver improved service; smart-grid and micro-grid. |

# Part 3: Key considerations in integrating urban planning and energy planning

### 3.1 Key Considerations in Urban Planning & Energy Planning

Current drivers for urban planning and energy (in particular, electricity) planning as well as their future trends are investigated in this section. Urban and energy planning has moved beyond simply providing for the basic necessities and societal needs – like roads and bridges, water and sewer systems, or electricity and gas utilities – to a stage where the central focus has become sustainability, making it much more complex and interdependent.

Urban and energy planning in all its facets, therefore, must focus on respecting, preserving and creating natural environment while improving human environment. Injecting sustainability into the planning process, as adopted by most if not all mega cities, also requires demonstrating efficiency in the use of land and other resources such as water, energy and materials required to run the cities, which ultimately also results in a lower ecological footprint.

Major trends amongst mega cities integrating urban planning and energy planning with an emphasis on sustainability include the following:

1. *Producing, integrating, and using renewable energy*
2. *Aiming for a net zero carbon footprint, i.e., "carbon-neutral" city*
3. *Reducing ecological footprint (waste reduction, energy efficiency, demand management, etc.)*
4. *Transitioning to distributed electrical power system (shift from large centralized power plants) – also refer to the next section for this*
5. *Promoting and developing sustainable transportation*

***Renewable Energy & Ecological Footprint**:* In pursuing the trends, there is emphasis on cities taking a sustainable route for energy from its production to consumption, all within city boundaries. Cities will not be simply consumers of energy; rather they will demonstrate leadership in developing energy, all within city boundaries, through innovative and sustainable means that also helps spur economic viability of the area.

Carbon neutrality goes hand in hand with reducing the ecological footprint of a region where a demonstrable and measurable outcome is continually achieved through sustained effort, such as reducing dependence on fossil fuels, improving efficiency in energy, lowering waste, and undertaking initiatives that offset carbon emission (like planting trees). Different sectors such as households, businesses and academic institutions are all encouraged and incented to participate. In this endeavour, cities can seek assistance from the following initiatives [Planning Sustainable Cities – Global Report on Human Settlements 2009 from United Nations]:

- International Council for Local Environmental Initiatives (ICLEI) – Local Governments for Sustainability's Cities for Climate Change, Architecture 2030
- The Clinton Foundation's C - 40 Climate Change Initiative
- UN-Habitat's Cities for Climate Change Initiative (CCCI)
- Federation of Canadian Municipalities (FCM)
- WWF Urban Solutions for a Living Planet (WWF)

Certain municipalities require new homes and buildings to meet green standards and increasingly stringent stretch targets in order to reduce emissions. This has culminated into the construction of zero-energy homes and buildings in several European countries. Furthermore, cities and regions are setting goals, or rather aspiring, to achieve carbon neutrality in not too distant future.

***Distributed Electrical Power**:* Driven by innovations in technology and concerns for environment, there is a shift from a centralized generation model to supply electricity to urban areas, where large conventional generators are located far away, to a distributed generation model where energy producing resources, often renewable in nature, are scattered within the city's electrical distribution system. The benefits of this include, among other things, improved electrical efficiency, greater grid resilience, and lower carbon footprint. Furthermore, incentives for solar energy on roof-tops of buildings and homes and community energy co-ops are providing additional impetus towards strengthening the distributed generation model.

***Electrical or Sustainable Transportation:*** The transportation system is one of major contributors to GHGs in the environment. According to the City of Toronto, transportation accounts for over 40 % of the city's GHG emission[1]. As the conventional transportation system shifts more towards electricity, it would be easier to make it cleaner and greener. It is this transition from conventional vehicles to EVs and PHEVs with newer and newer battery storage technologies that holds the potential to take the integration of urban and energy planning to yet another

[1] (http://www.toronto.ca/legdocs/mmis/2015/py/bgrd/backgroundfile-77635.pdf).

height for urban areas. EVs/PHEVs can be plugged in to the electrical grid as a source (generator) or sink (load) and, therefore, can play a significant role as a solution or option to system upgrades.

***Grid Resiliency Opens New Planning Avenue – The Community Energy Plans****:* The synergy created by the need for electrical grid resiliency in light of extreme weather, incentives for developing more and more renewables, and an influx of new cost-effective technologies for integration and control are pushing the envelope especially in urban and urbanizing areas. The result has been the development of "community energy plans - CEPs" by communities, towns and cities. The creation of CEPs is snowballing. In Canada, more than 170 communities, representing over 50% of the country's population, have developed a CEP as per the *National Report on Community Energy Plan Implementation*, published by Quality Urban Energy Systems of Tomorrow (QUEST, 2015), an organization focusing on smart energy for urban areas. The report identifies the municipal planning department, electrical utility and provincial government as the top three stakeholders in influencing CEPs. The 4$^{th}$ stakeholder group in terms of importance is of "real estate developers" who undoubtedly are a key in providing input into and implementing CEPs.

As more and more CEPs are created and projects implemented, the role of municipalities in shaping the future landscape of urban electrical utility distribution systems cannot be overemphasized. According to Toronto Hydro, as per the end of February 2015, there is a total of 4.1 MWp of installed microFIT capacity and 36.5 MWp FIT. The target for 2020 is 166 MWp of solar PV (Toronto Hydro, 2013).

### 3.2 Current Structure for Power System Planning and New Developments in Ontario

Power system planning entails assessing electrical needs for near, mid and long term and developing resources, specifically generation and CDM (conservation and demand management), and wires to meet the needs. Table 2 shows the current structure in place for developing energy and urban plans at different levels in Ontario as well as how municipalities should become more integrated into regional planning by presenting Community Energy Plans.

***Table 2:*** *Different levels of planning in an integrated system (dotted line and red arrows (communication) indicate our recommendations*

*Table 2 Different levels of the energy planning process and suggested interactions (arrows)*

| Stakeholder Level | Task/Planning | Consultation Process |
|---|---|---|
| MOECC/OEB and IESO | Bulk System Planning (e.g. LTEP) | Planning Working Groups |
| IESO, LDCs and Transmitters | Regional Planning (e.g. IRRP, RIP) for ~21 regions | Standing Committee |
| Transmitters (i.e. Hydro One) and IESO | Transmission Planning | Members of Provincial, regional, municipal representative and the public |
| Distributers (~80) | Distribution Planning | |
| Municipalities | Community Energy Plans | Should communicate concrete plans to both Tx / Dx Plans, RIP and LTEP |

### 3.3 Community energy planning

Community energy planning originated from the recognition of the importance of infrastructure related energy consumption and the effect that changes in land-use patterns play in determining energy consumption levels for an urban area. This can also be attributed to a raising awareness of the environmental impacts related with energy use in cities (e.g. smog and climate change). Community energy planning is increasingly being feasible in small-scale communities due to improving cost-effectiveness of technologies for small-scale, decentralized cogeneration of heat and electricity as well as the availability of greener energy technologies in urban settings (Jaccard et al., 1997; Rizi, 2012).

<u>Considerations for community energy planning are as follows:</u>

1. How growth impacts energy consumption? This is quantified in terms of population growth, changing land use pattern.
2. Who is going to provide the energy required?
3. Where in the city can energy be produced, to create decentralized and new sources of energy?

Community Energy Plans (CEPs) are guided by an integrated energy approach, which takes municipal, utility, transportation and other public and private infrastructure investments in a community and finds opportunities to create a more holistic energy system emphasizing reduction in energy consumption and increasing energy reliability. The community energy planning in Toronto starts with the land use plan, understanding how land will be used is the first step to understanding the future energy requirements of an area. Toronto, due to its large size, has opted for multiple local area CEPs, as part of land-use secondary and precinct plans:(CEP City of Toronto, 2014)[2]

- Westwood Theatre Lands
- Lawrence Allen
- Mimico
- Scarborough Centre
- Lower Yonge (in-progress
- Toronto core - Downtown infrastructure study includes energy (in-progress) ~ 8200 buildings
- Port Lands (in-progress) ~ 850 acre redevelopment area

<u>Drivers of community energy planning in Toronto are as follows:</u>

- Conservation and demand management:
    - Conservation reduces emissions and generates cost savings.
    - Reducing peak demand takes pressure off of existing infrastructure and makes capacity available for new development.

- Resilience:
    - In times of extreme weather phenomena buildings and homes often lose power, as Toronto residents have experienced in the last few years during flash floods and winter storms. Developing and implementing backup energy generation for buildings is an important consideration to reduce these incidences.

- Powering growth:
    - Local energy solutions such as renewables, combined heat and power, and district energy provide efficient ways to facilitate growth in areas with limited electricity supply.

The community energy plan in Toronto and elsewhere in Canada is a municipality driven plan, often created as an extension or supplementary to the land use plan, thus integrating urban and energy planning. However, the secondary plan outlines plans only for areas of the city, which are undergoing major changes in terms of new infrastructure, growth in population etc. Toronto drafted Official Plan policies (to go to City Council in Q2 2015)

[2] http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=168b4c3c4a7d8410VgnVCM10000071d60f89RCRD

that require an energy strategy as part of a complete development application for medium to large new development. The community energy plans developed are strategies for developing energy infrastructure and conservation and demand management plans for a specific area. They need to be more concrete and have specific goals and deadlines to be more effective.

BC Hydro under its Sustainable Communities Program has a community energy and emissions plan, prescribing criteria communities must meet to participate in the program as well as prescribed steps they must take to create a community energy plan.

QUEST's Integrated Community Energy Solutions: Municipal Policy Toolkit published in 2011 suggests that different sectors of a community shouldn't be viewed separately but rather as a whole system, to get a better understanding of the interconnectedness and thus leading to a better plan for energy savings programs and GHG reduction.

Other suggestions for an integrated and effective community energy plan include:

- Better understanding of the CEP process for municipal planners as well as utility companies.
- Provincial framework a top down approach with a clear outline of importance of CEPS
- Educational programs that enable learning about CEP for the community
- Better framework for consultation with public and including their inputs in decision making
- Policy and regulatory changes to support community energy planning from both provincial and municipal governments
- Community partnerships, between municipalities and community groups
- Cost-benefit analysis to be included in CEPs to create a more concrete energy plan
- Creation of an advisory group inclusive of different stakeholder representatives
- Strategic hiring decisions at the local level to include leaders of the community

**District energy and combined heat and power:**

An important addition to community energy plan is the idea of cogeneration (or combined heat and power [CHP]). In Canada the building sector is responsible for 12% of emissions (EPA, 2015). CHP together with district energy represent a demonstrated, cost-effective and clean solution for providing the heating and cooling needs of buildings.

District energy systems a central plant produces hot steam or cold water, which is then transport through underground pipes to buildings for heating, hot water and air conditioning needs. This is a collective utilization of resources, which eliminates the need for each building to own their own separate heating units, boilers, furnaces etc. Some other benefits include:

- Increase in energy efficiency
- Decrease in capital costs
- Better management of operation
- Increased environmental protection
- Flexibility in fuel choices
- Reliability
- Increased resiliency

CHP is the simultaneous generation of useful heat and power from a single fuel or energy source, thus increasing the efficiency of the process and reducing energy losses in conversion. CHP system can be designed and optimized to meet the thermal demand of different sectors, industrial, individual building or city-wide levels.

CHP and district energy are important ways of increasing resiliency of energy supply. The decentralized and behind the meter nature of the system keeps it isolated from effects that disrupt electricity transmission.

The potential benefits of CHP and District energy indicates that in future energy policy must inclusive of these technologies and ideas. A realization of their potential to bring in energy savings, increase resilience and reduce GHG emissions needs to be reflected in the policy.

### 3.3.1 Environmental Externalities

Understanding and quantifying the full cost of impacts to society and environment must be incorporated while estimating costs of energy production and distribution. An externality is any cost or benefit that is not currently reflected in the price paid for energy. These external costs are created by some impacts of the energy production and transmission process.

Some important externalities to be considered for energy production and consumption are as follows:

- Air pollution
- Carbon emissions
- Water pollution
- Land use change and its impacts
- Effects on human health
- Radioactive risk
- Effects to the environment e.g. fish population and hydro

Some methods suggested in literature for accounting or 'internalizing for externalities are:

- Setting environmental objectives, such as GHG reduction targets, setting emissions limits or implementing clean technology
- Introducing market based incentives, taxes, carbon credits etc.
- Including social and environmental optimums as criteria in the planning process

Quantifying externalities is difficult, yet possible. For example, total external transport costs in the EU (excluding congestion) amount to more than € 500 billion or 4% of total GDP, and more than half is attributable to environmental impacts[3]. To follow the last point of including social and environmental optimums as criteria, the planning process would have to follow an integrated resource model to achieve maximum results and include as many impacts and connections between different resource utilization as possible. Some studies suggest that including externalities in planning process now reduces the risk associated with having to comply with future stringent environmental regulations.

Including externalities in the energy production and distribution process would also lead to push for green energy, as the economic competitiveness of renewable energy compared to carbon intensive fuel sources will increase (Linares *et al.,* 2006; Rafaj and Kypreos, 2007). However, including externalities could lead to possible increase in price of energy, directly affecting markets and profits. A framework needs to be developed to account for externalities and creating a holistic system, which takes into account societal and environmental impacts as well as economic impacts of energy systems.

Carbon credits and pricing policy:

Recognizing the importance of emissions, global climate change and its growing impact on lives of citizens has led to nation states adopting policies to disincentivize the use of carbon intensive fuels. Canada is one of the high emitters per capita of carbon emissions. Thus there has been various considerations to lower the footprint domestically. Some of the instruments being looked at is carbon pricing.

Carbon pricing has some advantages, such as:

[3] External Costs of Transport in Europe. Update Study for 2008. September, 2011. Delft: CE Delft.

- Cost effectiveness
- Generating revenue
- Simple transparent and easy to understand concept
- Pushing for innovation
- Creating a favorable environment for low carbon technologies to flourish

The table below shows a carbon pricing and taxation policy comparison.

*Table 3 Comparative tax policy in Canada and other countries (Partington and Horne, 2013; Johansson, 1995)*

| Criteria | British Columbia | Alberta | Sweden | Denmark |
|---|---|---|---|---|
| **Start date** | 2008 | 2007 | 1991 | 1990 |
| **Carbon cost (per tonne)** | $30 | $15 | $168 | $31 |
| **Important Application Features** | Revenue neutral | Only affects large emitters. Emitters can reduce or buy offsets of pay $15/tonne in a clean tech fund | Lower tax for industry and electricity production sector | Using revenue from the tax to finance energy efficiency Investment. |
| | | | | Different rates for business and households. |
| | | | | Promoting behaviour modification |
| **Effects** | $5.7 billion in tax cuts | Unable to meet own targets. | 13% reduction emissions in a decade | Per capita reduction by 25% between 1990 and 2005 |
| | Drop in fuel consumption | Not significant reduction in emissions | Move from hydrocarbons to biomass | |
| | 9.9% reduction in emissions | | | |

Carbon pricing and taxation has been utilized by many countries to further their clean tech economies and lower emissions and their reliance on fossil fuel. Ontario can implement similar methods to create an environment of innovation and clean energy. Some successful methods are listed as follows:

- High and stable pricing
- Using the tax for tax refunds and investing in Cleantech

### 3.4 Challenges & Suggestions for Effective Integration of Urban & Energy Planning in Ontario

The comments made in this section stem from our R&D activities through literature search, attending relevant events and meetings with organizations operating within the GTA, the province of Ontario and nationally (please see Appendix A for the list). Opinions, views and suggestions expressed herein cannot be attributed to any one source, except as noted, rather they are our thoughts, findings and ways to move forward for a better integrated urban and energy planning in Ontario.

- Raising awareness for integration of urban and energy planning to all stakeholders is the first step towards achieving success in this area. **This can be done taking a top-down approach with a communication from the Government of Ontario to all relevant stakeholders or from the IESO as a government agency with the overall responsibility for planning for load and supply balance in Ontario.** Reinforcements to this message can be provided through means such as local conferences and joint meetings

- In the context of urban planning, according to a United Nations Report on *Planning Sustainable Cities-Global Report on Human Settlements* (2007), "one of the most important shifts in urban planning during the last century has been from an expert-driven technocratic activity to one that is inclusive of relevant stakeholders and communities" (p. 5) The report uses the term 'Participatory Planning', which results in many advantages including transparency and stakeholder acceptance of the outcomes. While Participatory Planning is well practiced in Ontario for some established planning processes such as those related to zoning and rezoning of parcels of lands within the city, room for improvement exists for some others such as planning related to electrical planning for the city and planning for new initiatives such as energy coops and new FIT and micro-FIT programs.

- Energy planning must make an **early entry into the overall urban planning process**, as early as at the land-use planning stage. Furthermore, for energy planning to be most-effective, it **needs to be undertaken in partnership** with communities and key stakeholders where these groups are meaningfully involved in contributing to the overall success.

- The urban planning processes going forward need to be more strategic as well as flexible and at the same time more short-term action oriented. In addition, urban planning needs to seek and adopt new approaches for engaging communities and stakeholders in order to integrate their needs.

- While stakeholders are specialists in their respective areas, **greater understanding and training to appreciate the role and engagement of other stakeholders** is also critical for effective integration of urban and energy planning. **This can be done through focused training and courses for the city planners as well as the LDC planners.**

- City (and land-use) planners and the planners of the local (electrical) distribution utility (LDC) responsible for supplying electricity to the residents and businesses of the city need to work together to develop their respective short-term and long-term plans. **Appropriate changes to the policy and regulatory framework need to take place to allow this to happen.**

- For city planners, planning for energy with emphasis on electricity is a new area. With the skyrocketing interest in community energy plans, energy coops and renewables, the challenge for cities is how to bring in more energy/electricity aspects of the plan into the urban development planning process early in the game. Cities need to develop some level of expertise in this area since they will not only interface the other stakeholders that specialize in this area, that is the LDC planners, but be also accountable to carry out some related work on their side as well.

- On urban energy planning related matters (example energy efficiency, building standards, FIT/mico-FIT, etc.) closer coordination and alignment between different ministries of the Ontario government and also between different levels of governments (provincial, municipal) are needed to see improved outcome of different initiatives.

- **T**he integrated urban and energy planning process **must deal with the major issues such as climate change/extreme weather impact, fast urbanization, resource depletion (i.e., conservation), and environmental externalities.** Currently, the planning processes in Ontario are dealing with only a few of these (such as electricity conservation), however, much more work remains to be done. Considerable effort needs to be devoted to understand climate change/extreme weather and environmental externalities as these related to Ontario and develop tools in order to bring them into the mainstream planning processes.

It is important to recognize that municipalities are often more adept in defining a cities needs and potentials pertaining to energy planning. Municipalities should therefore have a way to voice their input towards electrical system Infrastructure planners, operators and distributers. Furthermore, the contributions both regarding CDM and generation of energy installations led by individuals and/or communities must not be underestimated. Ultimately, the union of energy planning and urban planning requires the union of all stakeholders, where no one is to be excluded. Naturally, the responsibility remains with the various levels of government, thus a certain hierarchical structure is to be maintained.

## Part 4: Transformation of urban electrical distribution utilities

For almost a decade the electrical utility industry in North America and, to some extent, in other parts of the world has continued to see unprecedented levels of changes. While the drivers of these changes, as noted above, are due to the environment, ageing assets, economic industrial downturn, new technologies, and customer choice, the collective impact of these has been nothing less than a transformation of the electrical utility business.

The changes have affected in the way electricity is produced, delivered, utilized and controlled. Customers are no longer an entity that passively receives services, rather they are an active participant in the planning, design and operation of the electrical utility industry. Distribution systems are no longer only receiving electrons from transmission, but also at times supplying electrons to transmission. Generation sources are no longer only located at faraway places in transmission (i.e., centralized generation concept that prevailed for 80 years or so), smaller generation resources, called distributed generation, are increasingly embedded in electrical distribution systems often close to customer loads in urban areas. New generation resources, unlike their predecessors, are renewable and intermittent in nature, and therefore hard to predict and control. What's more, increasing use of new technologies and customer engagement resulting in micro-grids and 'zero-energy' (or 'net-zero') developments challenge the basic structure of the electric utility industry. Cities have much to gain from this transition and as cities and local governments continue to become increasingly important players in promoting the local generation and use of renewable energy, new policies emerge.

The transitioning of energy systems is nothing short but a conceptual clash of how energy is distributed. That is, this shift is reminiscent of the war of current at the turn of the century. We are experiencing a shift from centralized generation and AC distribution to more distributed generation and increased use of DC power. Thus "cities in energy transition can be thought of as moving from centrally supplied, one-way consumption modes to open systems of distributed, ubiquitous providers and users of renewable and other energy streams" (Gardner and Ashworth, 2008, p. 283).

As this transformation advances, electrical utilities must find newer ways to maximize the use of their physical and human resources, demonstrate efficiency on all fronts and bring tangible value to customers. Government policy makers, regulators and utilities all need to work together to ensure a highly reliable electrical supply at affordable rates continues to serve consumers as they have previously enjoyed, throughout the period of uncertainty and transformation.

## Part 5: Solar potential and energy co-ops in Toronto/Ontario

Thus far we have seen the various elements that make up an integrated urban energy planning structure as well as how such a union can be facilitated right here in Ontario. subsequently, it is crucial to assess the potential that a well integrated and inclusive urban energy planning could unlock in Ontario, the GTA and specifically in Toronto.

For this purpose, we are going to examine the Solar potential in the urban environment along with the opportunities for energy co-operatives.

### 5.1 Solar Potential

The development of solar energy is exemplary of the rapid growth of renewables around the globe. From 2011 to 2035 installed capacity of solar energy is expected to grow from 67 to 600 GWp (IEA, 2012). A recent IEA analysis projects that under extreme assumptions solar energy could provide up to one-third of the world's final energy demand after 2060[4]. According to *CanSIA*, by 2020 solar will produce approximately 1% of electricity generation in Canada, with almost 6,300 MW of installed capacity, create approximately 65,000 job-years, employing a labour force of approximately 1,0000 people per year, and displace approximately 1.5 million tonnes of GHG per year (2014). The 2008-2011 period was marked by the exponential growth of installed capacity for solar photovoltaic power, with the annual growth rate of 147.3% (National Resources Canada, 2014). Although Canada's use of solar energy has increased in recent years, it remains relatively small in terms of market penetration (ibid.)

#### 5.1.1 Solar in an Urban Environment

While the vast majority of PV and CSP capacity comes from large-scale solar farms, located in rather remote areas, solar PV has recently experienced increased uptake in urban environments. Thus far, the bulk of urban solar rarely exceeds 500 kW, in fact < 10kW residential rooftop systems are most common. Urban solar energy has several advantages compared to other forms of renewable energy, such as wind. The latter faces greater public opposition due to noise pollution and unpleasant aesthetics. Solar on the other hand is less of a nuisance. Today's solar cells and mounting systems have become less conspicuous as they can be integrated into a building's façade (BIPV) or lay on a rooftop, creating but little eyesores. Once installed, PV can produce electricity for 25, 30 or more years with minimum maintenance. Dropping panel costs together with incentive schemes such as FIT and microFIT or RPSs have made PV a viable alternative to conventional energy and many cities across Canada are betting on the power of the sun.

There are of course other ways to capture the power of the sun, via passive solar energy for example or, thermal energy. Solar thermal (not to be confused with CSP) heating is a simple yet mature technology, which can be used to meet a variety of water and space heating needs for residential, commercial, institutional and industrial sites. Solar thermal heating is considered to be one of the most cost effective form of on-site renewable energy generation.

The International Energy Agency, Solar Heating and Cooling Programme "released their latest statistics on worldwide solar heating and cooling. With a growth of 9.4% in 2012, the installed capacity of solar collectors reached 269 GWth. The collectors provided 228 TWh of solar thermal energy, thus saving 79 million tons of $CO_2$ emissions" (International Energy Agency, Solar Heating and Cooling Programme, 2015). With 228 TWh produced in 2012 alone, solar heating and cooling is second only to wind energy among renewable energy (excluding hydro). "The vast majority of the total 2012 capacity was in China (180.4 $GW_{th}$) and Europe (42.8 $GW_{th}$), which together accounted for 83% of the total capacity, [yet] the global market growth in 2011/2012 was primarily driven by the large markets in India (+44.4%), Brazil (+11.8%), China (+10.9) and the United States (+2.7%)" (ibid.). Solar Thermal could be used in urban environments for space heating (hot water) or pool heating.

**Examples of Solar (PV and Thermal heating) Cities:**

- **Dawson Creek** B.C., with a population of less than 12,000, is aiming to be Canada's first carbon neutral city. In 2011, it changed its building-code bylaws to require that every new house be built "solar ready"

[4] http://www.iea.org/topics/solarpvandcsp/

and a Green Fund ($100 levy per ton of GHG) makes it easier for homeowners to afford the infrastructure costs[5].

- In **Halifax**, N.S., solar hot water panels will be installed on up to 1,000 city homes. Residents who participate will pay for the systems through a surcharge on their property tax bill over 10 years while saving on their hot-water costs and earning a greater sense of environmental responsibility (Globe and Mail, 2012).
- The French city of **Montmélian la Solaire** (population 4,000) is firmly committed to the promotion and development of solar thermal. Nearly 1,500 m2 of solar thermal collectors are installed on buildings. Of this solar collector area, 56% are installed on municipal buildings and 44% on private multifamily houses. As of today, the town boasts some 370 m2 of thermal solar panels per 1,000 inhabitants, which is ten times more than the national average (*International Energy Agency Solar Heating and Cooling Programme, 2014).*

However, solar has its drawbacks, which are often more pronounced in an urban environment as opposed to a rural one. Shading is one of the major reasons why solar may not be feasible for a whole array of sites, especially in the downtown core, where tall buildings cast long shadows across rooftops and vacant lands. Yet, simply putting solar on the tallest structures is not the optimal solution either. High-rises that would be able to support solar installations often have a relative small roof area (compared to the amount of units) that is being occupied by building infrastructure such as HVACs. Further, many roofs on older city buildings do not have the structural strength to support solar arrays or the cost of reinforcement is often too high. Despite these challenges, in general terms most Canadian cities have a solar potential that is comparable internationally with that of many major cities.

*"[…] about half of Canada's residential electricity requirements could be met by installing solar panels on the roofs of residential buildings" – Natural Resources Canada – Natural Resources Canada*

### 5.1.2 Renewable Electricity: Targets and projections

Ontario is one of North America's leaders in in the production of clean and renewable energy. A key focus of the Province's future energy generation plan is so-called "distributed generation". The province has set a target 10,700 MW of non-hydroelectric renewable capacity (wind, solar, and bioenergy) by 2018 (Ministry of Energy, 2014). In 2009, the City of Toronto Executive Committee adopted a sustainable energy strategy dubbed *The Power to Live Green*. The strategy outlined a wide range of different goals and targets, including the installation of 500 MW of renewable generation by 2020 and reaching a total of 1000 MW of renewable generation by 2050 (see figures 4 and 5). Solar is expected to contribute a total of 166 MW by 2020. In 2013 there were over 20MW of aggregate Solar PV projects in-service across Toronto, with an additional 65 MW of committed Solar PV projects in progress. Although, Toronto Hydro is confident that the target of 166 MW by 2020 will be achieved (Toronto Hydro: Solar Capacity for Toronto, 2013), there are no plans beyond 2020 and no considerations are given to using brownfields and CEP.

| SOURCE | By 2012 | By 2020 | By 2050 |
|---|---|---|---|
| Conservation—Electricity * | Reduce by 200 MW | Reduce by 550 MW | Reduce by 1050 MW |
| Conservation—Natural Gas Heat | Reduce by 240 $Mm^3$ | Reduce by 730 $Mm^3$ | Reduce by 1560 $Mm^3$ |
| Renewable Electricity Generation | Increase by 120 MW | Increase by 550 MW | Increase by 1000 MW |
| Renewable Thermal Energy | Displace 20 $Mm^3$ of Natural Gas | Displace 90 $Mm^3$ of Natural Gas | Displace 200 $Mm^3$ of Natural Gas |

*Figure 3 Cumulative Energy Targets for Toronto. (Source: Power to Live Green)*

[5] http://www.dawsoncreek.ca/wordpress/wp-content/uploads/2011/08/inTheNews200711.pdf

### 5.1.3 How to achieve these targets

The Green Energy Act of 2009 is instrumental in achieving these goals. The Feed-in Tariff scheme has two streams:

1. microFIT (≤ 10kW) - Very small projects typically at a home or small business
2. FIT (>10kW to ≤ 500kW) - Larger projects typically for commercial buildings, schools, community centers, etc.

As of the end of February 2015, there are a total of 733 microFIT installations in Toronto and 233 FITs, producing a cumulative total of 4.1MWp and 36.5MWp, respectively This accounts for over 30% of the OPA's procurement target for FIT 2.0. These FIT 2.0 projects are expected to be connected to Toronto Hydro's distribution grid within the next 2-3 years. Since it was introduced, the FIT program has seen around 1,800 small and large FIT contracts and about 25,000 microFIT contracts Province wide, together representing more than 4,800 MW of electricity generation capacity (IESO). The microFIT Program annual procurement target for 2015 is 50 MW (IESO, 2015).

The City of Toronto has also undertaken various initiatives of its own that aim at reducing the overall amount of energy needed and at the same time, increase the amount of in-city generation to respond to the increase in demand due to the city's growth. Since 2013 all newly constructed city buildings with a floor area greater than 600 m2 need to have renewable energy systems to meet at least 5% of their total energy demand (Toronto Renewable Energy Office, 2014). In September 2012, the City of Toronto in partnership with Toronto Hydro-Electric System Limited (Toronto Hydro) launched the first phase of a program that will see City-owned buildings outfitted with solar photovoltaic (PV) panels:

- Generate over 3,300 MWh/y (~280 households)
- Reduce greenhouse gas emissions by about 400 T/y
- Produce approximately $17 million in revenue over 20 years, by feeding energy into Toronto Hydro's electrical grid.

The first phase was completed in June 2014, resulting in 10 Solar PV rooftop systems operating on City facilities totaling 1 MW of installed capacity. They generate approximately 1,357 MWh/y of electricity, which is roughly equivalent to the consumption of 113 households, and will result in the reduction of approximately 146 tonnes of GHG emissions a year[6].

### 5.1.4 Finding new lands: The reuse of brownfield lands and commercial/industrial roofs for electricity generation

Like conventional energy plants, renewable energy infrastructure generally occupy a considerable footprint (land area), requiring vast amounts of land. The latter has become a scarce resource especially in smaller and already densely populated areas. Finding appropriate areas for REI is challenging, given high land costs and the augmented desire to protect the natural landscape as well as the want to produce energy locally (i.e. distributed energy). On the other hand, marginalized land such as brownfields (or "surplus lands), are still aplenty, despite notable redevelopment efforts in North America and Europe. Brownfields can be described as previously developed land that is now underused or abandoned, afflicted by either real or perceived contamination, but with an active potential for redevelopment. They include, vacant lands, closed landfills, ex-military sites, abandoned parking lots and gas stations etc.

The conversion of these brownfields into energy producing so-called brightfields could kill two birds with one stone (Adelaja et al., 2010), by combining sustainable brownfield reuse and RE production (EPA, 2010; Ribeiro, 2007). The idea is to leverage the benefits of brownfields such as (often) existing infrastructure (e.g. roads or grid) and proximity to consumer. Additionally, while often close to population centers (good for distributed energy), brightfields are for the most part located in non-residential areas. Benefits of using marginalized lands for renewable energy:

- Remediation of contaminated site and protection of public health and safety
- Renewable energy generation and reduction of GHG emissions
- Neighbourhood renewal and revitalization
- Disappearance of eyesore, nuisance and blight, and elimination of social stigma
- Leveraging of existing infrastructure and restoration of tax base

[6] http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=168b4c3c4a7d8410VgnVCM10000071d60f89RCRD

- Reduction of development pressure on greenfield sites.

In 2010, out of the over 450’000 U.S brownfields (EPA, 2014), some 11’000 have been screened for their brightfield potential totaling over 14 million acres, and in 2014 this number rose to 66’000 sites equating to nearly 35 million acres (EPA, 2014). Additionally, as of 2014, the EPA and the NREL have officially converted a over 130 marginalized sites into utility-scale brightfields in 31 States under the RE-Powering America’s Land Initiative (OSWER, 2014), with a total installed capacity of over 700MW. The potential for this type of REF remains largely untapped and as Milbrandt et al., (2014) suggest that the total amount of RE produced on marginalized land in the U.S could produce as much as 4.5PWh of electricity.

Naturally there are several known disadvantages of using brownfields for the development of renewable energy; chief among which is potential site contamination. It has detrimental effects not only on the technical feasibility, but also financial, regulatory and social ramifications. Further, the value of land in urban areas can be very high and often times owners are reluctant to lock up their land for 20+ years thus forgoing future development opportunities that bring more money. Additionally, brownfields are being more and more used for urban densification purposes and have thus competing end uses, energy just being one of many. However, the majority are municipally owned.

*Figure 4: Exelon City Solar is a 10-megawatt solar installation located on a 41-acre brownfield in Chicago’s West Pullman neighborhood.*

| OVERVIEW | |
|---|---|
| Total # of sites | 128 |
| Total # of installations | 135 |
| Total installed capacity (MW) | 773 |
| Total # of states represented | 34[11] |
| Max individual installation size (MW) | 118.5 |
| Min individual installation size (MW) | <.001 |

| Installation by Site Ownership Type | # Installations | Installed Capacity (MW) |
|---|---|---|
| Private | 46 | 557.1 |
| Municipal | 52 | 105.4 |
| Federal | 12 | 89.6 |
| Other | 11 | 17.2 |
| Unknown | 9 | 2.1 |
| State | 2 | 0.9 |
| Public | 1 | 0.5 |
| Federal/Municipal | 1 | 0.2 |
| Foundation | 1 | 0.0 |
| Total | **135** | **773.1** |

| INSTALLATIONS BY SITE TYPE[12] | |
|---|---|
| Solar and wind projects on landfills/landfill buffer | 70 |
| Renewable energy projects on mine sites | 7 |
| Renewable energy projects on Superfund sites[13] | 24 |
| Renewable energy projects on RCRA corrective action sites | 13 |
| Renewable energy projects on current/former federal facilities and contaminated properties | 17 |
| Renewable energy projects on brownfield sites | 30 |

| Installations by Renewable Technology | # Installations | Installed Capacity (MW) |
|---|---|---|
| Wind | 21 | 497.2 |
| Solar PV | 110 | 255.9 |
| Biomass | 1 | 20.0 |
| Hydro | 1 | <0.1 |
| Geothermal[14] | 2 | <0.1 |
| | **135** | **773.1** |

| Installations by Energy Production | # Installations | Installed Capacity (MW) |
|---|---|---|
| Wholesale Electricity | 84 | 693.2 |
| Onsite Use - General | 18 | 60.6 |
| Onsite Use - Green Remediation[15] | 23 | 7.8 |
| Rooftop | 4 | 4.7 |
| Local Use | 1 | 3.2 |
| Onsite Use – Training | 1 | 0.5 |
| Community Owned/Subscription | 2 | 1.0 |
| Unknown | 2 | 2.0 |

*Figure 5 Overview of Renewable energy on marginalized lands in the U.S (EPA, 2015)*

**5.1.4.1 Case Study**

For the purpose of this study, the Toronto Port Lands were examined for their potential to generate renewable electricity and may serve as a case study. It was chosen for that it is home to a great number of relatively large-sized brownfields, as well as the location for one of Toronto’s most ambitious development project; Waterfront Development. Additionally, it has recently received a transmission line that could be favorable to added renewable power generation facilities. Toronto’s Portland Energy Centre – a natural gas fired electricity plant - has a capacity of 550 MW. It went online in 2009 providing the nearby downtown core with electricity via high voltage mains.

Surrounding the plant, in a radius of 1.5 km, are vacant brownfield lands with a total of approximately 244 acres (see figure 8). Accounting for industry standards with regard to power density (~7 acres/ 1 MWp), a 15 % capacity factor and

10-20 % losses, these sites could be used for solar PV farms with an installed capacity of between 34 MWp and 48 MWp. Locally generated electricity from PV and, could produce enough electricity for as much as 5,000+ households out of the projected 40,000 for the Waterfront Development. According to *RETScreen* estimations, this would translate to as much as 8,831 Gross annual GHG emission reduction tCO2 or close to 2,000 cars and light trucks taken off the road. Early estimations project initial costs (~$250 million power system costs and ~ $28 millions of BOS costs) of $278 millions with an equity payback of 17 years and a B-C ratio of 0.37. Figure 9 shows the absence of any FIT installations in that area.

This is a best-case scenario in which all vacant land is being used for solar PV. Realistically, not all of these sites will remain vacant and thus cannot be used for ground mounted solar arrays. However it shows that large-scale solar energy is possible in an urban environment.

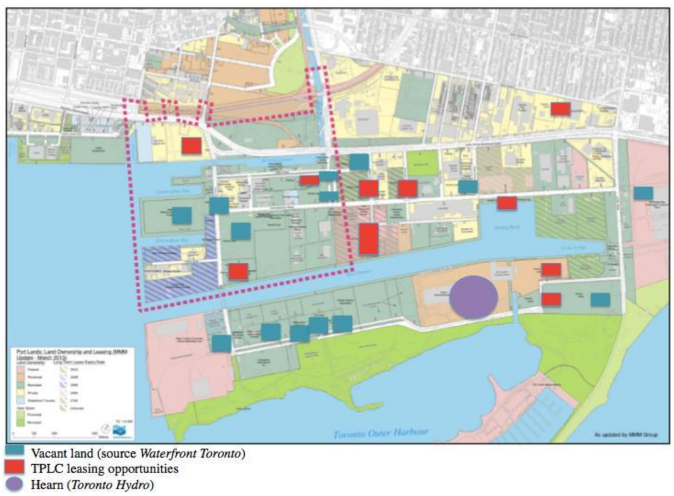


*Figure 6 Case study area and properties used for calculations and FIT locations in Toronto*

Apart from brownfields, Toronto has another abundance; commercial and industrial roofs. Everyone who has ever looked out the window of an aircraft approaching Pearson has seen the vast expanse of largely underused space onto of commercial and industrial buildings. The FIT again acting as a catalyst, the race is on to lease one's roof space to generate clean electricity via PPAs. However, not every roof is suited for PV. Roofs need to be free of shading, structurally sound and of a minimal size (range of 30,000 to 100,000 square feet) to make a project viable. Commercial and industrial rooftop solar has the potential for several 1000 MWp of capacity.

#### 5.1.5 Recommendations to facilitate augmented solar uptake

- ❖ Municipalities are urged to take advantage of vacant lands not only for residential intensification purposes but also for renewable energy considerations. To that end each municipality should have an appropriate inventory of private and municipal brownfield lands. In the case of Toronto, 68 % of all brownfield are being redeveloped for residential purposes and little considerations are given to a renewable electricity generation end use.
- ❖ Waterfront Development for example, is one of the largest urban revitalization and brownfield redevelopment projects anywhere in the world. While most of its proposed buildings and some existing ones (will be) are LEED certified, little considerations has been given thus far to utilizing brownfields for on-site electricity generation. In the case of the Portlands, it is crucial to undertake load capacity and distribution assessments, as well as connection cost estimations to determine the feasibility of such large-scale arrays.

- We Recommend that big land use developments, especially residential ones like the Waterfront Development, consider on-site generation, either on rooftops or ground mounted PV.
- Solar farms in urban areas are becoming more popular as a form of distributed generation. The use of brownfields for solar farms can not only remove neighbourhood blight, but produce embedded electricity. We urge the city to formally assess its brownfields in an inventory and screen them for their 'brightfield potential'.
- Similar to the Green Roof initiative, all newly constructed commercial or industrial roofs of a certain size, should produce some amount of distributed electricity via Solar.
- Furthermore, many cities in Europe, London for instance, have what is known as the right to ancient light. Toronto does not have this right (anymore) and a newly constructed building might render a PV panel (rooftop) or whole array (ground-mounted) useless from a production point of view due to a casting shadow.

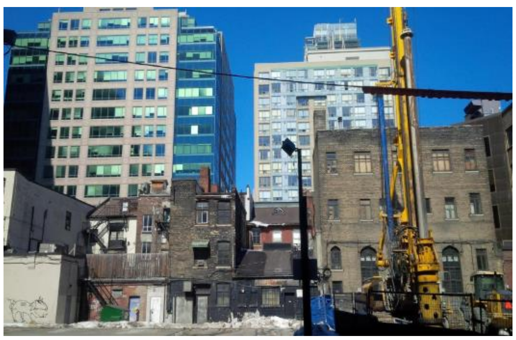

*Figure 7 Picture showing how a new building (under construction) may take away the light of older dwellings in Toronto*

**5.2 Energy co-operatives**

An energy co-operative is a business model, where people in the community or from farther away come together to pool their resource and invest in a renewable energy project. In Ontario the history of energy co-operatives mainly starts with the green energy act and the Feed in Tariff program (Ontario Power Authority[OPA], 2009), which incentivised local renewable production in an effort to reduce GHGs and create a green energy sector. Energy co-ops are an important ownership model for energy sector, especially for renewable energy project (Walker, 2008). They can be important stakeholders for energy planning, especially as part of community energy plans and seeing the plans to their fruition in terms of reaching people and adding to renewable energy generation. Co-ops can play an important role in making community energy plans a reality by getting local people together and co-operatively owning partially or completely energy projects. Co-ops can lead in awareness and education of community members about energy issues. Also, private developers are now a days partnering with co-operatives for renewable energy projects. This is policy driven as partnering with a co-operative or a co-operative owned project gets more points in the FIT application process. This is beneficial to the co-operative, as now they have a big influx of money, which is important for building large scale renewable energy projects (Evans, 2012). This supports the mandate of increasing private investment in the energy sector.

**5.2.1 Comparison of Ontario's Green energy Act and the Feed-in-Tariff program model in other countries**

Ontario green energy act (GEA) was passed in 2009. As with other legislation similar to green energy act, it focused on energy security, economic security and job creation as well as reducing and managing energy demand

and fostering more renewable energy. With this legislation the Govt. of Ontario has put in place different policy tools like monetary incentives, regulatory changes etc. to foster the development of renewable energy sector in Ontario. The Feed-in –Tariff (FIT) program was introduced in Ontario under the GEA, North America's first (OPA, 2009). The FIT program's main goals are to push renewable energy by providing lucrative rates for renewable energy source generated electricity being fed into the grid and support economic growth in the province.

FIT models have been used in different countries to initiate and support a growing renewable energy industry. "Feed in tariff programs all over the world have been responsible for 50% of wind and 90% of Photovoltaic capacity" (Gipe, 2010). The FIT program in Ontario is modeled on the successful German model. However, on comparison the German and Ontario programs reveal numerous differences in program length, the method of rate-setting and rate review, responsibility of rate different project approvals process, domestic content requirements, different grid connection mandates, management of issues related to land use, especially agricultural land (Sustainable Prosperity, 2010).

The FIT model has been the main catalyst for energy co-operatives being formed in Ontario. Ontario's program has a conditional treatment for different levels of projects imposing restriction on sites through different requirements and also excluded agricultural land unlike the German model. Restrictive with respect to large projects, and facilitating for small, the Ontario program strongly favors residential and roof mount projects, especially discouraging ground mount projects by offering lower rates. The Ontario program offers high FIT rates and mandated connection for residential programs which often fall into the micro-FIT category and has less restrictions. The major differences between the Ontario and the German FIT programs are shown below in the table.

*Table 4 Comparison of FIT models (adapted from Deutsche Bank Group & dBITs (2010))*

| Criteria | Ontario | Germany |
|---|---|---|
| **Contract term** | 20 years | 20 years |
| **Projected investor IRR Target** | 11% | 7-9% |
| **Peak FIT rate** | $.80/kWh | $47/kWh |
| **Rate adjusting** | Fixed by OPA | Legislated and modified at 9%/year reduction |
| **Grid parity target** | No | Yes |
| **Project size cap** | Yes | No |
| **Connection cost/grid upgrade** | Borne by project over 500 kW | Borne by utility |
| **Electricity rate (residential)** | 7.7-14 cents/ kWh | 30 cents/kWh |

**5.2.2 History of energy co-ops in Ontario and their role in a decentralised energy regime**

Energy co-ops started in 2005 in Ontario but didn't really take off till the FIT program was introduced. If all FIT projects are operational there will be 17 MW of co-op owned power in Ontario and another 12MW with some kind of co-op participation. Under the first FIT program, there were only 2 co-ops, however the number increased when co-ops had special provisions under FIT 2.0 and led to 59 co-op contracts and 15 MW of energy (Federation of Community Power

Co-ops [FCPC], 2013). The Association of power producers of Ontario lists that "Currently 77 organizations are listed by the Financial Services Commission of Ontario as renewable energy co-ops" (IPPSO FACTO, 2013).

According to Canadian Co - op Association's (CCA) 2011 publication:

26% of renewable energy co-ops are biofuel co-ops. This is followed by wind co-ops (22%), and then followed by solar (13%). The renewable energy co - op sector is in growth stage and has a huge potential in terms of renewable energy production with less than 40% of incorporated co - ops are currently operating in the marketplace (CCA, 2011).

While the conventional system of energy production, transmission and distribution usually involves highly centralized and orthodox system with a top down approach where there is a central decision maker with numerous end-of-the-line dependent consumers. Locally and cooperatively owned facilities for energy projects can and do bring in a completely different model, focusing not only on the technical aspects but bringing in an important human and community focus. An energy plan which is community focused and led can not only produce energy and purchase energy, but also reduce energy use and manage demand. Community led projects development are often better at tackling local challenges and develop more effective solutions which focuses on local needs and involves the community, leading to higher trust and effectiveness of the project. Putting communities in control of the energy they use can have wider benefits such as building stronger communities, creating local jobs, improving health and supporting local economic growth.

Studies have found that community energy can be financially beneficial for consumers as well. By putting communities in control of the energy they use, generate and purchase, community energy can help people control their energy spending and keep down the cost of living.

One of the characteristics of the Danish wind energy sector is the cooperatives or guilds. Many of the wind turbines erected in the 1980s and early 1990 s were and still are owned by local cooperatives/guilds. Public resistance is one of the largest barriers to the development of renewable energy projects especially wind power. This is in contradiction with the favourable view people have in general for wind energy. There are some barriers to renewable energy projects. One of the most important is public acceptance of renewable energy projects, especially wind energy projects. Studies suggest a positive relationship between public acceptance and local ownership and management of renewable energy projects. Studies also suggest that often public opposition comes from a lack of public consultation by the project developers and what is often seen by the public as heavy handedness of bureaucrats and experts. This is a great advantage of energy co-ops, where members of the co-op own monetary stake in the project and are also consulted as stakeholders. Studies of wind energy projects in Denmark shows that acceptance of wind projects increases when the public are involved in consultation prior to project approval and when given the option of co - ownership. The Middelgrunden Offshore Wind Farm (40 MW) has been built with the collaboration between the municipality, an energy company and nearly 8000 members of the cooperative (Sorensen et al., 2000).

Various studies have emphasized the significance of active engagement by all citizens in the environmental debate. This shift in attitudes towards citizen participation has been characterized as a rejection of the top-down policymaking approach: "Sustainable development cannot be imposed from above. It will not take root unless people across the country are actively engaged." (DEFRA, 2002).

Over the past several decades, the scope of public decision making has changed from a focus on opinions from experts and bureaucratic officials to broadly addressing stakeholders' interests and actively engaging citizens to understand local issues (Savan *et al*., 2004). Thus, there has been a distinct increase in public participation in environmental decision-making processes.

Community renewable energy and especially co-operatively owned and run energy projects are being supported by environmental activists and the civil society alike as a way of increasing renewable energy technology innovation and also increasing public discussion in the energy sector, leading to more self-sufficient communities (Walker, 2008). Community energy projects are a great way of bringing the public voice into the energy policy making. Focussing on community involvement in renewable energy projects is an important way of assuring continued prosperity for communities in developed nations like Canada.

However, though co-ops are generally considered a great way to support local renewable energy generation, there are important considerations, especially from the utilities standpoint. Co-ops are an economic model for ownership and management of energy projects. Co-ops producing energy are often reliant on public utilities for transmission and distribution of the energy produced. Thus, this arrangement raises issues of division of risk and responsibility between the co-op and the public utility. There are many different aspects of energy system and different steps between production and consumption and risk associated with these steps. Some of the major factors to be considered which have risks associated with them, which need to be clearly divided and decided between the private and public partners. The public partner can't bear all of the risk without increasing the price for the end consumer as has happened in Germany and some other European countries. Whereas letting the private partner in this case co-operatives bear too much risk will restrict their involvement in large scale projects.

Some important aspects of an energy project where risk needs to be shared are as follows:

- Grid connection risk
- Environmental risk
- Technological risk
- Performance risk
- Legislative/regulatory risk
- Extreme weather event related service disruption risk

As in any project which has public and private partnership careful consideration has to be given to risk mitigating strategy.

### 5.2.4 Barriers to energy co-ops

The installed renewable capacity in Germany makes up around 150 TWh, amounting to about 30% of the net consumption of electricity. This high value can be attributed to about 800 energy co-ops that function in Germany. The installed renewable capacity amounts to about 3.5 percent of the total consumption in Ontario (Sustainable Prosperity, 2010). Denmark is one of the leaders of renewable energy, managing to provide one third of their demand through wind energy. This journey to include large scale renewable in the energy mix is a result of careful planning and support from the government. Long term planning is and transmission is managed by public owned electricity entities, with an overarching mandate to provide societal benefit. Denmark's electricity market is "unbundled"—meaning that generation, transmission and distribution are in the hands of different operators. And there is open access to the grid for all renewable energy producers (International Renewable Energy Agency [IRENA], 2013). The generation of renewable energy has been incentivized, however, all energy projects need to go through a rigorous process to ensure their position is optimal for transmission purposes and that there is no opposition to their location, and that environmental externalities are minimal. These policies have led to the creation of a well-planned and transparent electricity sector promoting competition, keeping costs down and fostering renewable energy. Denmark suggests that investment needs to be not only in renewable energy technology but also in complementary systems such as storage, demand response, smart grids etc. (Lund and Mathiesen, 2009).

The RECO report (RECO, 2013) points out that while there is a budding concern about renewable energy projects especially in community based initiatives. The reports also states that there is a huge potential for energy co-ops and that they should be looked at from the perspective to "insulate itself from many of the key risks embedded in a more traditional energy strategy, grounded primarily in centralized generation and transmission" (RECO, 2013). The main barrier identified in the RECO report is regarding the FIT program and changes required to it.

Other barriers identified include the problem of generating the capital required for initial expenses and project development. Another important point was that city owned land was harder to procure for renewable energy projects. This was emphasised by Zooshare as well, who have their biogas electricity producing unit on city owned land.

Another barrier identified for energy co-ops is uncertainty in the legislative process regarding the FIT program. The long-term stability of policy for renewable energy consistently ranks among the most important factors in private sector investment decisions among competing jurisdictions. Ontario has seen frequent change in policy and an uncertain future in terms of regulation and policy environment inhibits private investment, especially in terms of co-ops which have small capitals to begin with.

#### 5.2.5 Recommendations

Thus, it is evident that the renewable energy sector is largely emergent still, whereas they have been flourishing and a force involved in the change of the energy sector in Germany, Denmark and some other countries. “Co - op formation in Canada is heavily dependent on provincial electricity policy as well as on the co - operative regulatory processes” (Lipp and McMurtry, 2012). Some suggestions for the regulatory/policy changes required to further support energy co-ops are as follows:

- Changes to FIT program:
    - Providing a bigger window for applications or having rolling applications procedure
    - Small co-ops audit needs to be defined separately from big developers so as not to unjustly tax the small entities
    - Introducing another category of FIT program between large scale projects and micro fit, to facilitate co-operatively owned or community owned power production
- Changes facilitating easy borrowing of money for infrastructure development by energy co-ops.
- Energy co-ops have a role to play in district energy and CHP plants as well. The enormous potential for heat generation, supplies and use by energy cooperatives must be leveraged further by creating appropriate or modifying existing legal and business conditions.
- Incentives for private developers to partner with co-ops by providing monetary incentives or increasing the points allotted in the FIT program
- Establishing targets for community energy procurement
- Monetary incentives to support co-ops and community power, such as reduction in taxes etc.

## Part 6: Lessons learned from ‘mega cities’ around the world

Mega cities on different continents have been learning from each other in terms of addressing demands placed on them and, at the same time, taking steps to move towards sustainability. While they all are on an evolutionary path, their unique geographic location, needs and constraints all factor in decisions they make to move forward. As unique as their drivers may be, on a closer look, some common themes or categories emerge. Consistent with the theme of the white paper, we have focused on those drivers that have strong links to urban and energy planning. Since energy such as electricity and gas touch many categories of urban planning, and since environment and energy are intimately connected, taken together energy and environment influence most if not all categories of urban planning.

Our goal here is to compare some of the leading mega cities of the world on aspects of energy and environment. This will not only provide a frame of reference, it will also shed light on what can be learned from other mega cities. It is to be made clear, however, that while energy and environment is the basis of comparison, it by no means implies that “affordability of energy” or “promoting economic opportunity” is of less value as far as urban planning is concerned. Minimizing environmental footprint is a common goal observed amongst all mega cities. In total there are well over two dozen measures spread over a half a dozen or so categories.

Spearheaded by some of the world’s largest urban agglomerations, energy, its generation and distribution, has become part of the urban planning effort the same way buildings, public transportation, bridges and roads have been integrated into plans to expand and better cities for centuries. Urban communities in developing countries are inherently not unlike their iconic counterpart in the developed world, striving to secure ample energy supplies for their inhabitants, while trying to reduce pollution and waste (Droege, 2008). In fact cities in developing countries represent the biggest increase in energy demand worldwide (e.g. 195% rise in electricity demand in China and 282% in India). While the efforts of these emerging megacities is less publicized and adoption often hindered by economic priorities of rapid growth, they have enormous potential to make a lasting impact on global demand. For more information on some of these innovative and forward thinking mega cities, please find a few short descriptions in Appendix A.

*Table 5 Overview of cutting edge developments in cities from around the world*[7]

| What? | Who's leading the way! |
|---|---|
| **Energy and Urban Planning** | "**Barcelona** requires solar water heaters in all new buildings and renovations. Over 70 municipalities have since followed its example. This ordinance helped Barcelona reduce the carbon intensity of its electricity by about 30%. In **Edmonton,** The Way We Green is an environmental strategic plan, a comprehensive and detailed set of actions with the ultimate goals of carbon neutrality by 2040. With input from residents and different stakeholders, Way We Green is a strategic plan covering the whole spectrum of sustainable urban development: finance, environment, growth, livability, transport, and prosperity. |
| **Renewable Energy Targets** | San Francisco aims to reach 100 % city-wide renewable electricity generation by 2030. Vancouver City has the same target for around 2035. " In 2009, the City of Malmö launched the "Environmental Program," a city-wide project with a progressive environmental agenda to improve the sustainability of the city and the quality of life of its citizens. According to the Program, by 2020 the city will be climate neutral and by 2030 the entire city will run on 100% renewable energy" City Climate Leadership Awards). |
| **Reducing Ecological Footprint** | Being identified as the Canadian City with the largest footprint by the Global Footprint Network, **Calgary** Climate Change Action Plan Target Minus 50 is now one of the most ambitious climate plans in North America. |
| **Distributed Electrical Power** | **Copenhagen** obtains some 3-4% of its electricity from a single offshore wind farm, Middelgrunden. With 20 turbines for a total of 40MW, Middelgrunden is located in one of Copenhagen's harbours, and is highly visible from a number of vistas. **Sonoma Mountain Village** is the largest approved One Planet Community project to reach the construction phase. Two solar power plants, of more than 1 MW each, will help provide 5,000 people there with green energy. |
| **Implementing Smart Grids** | GE and ComEd have committed $200 million to install 4 million smart meters in the city of **Chicago** between 2013 and 2021 (greenbiz.com). **Austin,** Texas, is the first city in the world to have built a citywide smart electric grid. Their Smart Grid 1.0 was completed by 2009, much due to the fact that the utility is owned by the city. |
| **Addressing Climate Change** | In 2006 **Cape Town** became the first African city to adopt an energy and climate strategy. In a detailed plan of action in 2009, the goal of a 10% reduction (from the 2009 level) in carbon dioxide emissions for the entire city was set to be achieved by 2014 |

[7] Source: http://wwf.panda.org/what_we_do/footprint/cities/urban_solutions/

| | |
|---|---|
| **Land Use** | **Scitiate** is the first municipality in Massachusetts to become 100 % renewable by installing a 3 MW solar plant on its abandoned landfilling site (solarbrownfields.com). Two-thirds of **Freiburg's** land area is devoted to green uses. Just 32% is used for urban development, including all transportation. Forests take up 42%, while 27% of land is used for agriculture, recreation, water protection, etc. |
| **Building Retrofits** | Through its Energy Saving Partnership, **Berlin** has retrofitted over 1400 buildings since 1996 and was one of the first city to introduce energy performance contracts to help finance retrofits. |
| **Mobility and Transportation** | **London's** ground-breaking congestion charge has resulted in a reduction of central traffic and increase of public transportation by 20 %, respectively. Bicycle use increased by 80 % (WWF Urban Solutions).In 2009, **Adelaide** began using solar panels to build the roofs of tram stops: these supply electricity for the stops and the city grid. |
| **Energy Conservation** | **Los Angeles** is migrating its street light system from conventional high pressure sodium lamps to Leeds. The city's massive migration to LEDs will improve light quality, reduce light pollution, enhance traffic safety, and above all save money and energy. |
| **Public Action and Governance** | **Sendai** was one of the leaders of the Japanese grassroots movement for green public procurement in the 1990's. It led to Japan becoming a forerunner in the field, with national legislation being set up as early as 2000. More than 90% of Sendai's municipal purchases are made from a list of green products the city has set up. |
| **Innovation** | **Denmark** is a leading user of district heating in Europe. District heat is used by approximately 2/3 of the Danish population – 60% of households. This is mainly in combination with CHP. And waste-to-energy, in the form of incinerating municipal solid waste, provides 20% of the heat for Denmark's over 400 district heating networks" |

## Part 7: Where Toronto is leading the way

Toronto uses over of 72,000,000,000 equivalent kilowatt-hours (ekWh) of energy annually from all sources including electricity and natural gas each year (Toronto's Sustainable Energy Plan, 2007). Rising energy costs, growing demand for energy, higher peak energy demand due to changing weather conditions, aging energy infrastructures and the increasing impact of our energy choices on the environment. Toronto also faces risks to our current quality of life from climate change impacts. These will range from greater energy use in the summer that can cause energy brownouts or revolving power cuts, heat waves that will affect the poor, the sick and the elderly the most, and extreme storms leading to transmission failures and power blackouts.

As of 2012, the city (administration) has cut its emissions by close to 50% against 1990 levels via a variety of measures such as retrofitting city-owned buildings, collecting methane at city landfills or installing solar PV on city properties. The city's energy goal of "[ensuring] that Toronto's energy supply becomes and remains environmentally sustainable, safe, secure and affordable" was laid out in Toronto's Sustainable Energy Plan (2007). Among the Plan's objective was the goal of developing "local sources of energy generation and distribution" (ibid.). Toronto's main emphasis, indeed the Province's single most important strategy is energy conservation & reduction. This is not to say the Toronto is not investing into RE projects, but conservation will lessen the overall demand for new energy supply and its trickle down effects save billions in new infrastructure and generation costs.

Today, up to two-thirds of centrally produced energy is wasted due to generation and end-use inefficiencies, and transmission line and distribution line losses. Torontonians spend nearly $4.5 billion per year on energy — $2.7 billion on electricity, and $1.8 billion on natural gas. This amounts to $3 billion being spent annually on energy that is never used (Toronto's Sustainable Energy Plan, 2007).

Beyond conservation, Ontario is faced with the replacement of current energy plants that have (or are near) reached the end of their operational life and more importantly the phasing out of coal. The latter is viewed as the most ambitious climate change initiative in North America. While the government is committed to nuclear and natural gas, wind and solar are also set to play an important role in Ontario's future energy mix. At the moment there are no large-scale RE projects planned in the city of Toronto, although solar rooftop programs receive the continued support of both local and regional government funding and initiatives. However, the city's main focus, apart from conservation, is on improving reliability and resilience. This is done by updating and improving existing stations and reinforcing transmission and distribution lines.

The following three paragraphs showcase some examples of Toronto's leadership in green energy infrastructure and innovative forward thinking programs.

**7.1 Enwave Energy Corporation**

Enwave Energy Corporation (EEC), partly owned by the City, is the largest district energy company in Canada and one of the largest in North America. EEC provides heating and cooling to commercial, institutional and multi-residential buildings in Toronto. District energy customers get their heating and air conditioning via underground pipe distribution networks that are connected to one or several large plants. Enwave operates four large energy plants with over 20 kilometers of distribution piping, and sells over 2.5 billion pounds of steam each year. Its deep lake water-cooling system uses the cold water from Lake Ontario to cool buildings in downtown Toronto. City Hall, Metro Hall, Police Headquarters are now connected to Enwave's deep lake water-cooling system. The system has enough capacity to air condition over 3.2 million square meters of building space or approximately 100 large office towers (The Power to Live Green, 2009).

**7. 2. Community Energy Storage Programs**

Toronto Hydro together with the city of Toronto has launched a program to outfit several municipal buildings across the city with more than 4,400 photovoltaic (PV) panels that will generate around 1,400MWh. In order to absorb these and other future loads generated by RE, Community Energy Storage Programs are being developed that will help smooth the ebb and flow of PV systems. These storage tanks have a small enough footprint to be located in an urban area, but contain powerful batteries to power many surrounding households.

**7. 3. Toronto Solar Neighborhoods**

The Toronto Solar Neighborhoods Initiative offers financial incentives for solar hot water installations for homes in Wards 31 and 32 (Power to Live Green, 2009). Prior to the actual installation, residents receive assistance in identifying opportunities to save energy and reduce hydro bills. This is pilot program has an objective to install up to 150 solar hot water systems on homes, which will serve as a model for the City of Toronto's Live Green Toronto program.

*Table 6 Noteworthy examples from Toronto and Ontario*

| What? | Examples from Toronto (Ontario) |
|---|---|
| **Energy and Urban Planning** | A study conducted by the Canadian Urban Institute evaluated the potential for **district energy system**s in three Toronto neighborhoods (Scarborough Centre, North York Centre, and the Sheppard Corridor). The study finds that the development of CHP district energy systems in these neighborhoods would yield significant energy and greenhouse gas emissions reductions. The total annual energy reduction for these three communities is estimated to be approximately 4,100,000 gigajoules, corresponding to a reduction in greenhouse gas emissions of approximately 200,000 tones. |
| **Renewable Energy Targets** | The **Power to Live Green** of 2009 outlines a wide range of different goals and targets, including the installation of 500 MW of renewable generation by 2020 and reaching a total of 1000 MW of renewable generation by 2050 as well as 1000 MW of Conservation (CDM). |
| **Reducing Ecological Footprint** | Toronto's reduction targets for GHG emissions, from the 1990 levels of approximately 22 million tones per year for the Toronto urban area, are: 6% by 2012 (The "Kyoto Target"), 30% By 2020, and 80% by 2050. |
| **Distributed Electrical Power** | Although, Toronto is committed to 1000 megawatts of renewable electricity generation distributed throughout Toronto in the form of small scale solar photovoltaics ("PV"), wind energy, and biogas, we have thus far seen little installations on a larger-scale. Energy Co-ops could fill this gap |
| **Implementing Smart Grids** | Toronto Hydro is investing in the development and implementation of a smart grid in the City of Toronto that will modernize an aging infrastructure, significantly improve the efficiency of the existing electricity distribution system, provide access for renewable electricity and emerging technologies, prepare for electrified transportation, and empower customers with information, options, and control, to manage their electricity and reduce their carbon footprint. |
| **Addressing Climate Change** | The City of Toronto is not only committed to reduce its GHG emissions, but has also acknowledged that Climate Change will require a great deal of adaptation. Preparing Toronto for Climate Change, is a report that outlines a number of actions that will improve the City's resilience to climate change and extreme weather events. |
| **Land Use** | The **Greenbelt** is a permanently protected area of green space, farmland, forests, wetlands, and watersheds in the GTA that includes and protects the Oakridge Moraine and Niagara Escarpment.<br>Toronto has recognized that Parks and trails are vital components of city infrastructure and must be recognized for the contribution they make to a vital city. It has therefore set out a long term plan to increase and maintain the city's parks. At the same time, the Toronto waterfront renewal is the multi-billion dollar long-term plan for environmental improvements, economic activity and overall enhancement of quality of life through energy efficient developments (LEED), cutting-edge Wastewater Treatment Plants (Sherbourne Commons) or award-winning open spaces (Sugar Beach). |

| | |
|---|---|
| **Building Retrofits** | **Toronto's Home Energy Loan Program** is a new financing tool offered by the City of Toronto to help homeowners improve their home's energy efficiency while saving money with incentives of up to $2,000 are available from Enbridge Gas, or up too $650 from Toronto Hydro for replacing your furnace and air conditioner with high efficiency units.<br>The **Toronto Green Standard** is a two-tier set of performance measures for sustainable site and building design. Tier 1 is required for new construction in Toronto and Tier 2 is a higher, voluntary level of performance with a financial incentive. Projects that achieve Tier 2 may be eligible for a partial refund on Development Charges paid to the City.<br>The **Better Buildings Partnership** has created more than $80 million in energy retrofits in buildings; the City's Energy Retrofit Program has carried out $30 million worth of energy-related projects in City facilities. |
| **Mobility and Transportation** | **Idle-free Zone,** where running your engine while parked for more than 60 seconds is prohibited under City of Toronto By Law.<br>**Bike Share Toronto** offers a network of bikes throughout the downtown core which you can borrow, and then return to any docking station<br>**Smart Commute** helps employers and property owners reduce their costs and carbon footprints by providing programs that help their employees commute to work in sustainable ways |
| **Energy Conservation** | The City of Toronto is committed to reduce consumption of energy and increase conservation via its **Energy Conservation & Demand Management** Plan that runs from 2014-2019. Average energy use intensity in larger corporate facilities has been reduced by about 15% since 2004. Further efforts in analysis of building operations, energy efficient upgrades and training across the portfolio of City-owned facilities can further reduce energy consumption by up to 30%. |
| **Public Action and Governance** | Toronto is a pioneer in research on the health effects of air pollution. Toronto Public Health (TPH) has published a dozen reports in the past ten years that quantitatively document the link between poor air quality and illness. These reports have built up support for major remedial measures. And in recent years, Toronto has copied the same approach with climate change. The TPH also builds political support for action both within the public sphere and in collaboration with private operators – citizens, businesses, and NGOs alike. TPH's strategy has been successful. Toronto currently has ambitious plans for reducing greenhouse gas emissions and improving the quality of the air. |
| **Innovation** | "The **Hydrostor** system efficiently converts electrical energy to compressed air via an advanced adiabatic compression system. This air is then sent to a series of flexible accumulators located 50-500 meters below the surface of a body of water. Once in the accumulators, the energy can be stored until required by the grid. When the energy is required, the weight of the water pushes the air back to the surface where our system directs it through an expander driving a generator thus supplying energy to the grid and completing the storage cycle" (Hydrostor.ca) |

# Part 8: Conclusion, Suggestions and Vision

In recent years, cities/municipalities have often set more ambitious goals for renewable energy and GHG emission reduction, compared to provincial and especially federal governments. This shift in leadership is demonstrated by Vancouver's ground-breaking target of becoming community powered 100% by renewables. Clean Energy Canada Senior Analyst Jeremy Moorhouse said the city (Vancouver) has "joined […]a small group of other visionary cities that have set ambitious goals to meaningfully tackle climate disruption"[8]. The negative local and global ramifications - air pollution, price volatility, energy dependence, climate change, etc. - resultant of the immense urban appetite for energy, are not only well documented, but have become an impetus for cities around the world to bring about change. Change in the way they generate, distribute and consume energy with the ultimate goal to reduce its demand and manage (generate and store) it more sustainably. We have seen the government of Ontario take charge in protecting our natural landscapes and green belts and more recently in the phasing out of coal. It is pivotal not to forget about the power of top-down-bottom-up mix and collaboration when it comes to energy.

The desire to improve quality of life of all its citizens has been and will remain one of the key drivers for urban energy planning, which is a multifaceted and interconnected approach that includes a myriad of factors. These are; energy security, economic considerations, resource scarcity, societal/behavioral change, resilience and climate change mitigation policies to name just a few. Whatever the motivation, significant change is only possible by designing new infrastructure for the future and integrating 'Energy' into Urban and Regional Planning. Urban Energy Planning is driven by a multidisciplinary approach aiming to address issues of generation, conservation, and distribution from an economic, engineering, political, and social perspective.

"The LDC of the future must have a stronger balance sheet, and the capacity to adopt new technology and offer advanced services in a cost-effective manner. This requires *"shoulder-to shoulder, robust, well-resourced, and efficient LDCs,"* to borrow a phrase from the Electricity Distributors Association (EDA)"[9].

In general, the integration of energy planning into the broader context of sustainability and resilience requires:

- Courage to have a vision for the future for that Ontario can continue to lead the way in securing a more sustainable energy future for the benefit of its people(s)
- A discussion at the top level of government with all concerned stakeholders and concrete goals and a clear roadmap for the future
- An increase in the overall literacy. Urban planners need to speak in energy terms and utilities need to speak in urban planning terms. Universities will play a vital role in providing this "language" education.
- Stakeholders to explore every option and alternative going forward and not shy away from thinking outside the box.
- A degree of risk to try something new, yet be flexible and courageous enough to admit failure and try something different

[8] http://smartershift.com/energymix/2015/03/30/vancouver-sets-100-renewable-energy-target/

[9] http://www.energy.gov.on.ca/en/ldc-panel/#h

## We make the following suggestions:

**Provincial Government:**

- We underline the Ministry of Energy's statement in the LTEP that "communities must be allowed to take a more central role when implementing provincial policy objectives. The opportunity for communities to participate in energy infrastructure must be balanced with their responsibility to take ownership of local decisions"
- At the same time, a vision is needed that aims to further the union between energy planning and urban planning and regional planning to include all stakeholders and increase coordination.
- Energy should be regarded as a whole (power, gas, heat etc.) and not separate to avoid mis-coordination.
- Energy planning should encompass not only generation and different levels of distribution, but include plans on how to store renewable electricity on small and large-scale in order to increase viability and feasibility of green energy sources.

**Municipalities and Communities:**

- Apart from long-term strategies and goals with regard to conservation, Community Energy Plans should also aim to provide specific roadmaps on how to achieve these goals and whether or not they are able to go beyond conservation and generate electricity themselves.
- CEPs also need to address local risk and how to become more resilient in the future, in view of ever more severe weather events.
- CEPs need to address energy storage where possible and communicate their needs to and work with the industry, academia and electrical system infrastructure planners and operators.
- CEPs need to include cost benefit analysis for different scenarios to create a more tangible impact on energy planning and participate in long term energy planning as and when done by the provincial governments.

**R&D and Educators:**

- Advance the knowledge on smart grids and resilience and the impact distributed renewable energy will have on it
- Further the education of the public on urban and energy planning, especially to create a common language that all stakeholder understand.
- Create a platform for academic discussion (e.g. Journal, Conferences, etc.) on urban and energy planning.
- Offer programs to students that incorporate all aspects of urban energy planning.
- Advance the knowledge and technical feasibility of reliable and affordable energy storage systems, without it, the renewable energy revolution (or Energiewende) is less certain.

**Electrical System Infrastructure Planners & Operators:**

- Recognizing the paradigm shift that energy and urban planning are no longer to be regarded as separate entities, but two collaborators working on a common goal.
- Energy and energy planning needs to become more inclusive to all stakeholders

- Energy and urban planning requires both a top-down and bottom-up approach. The two are not mutually exclusive but coexist collaboratively
- Recognizing that communities/municipalities also know what is needed and what their potentials are both in terms of know-how and generation, conservation and resilience, it is vital to make them a key stakeholder on local as well as regional and provincial electricity planning matters.
- Need for a vision that integrated energy planning in the broader context of sustainability and resilience.
- System Operators can benefit from cooperating with local energy storage programs to increase reliability and resilience. This requires a great deal of coordination in order to accommodate these technological advancements.
- Electrical System Infrastructure Planners and Operators need to try and accommodate municipal efforts to generate energy, conserve it or store it more effectively and cost efficiently.
- It is essential to integrate sustainability and climate change targets into land use planning at the regional and city levels to ensure that, amongst other goals, maintenance and new infrastructure investments are consistent with the long-term goal of sustainability.

## Vision for the Future

Business as usual is a prescription for failure. This is especially true for urban energy consumption and electrical system infrastructure planners and operators. Urban sustainability is a great challenge that will require a major and concerted effort by cities and nations around the world. We must develop new and manage our existing urban infrastructures during the next three decades. To achieve this, WWF estimates that an approximately US$350 trillion need to be spent on urban infrastructure and usage over the next 30 years directed towards low to zero carbon emissions. Thus an over-arching theme of sustainability needs to be adopted for energy planning.

We are at a crossroad, where the opportunities for change are aplenty. The province of Ontario, the electrical system infrastructure planners and operators, the City of Toronto and other municipalities are in a position to take the lead towards creating a structure that is beneficial to all stakeholders. This can be done by increasing cooperation, coordination and inclusiveness in the way electricity is being generated and distributed. This takes a vision for the future and the courage and conviction to pursue this vision.

The integration of urban and energy planning should by no means be understood as *the* solution, but simply as a vital piece of this puzzle. Our recommendations made in this White Paper together with other studies and reports can be put forward for consideration. Questions such as the impact of renewables on smart grids or the assessment of risk, resilience and externalities require further research and attention, as well as the collaborative effort of a multitude of disciplines. The integration of urban and energy planning is also to be understood as a way of getting ahead of climate change, not only as a response (e.g. adaptation) to current events but also as a way to mitigate and anticipate future severe events.

## Appendix A: Examples from mega cities around the globe

The descriptions of the following four cities were taken more or less directly from WWF Urban Solutions and the ICLEI-Local Governments for Sustainability Report.

**Amsterdam**

Amsterdam has more bicycles than people. According to the WFF, "No city has yet embraced the smart city concept quite as thoroughly as Amsterdam. Amsterdam's 2040 Energy Strategy aims to become a climate-neutral municipal organization in 2015 75% reduction in CO2 emissions in 2040, compared to 1990. Amsterdam is in the unique position of being one of the world's largest port cities and a hub for continental Europe, thus able to have a big impact on sustainability and spreading inspiration. The city's strategy involves four key aspects; efficient buildings, cleaner transport, sustainable port and industry and renewable energy. The most innovative elements include; a comprehensive program for launching an electrification of vehicle traffic - including canal boats - with the target of 10,000 electric cars by 2015; in the Zone spot project, solar-power-driven hotspots were installed to facilitate outdoor work with laptops in open spaces, or Renewable energy sources were tested in three projects: collective financing of seven wind farms, 3,000 solar panels in a business district, and installation of fuel cells in an 18th-century building to name just a few".

(Source: http://wwf.panda.org/what_we_do/footprint/cities/urban_solutions/themes/energy/?204657)

**London**

"The London Energy Partnership (LEP) was established as an independent body to provide coordination and synergy between the many groups, organizations and networks working on energy issues in London. It provides a vehicle for the delivery of the City's energy policy. Until the formation of the Partnership, London lacked an adequate mechanism to enable broad collaboration that is required to tackle these crosscutting issues. Through a consensual process with energy stakeholders, the LEP guided the development of the City's 2004 Energy Strategy. In 2007, the City developed a Climate Change Action Plan to further strengthen action in this area. The Plan aims to achieve a 60% cut in CO2 emissions by 2025. The LEP is responsible for implementing and reviewing the City's Energy Strategy and Action Plan. LEP activities are directed by the LEP Steering Group. Task Groups are responsible for driving the implementation of the Energy Action Plan. The London Energy Forum is a broader grouping of stakeholders which functions as a networking and discussion forum and feeds into the LEP. The main aims of the partnership are to: (1) Assist in the delivery of London's CO2 reduction, fuel poverty and security of supply targets for 2010, 2016 and 2050. (2) Provide a single voice for sustainable energy in London and achieve a shift in thinking about sustainable energy by key stakeholders. (3) Enable a number of high profile, London-wide initiatives that deliver social, environmental and economic benefits. (4) Create commercial opportunities in sustainable energy and help to build London's green economy".

(Source: UN-Habitat, UNEP and ICLEI-Local Governments for Sustainability, 2009)

**Seoul**

"Seoul's wish to divest from nuclear is partly a response to the growing public opposition to nuclear energy in the wake of the Fukushima disaster in Japan. In the first phase of the Sunlight City project, Seoul is installing rooftop solar PVs on about 10,000 buildings, for a total capacity of 320 MW. In addition, the city is building solar power stations with a combined capacity of 30 MW in spaces such as sewage facilities and parking lots. Seoul will also support the creation of 25 resident-led, energy-independent communities with on-site renewable energy production and a minimum of external energy supply. Seoul has developed a solar map to show areas suitable for solar PVs and to quantify the savings rooftop installations can deliver, in order to increase citizen engagement in the program. Additional actions to achieve its solar goals include: renting out unused public facilities for solar PVs; signing investment agreements with companies and civic organizations; amending an ordinance to calculate public facility rents based on power generation volume; and increasing installation permits twentyfold. Seoul has supplied approximately 3,000 households with solar PV installations, and has invested $US 43 billion on 285 public building installations. The city has also launched a renewable portfolio standard (RPS) program to replace a now defunct feed-in tariff and with the goal of 1.2 GW of solar PV capacity to be added by 2015. Seoul also launched a massive building retrofit program, with the goal of energy savings renovations and leakage prevention in 12,000 buildings by 2014. Building codes with energy caps and energy saving standards are to be expanded from large buildings to all new construction".

(Source: http://wwf.panda.org/what_we_do/footprint/cities/urban_solutions/themes/energy/?229196)

**Vancouver**

"Vancouver is one of a few cities around the world, where the environmental agenda has become the unifying principle and main project. After decades of work with the environment, starting with the cancellation of a massive freeway project in the 60s, and continuing with Transit Oriented Development (TOD) and an early climate plan (1990), Vancouver has now launched a comprehensive action plan to "become the greenest city in the world". The Greenest City 2020 Action Plan, approved 2011, is inspiring not only because it sets high goals across the board of urban sustainability, nor because it is integrated throughout the departments of the city, but also because it shows that it is possible to quickly achieve improvements. Only a couple of years into the plan's implementation, Vancouver is well on its way to reaching its ambitious goals. In 2013, hundreds of projects had been launched and improvements over the baseline had been achieved in all areas. The overarching goal of Greenest City 2020 Action Plan is to bring the community-based GHG emissions down to 5% below 1990 levels, even as its population has grown by over 27%. For instance, the city had reduced greenhouse gas (GHG) emissions in existing buildings by 3% and in the whole community by 4%, or installed 40 public EV charging stations, with another 40 underway".

(Source: http://wwf.panda.org/what_we_do/footprint/cities/urban_solutions/themes/governance/?212273)

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- The Clinton Foundation's C-40 Climate Change Initiative
- UN-Habitat's Cities for Climate Change Initiative (CCCI)
- Federation of Canadian Municipalities (FCM)
- WWF Urban Solutions for a Living Planet (WWF)