FUTURE CITIES CANADA

REIMAGINING PUBLIC SPACES

GREEN ENERGY SOLUTIONS

A Practitioner's Toolkit

March 2023

EVERGREEN

ACKNOWLEDGEMENT OF INDIGENOUS LANDS AND TREATIES ACROSS CANADA

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WHAT'S INSIDE

PREFACE

Communities across Canada are rich in public spaces of all kinds and sizes. These spaces are essential social and environmental infrastructure that can become a powerful lever towards building innovative, smart and more sustainable communities for all. At their best, these physical spaces, part of the civic commons, foster greater livability, vibrancy, belonging and engagement. Positive outcomes range from stronger connection, wellbeing and community, to improved climate resilience, safety, inclusion and diversity. However, it can be challenging for communities to understand how to better tap into the potential of these spaces in ways that work for them.

Public Space

Areas or places that are open and accessible to all people, including streets, public squares, parks, beaches and civic spaces. Successful public spaces are designed with all residents in mind and allow people to interact with these spaces in different ways. Great spaces enhance livable cities by supporting a sense of connection, individual and social wellbeing, and community expression, identity and diversity.

WHY THIS TOOLKIT

Communities across Canada are taking action to tackle climate change to meet the United Nations' target of a maximum global temperature rise of 1.5°C. Mitigating climate change, through the reduction and prevention of greenhouse gas emissions and to transition toward a "net zero" future, is imperative. Energy use is a primary source of greenhouse gas (GHG) emissions and so, the energy system is undergoing transformation, moving towards green energy and the reduction of carbon in the energy sector.

Greenhouse gas emissions in Canada come primarily from producing energy (45% from burning fuel for electricity and heat) and from transportation (28%).[1] Canada's per capita energy usage is also the highest in the world.[2] Canadian communities are responding by using energy technologies to meet ambitious GHG targets. Examples include electrification, energy efficiency, conservation and reduction, de-carbonizing the transportation sector and enhancing renewable energy generation. From building retrofits (public and private) and infrastructure to new transportation models (see Toolkit 1 - New Shared Mobility: A Practitioner's Toolkit), the green energy revolution is well underway.

Public spaces are key assets in communities and they help to make them more livable. They also offer great potential to support green energy technology initiatives that reduce emissions and contribute to a climate resilient future. And yet, beyond creating greenspace (e.g. capturing carbon) and supporting greener transportation (e.g. bike lanes), they are an undervalued resource in climate mitigation strategies. **Imagine if your public spaces could be green energy hubs for reducing carbon emissions, using technology to generate and store energy from renewable sources for on-site and beyond.** Public spaces often have the necessary elements to incorporate green energy: sun, wind, land, open space, buildings and infrastructure . "As cities develop new interventions for climate change mitigation, incorporating renewable energy in urban public spaces becomes a common norm to address sustainability objectives."[3]

The **Green Energy Solutions** toolkit is designed to support you and your team in understanding and incorporating energy technologies and green energy solutions into your public space projects. Tap into this introductory resource to be better equipped to meet your community's sustainability and carbon-reduction goals. Included inside are easy-to-understand tools, covering three main themes:

1. **Overview of Green Energy**
2. **Implementing Renewable Energy in Public Space**
3. **Innovative Green Energy Technologies**

Climate Mitigation is any action or response intended to reduce or prevent greenhouse gas emissions, or to enhance sinks that capture or store carbon, usually towards long term benefits.

Green Energy is a broad term used here to describe a range of approaches and solutions used to reduce emissions and mitigate climate change. These may include various renewable energy applications, increase efficiency and conservation, and moves away from fossil fuel energy production, often towards electrification. (reducing energy usage).

Greenhouse Gas emissions (GHGs) are gases in the atmosphere that trap energy from the sun and cause the Earth's temperature to rise. The burning of fossil fuels has accelerated this effect, through the emission of large amounts of carbon dioxide, methane and nitrous oxide to the Earth's atmosphere.

Electrification is about switching from fossil fuel energy sources, such as coal and gas, to electricity for energy, which may come from various electricity generation sources.

[1] Prairie Climate Centre, "Greenhouse Gases", Climate Atlas of Canada, 2019, https://climateatlas.ca/greenhouse-gases#:~:text=gases%20(GHGs).-,Where%20do%20greenhouse%20gases%20come%20from%3F,fires%20and%20decomposing%20organic%20matter.
[2] Rabson, Mia, "IEA Cites Canadians as Biggest Per Capita Energy Users, Three Times the Global Average", *The Energy Mix*, (blog), Oct. 19, 2021, https://www.theenergymix.com/2021/10/19/iea-cites-canadians-as-biggest-per-capita-energy-users-three-times-the-global-average/.
[3] Kaan, Ozgun, "Towards a Sustainability Assessment Model for Urban Public Space Renewable Energy Infrastructure", *Energies*, 2020: Abstract, https://www.mdpi.com/1996-1073/13/13/3428.

HOW TO USE THIS TOOLKIT

This toolkit is best used as a resource to complement the development of your climate resilience, de-carbonization and public space projects and plans. It can be helpful in establishing shared understandings, sparking ideas and creating a holistic and impactful approach as you work towards a low-carbon energy future.

You are encouraged to work through this collaboratively with your team and key stakeholders, ensuring a range of perspectives across key municipal departments.

This resource is intended for leaders in communities in Canada of all sizes who are looking for strategies, approaches and solutions for greener energy and for innovative ways to leverage public spaces towards these goals. These leaders may include municipal staff, elected officials and leaders at other organizations focused on parks and recreation, planning, local utilities, environmental and climate change . It is meant to be an introduction and resource for your green energy journey, rather than a comprehensive or technical guide.

We know that each community is unique, with its own strengths, assets and challenges. Communities and their leaders are invited to use the tools as they wish, to explore a range of options and craft their own green and resilient public space approaches. **Use what works for you and feel free to adapt or expand along the way.**

Deploying greener energy solutions in your community's public spaces, and leveraging these underutilised spaces toward renewable and de-carbonized energy, is a powerful opportunity to expand and accelerate impacts towards your energy goals.

Let's delve into how green energy solutions can be used in public spaces.

Green energy has been around for centuries but, in recent years, new technologies have been developing rapidly while costs are going down. There are many ways to think about green energy in the context of climate mitigation. It includes energy used for electricity, as well as heating and cooling. It includes the production of greener forms of electricity produced through renewable energy sources, such as solar and wind, moving away from fossil fuels. It also involves efforts to reduce energy usage through efficiency and conservation. Optimizing many of these efforts involves the use of data and connected technologies – to monitor, assess and optimize across energy systems.

Considering green energy solutions for public spaces begins with a solid understanding of green energy, and its possibilities for public spaces, whether creating new spaces or retrofitting existing ones. Then, community leaders can explore how to "consider renewable energy as an important 'ecological infrastructure' similar to the management of water resources, waste cycling, food production and mass mobility. Renewable energy infrastructures can also be fully recognized as complete localized electricity production, consumption and distribution systems when integrated in public spaces."[4]

ABOUT THIS TOOL

The **Green Energy Primer** has been developed to provide a brief overview of key renewable energy sources, and where they might be sited in a public space. By reviewing a range of options, you and your team can build on existing knowledge and spark new ideas. As you reflect on your own public space project and approach, you will then be better equipped to leverage your public space and incorporate green energy into it to serve the site needs and possibly beyond. It is up to each community to decide what makes the most sense based on their context. By implementing green energy in public space, you not only will contribute to your mitigation goals but also lead by example, inspiring and catalyzing action across sectors in your community.

Renewable energy is energy derived from natural processes that are replenished at the same (or faster) rate than they are consumed. Sometimes called clean energy, renewable resources such as wind, sun or moving water get converted into usable energy such as electricity and heat, through a range of technologies including turbines and photovoltaic panels.

[4] Kaan Ozgun, Ian Wier and Debra Cushing, "Optimal Electricity Distribution Framework for Public Space: Assessing Renewable Energy Proposals for Freshkills Park, New York City", *Sustainability*, 2015: 348, https://www.mdpi.com/2071-1050/7/4/3753/htm.

TIPS

- ✓ Be context-specific – consider what types of renewable energy might work in the space (e.g. is there lots of wind or sun?) and what the community will support.
- ✓ Work with your internal technology and IT teams to ensure that energy management, data collection and reporting can be supported. Ensure cybersecurity.
- ✓ Consider long-term economic, environmental and social benefits for your investments in green energy and public space can have.
- ✓ Support green energy in public space with supporting policies, land use guides, bylaws and other guidelines for publicly and privately owned spaces.
- ✓ Green energy initiatives can be aligned to other community priorities such as labour force development for the green economy.

Recovering Heat from Wastewater in Vancouver

A district energy project in Vancouver, British Columbia's False Creek neighbourhood, recovers waste heat from a wastewater treatment system to supply both hot water and heating for mixed-use buildings through the False Creek Neighbourhood Energy Utility. In this ground-breaking and award-winning project, insulated closed-loop piping is underground, beneath streets and other public spaces, connecting buildings in the community. This sewage heat recovery captures high heat from sewage, which is more efficient and cheaper to install than ground source heat pumps, and is expected to reduce greenhouse gas emissions by 70%. It is even more efficient than traditional geothermal ground sources and is adaptable to incorporate future green energy supply.

Conceived as a legacy outcome from the Vancouver 2010 Olympics, the city ensured the project's success by forming a cross-functional steering committee and neighbourhood committees, and hosting public engagement events in the early days. It also engaged artists to transform the prominent exhaust flues into public art that has a story to tell. Energy consumption is monitored and usage is managed through technology to optimize and improve operations. The project is undergoing significant expansion to create even greater positive impact.

Solar Lighted Trails in Sudbury

The addition of off-grid solar lighting in Kivi Park in Sudbury, Ontario, is adding great benefits to this northern town. Through federal and other funding, these lights will improve safety, enhance physical activity and build nature connections along a 3.5 km section of multi-use trails. The project does not require a connection to the grid and allows users to enjoy the trails even during short winter days. Mayor Brian Bigger comments that "The solar lighting is transformational".

Types of Renewable Energy

Review this list and reflect:

- Is this a good option for our public space project?
- How might this be used to retrofit existing public spaces?
- How might these solutions be integrated into various aspects of the space? How might they connect into the adjacent area?

Renewable Energy Source[5]	Uses in Public Space	Considerations
Solar photovoltaics (PVs) The use of solar cell technology to convert the sun's energy directly into electricity. There are many new technologies for solar PV that have expanded where PVs might be deployed (e.g. flexible, transparent, thinner).	Commonly used on rooftops or atop poles or signage to power lighting or other on-site services. Solar PVs can be combined with architectural or public art elements and may provide shade as well.	• The cost of PVs has dropped a lot in the last 10 years, making them highly affordable. • Solar PVs can be deployed on different scales (from a small light to a powering an entire building). • Power generation fluctuates with light availability so connecting to the electrical grid and/or adding storage capacity adds value (e.g. battery). • Consider best locations for sunlight and ensure the structure can handle the weight.

[5] Learn more in: Environmental Science, "Renewable Energy: All You Need to Know", *Environmental Science*, 2023, https://www.environmentalscience.org/renewable-energy; Robert Ferry and Elizabeth Monoian, *A Field Guide to Renewable Energy Technologies, Second Edition*, Land Art Generator, 2020, http://www.landartgenerator.org/LAGI-FieldGuideRenewableEnergy-ed2.pdf; Ingenium, "Energy 101: Energy Sources", Let's Talk Energy, 2023, https://energy.techno-science.ca/en/energy101/energy-sources.php; IRENA, *The Rise of Renewables in Cities – Energy Solutions for the Urban Future*, International Renewable Energy Agency (IRENA), 2020: 8-9, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Oct/IRENA_Renewables_in_cities_2020.pdf; Natural Resources Canada, "About Renewable Energy", Government of Canada, last updated Dec. 13, 2017, https://www.nrcan.gc.ca/our-natural-resources/energy-sources-distribution/renewable-energy/about-renewable-energy/7295.

Renewable Energy Source	Uses in Public Space	Considerations
Solar thermal A system that uses the sun's thermal energy, through collectors, to heat liquid or air to use for heating or even energy storage.	Solar thermal can be used for pool heating or hot water or radiant floor heating for public spaces like community centres. A community greenhouse is a very simple example of solar thermal application.	• Canada has high solar potential. • Concentrated solar thermal can greatly increase the output of solar thermal energy. • Solar thermal has a low carbon footprint.
Wind power The conversion of the kinetic energy of wind into electricity (or mechanical energy), using turbines and other technologies.	More compact and vertical axis turbines can be incorporated into public space design and onto rooftops. Micro-wind generation can be deployed for energy needs on site or combined with solar installations. Newer technologies allow wind power installations to be used in kinetic public art.	• Wind turbines have a relatively low cost with a high return-on-investment. • Many Canadian communities are well-situated to capitalize on wind energy. • Different turbines have different directional and spacing needs that can be maximized to meet the needs of public spaces. • Combine wind power with a grid connection or storage to maximize potential.
Geothermal/geo-exchange The capture of natural energy stored underground or absorbed in the atmosphere or ocean to provide heating and cooling (e.g. heat pumps) most commonly, and sometimes electricity (underground steam).	Any public space building can utilize geothermal technology to provide heating and cooling. Additionally, when public spaces are created, whether roads or parks or anything else, piping to support geothermal and heat pumps can be installed under the ground to support current and future initiatives.	• It has high and consistent energy capacity 24/7. • It provides both heating and cooling. • It has a relatively small environmental footprint. • Community centres, pools, arenas and libraries are all good sites to incorporate geothermal. • Initial costs may be high. • Canada has limited places for direct steam electricity from geothermal.
Hydroelectricity The transformation of the energy from flowing water into electricity, through turbines, often enhanced by an elevation change. Installations can have dams or be more "run-of-the-river".	Public spaces with flowing water like small rivers or streams can install micro- (under 100 kW) or pico-hydro (under 5kW) with 'run-of the river' generators.	• Canada has strong expertise and public support for this tried-and-true green energy source. • It is relatively cost-effective to build and maintain. • Beware of ecological side effects caused by flooding with dams and changes to water flows in the region. • Dam-less hydro power plants are lower cost and have a much lower environmental impact.

Renewable Energy Source	Uses in Public Space	Considerations
Tidal An emerging area, this source converts tidal energy into usable energy, usually electricity, similar to hydro, harnessing the kinetic energy of the tides.	Use in maritime communities where public space includes the waterfront.	• It is more predictable compared to wind or solar, which makes it a more reliable source of energy. • Low wave activity has the potential for high energy production. • Tidal power is a newer way to produce energy, with less on the ground examples, and high costs
Bio energy and waste-to-energy Usable energy captured from biological materials (biomass) to produce electricity and/or heat energy. This can happen chemically (e.g. methane production) or via incineration, which is not as desirable.	Municipal waste, sewage and water treatment facilities can result in excess heat and methane. When part of or near public spaces, these spaces can be leveraged to enable energy generation.	• It has potential to use in every community. • It can help to reduce municipal waste. • It may be more challenging to situate in public space. • Burning of biomass (incineration) has negative environmental and human health impacts (although not as much as fossil fuels).
Kinetic Energy The capture of energy from motion to convert into electricity. Piezoelectricity specifically converts mechanical strain, through pressing or squeezing, into electricity.	Energy-generating sidewalks and pathways can harvest the energy of walking. The kinetic energy of children can be captured in playgrounds. The potential for energy-generating roads is in the early stages.	• It can be a more playful and creative way to connect the public to renewable energy. • It is a newer technology with less testing and examples on the ground to learn from. • It has limited capacity to generate large amounts of electricity.

Emerging Technologies

- **Concentrated solar thermal** focuses the sun's rays to a point to generate huge amounts of heat., This heats water to steam to generate electricity.
- **Photovoltaic Thermal (PVT)** integrates heat and photovoltaic technologies into one.
- **Concentrated PV** directs a magnified beam of solar radiation onto solar cells to produce more energy.
- **Solar PV** integrates solar technologies onto clear glass to produce electricity.
- **Vortex Induced Wind** harnesses the phenomenon of vortexes to generate electricity in vertical cylinders.
- **Bladeless Wind** innovations use new models that don't require any type of turbine.
- **Wave and Marine Current Power** harnesses the energy in waves and powerful oceanic currents.

Communities like yours are committed to reducing greenhouse gas emissions. Adam Campkin of Saanich encourages communities to "Implement a climate plan with ambitious targets". "Make your targets science-based," adds colleague Glenys Verhulst, with a strong plan to reduce reliance on fossil fuels, limit global warming to 1.5°C degrees in line with the 2018 IPCC special report on global warming and get to net zero carbon emissions by 2050.

Building on these goals, people across Canada and around the world are exploring ways to leverage public spaces towards these efforts. There is great value for communities to learn from the experiences and learnings of others. By understanding some keys to success, you and your community can be better equipped to implement effective and impactful projects including green energy in your own public space project, moving forward more smoothly and quickly. There is significant untapped potential of renewable energy infrastructure within the build environment of cities that "can help reduce energy sprawl and transmission losses while creating an opportunity for social engagement and education. Making urban space multifunctional is important because of limited land availability and competing land uses."[6]

About this Tool

Drawing on insights from civic leaders, real-world projects and innovative research, the **Principles for Public Realm Green Energy** tool distills key learnings into actionable approaches to inform your own project. By reviewing and discussing each principle, in collaboration with stakeholders and partners, you can be better equipped for success. As you move to leverage your public spaces for green and renewable energy, you will not only be taking action on climate change but also helping to provide a visible bridge between more traditional energy systems and new models and approaches. "Public space can shift society into a sustainable energy lifestyle when used as an educational and information platform."[7]

[6] A Grover, "Hyperfunctional Energy Landscapes".
[7] Ozgun, Kaan, "Towards a Sustainability Assessment Model for Urban Public Space Renewable Energy Infrastructure", *Energies*, 2020: 3.1, https://www.mdpi.com/1996-1073/13/13/3428.

TIPS

- ✓ Engage experienced experts and designers to help integrate green energy technologies with other elements. This will create a cohesive public space experience.
- ✓ Join a network of practitioners in these kinds of initiatives – energy management networks, resilient cities, utilities, sustainability practitioners and similar groups.
- ✓ Take advantage of available grants and other funding to expand what you can do. It is also easier to get a project going when there is already funding in place.
- ✓ Prioritize sharing of land uses and make the space as multifunctional and accessible as possible.[8] This might include geothermal piping under a sports field or solar panels at a bus stop or parking lot. A space can meet a host of community needs, while also including green energy elements.
- ✓ Monitor and evaluate along the way. Consider to what degree you are meeting the lifetime energy needs of public space on site, feeding into the local grid, storing energy, meeting local energy needs and using the site as a platform for public engagement around sustainability.[9]

[8] Nicholas Pevzner, Yekang Ko and Kirk Dimond, "Power Player: Designing for Just and Multifunctional Energy Landscapes", *Landscape Architecture Magazine*, June 8, 2021, https://landscapearchitecturemagazine.org/2021/06/08/power-player/.
[9] Ozgun, "Towards a Sustainability Assessment Model"

A Community Energy Plan for Charlottetown

The community of Charlottetown, PEI, has developed a "Community Energy Plan" that maps out ambitious targets for the reduction of greenhouse gas emissions, in response to their *Integrated Community Sustainability Plan* of 2017. The plan was developed in consultation with residents, experts and stakeholders and takes a holistic approach to green energy actions. They are using a range of means to monitor and track progress, including a citizen-led sensor technological network, and they project significant financial savings along with reduced emissions and other co-benefits. The holistic plan includes energy efficiency in buildings, low energy transportation, clean renewable energy production like solar, wind and biomass and more. The city's goal is to become a carbon neutral, 100% renewable city by 2050.

Efficient and Renewable in Saanich

In 2020, the community of Saanich, British Columbia set ambitious goals in their climate plan: to reduce greenhouse gas (GHG) emissions by 50% by 2025 and net zero carbon and 100% renewable energy by 2040. In a province with affordable green energy (hydroelectricity), they are focused on electrification and making their operations more efficient. For example, the G.R. Pearkes Recreation Centre (which includes two ice rinks, a fitness gym, a library, a field house/trade show space and community spaces), has incorporated electric zambonis, heat reclamation from ice rinks, variable frequency drives to achieve efficiency improvements and lighting upgrades.

To support all of these efficiency goals, the District is working on standardizing their building Direct Digital Control systems to collect data through sensors (e.g. temperature, CO2) to connect digitally through a centralized database. Looking to the future, Saanich is also working on improving the resilience of their buildings to climate change, including increasing mechanical cooling capacities and air filtration levels.

Principles for Public Realm Renewables
Implementing Renewable Energy in Public Spaces

As you bring renewable energy to your public space project, review these principles and determine how you will put them into action.

PRINCIPLE	HOW YOU WILL PUT THIS INTO ACTION?
1. Be purpose-driven. Connect your green energy solution to your community's goals: greenhouse gas emission reduction, de-carbonization, net-zero (or positive) goals and climate change mitigation. Be ambitious!	
2. Situate for context. Be sure to situate any renewable energy solution where it makes the most sense – solar needs sun, wind power needs air movement and hydro needs water.	
3. Leverage digital technology and data. Data and connected technologies are often a critical component of bringing renewable energy projects to life. Be sure to use these tools for good, but also avoid "techno-fixes" that don't necessarily address real needs and goals.	
4. Integrate renewable energy everywhere. Consider how renewables can be a part of virtually every aspect of your public spaces. These can include shelter and shade, safety installations, structures, parking, services and more.[10] Think about underutilized areas.	
5. Think holistically. Renewable energy cannot only contribute to environmental sustainability, but also can bring economic and social benefits (and costs).[11] Well-deployed renewable energy can add aesthetics, reduce noise, and improve air quality and thermal comfort.[12]	

[10] Alison Grover has proposed 12 ways to integrate renewable energy into landscape architecture elements. Access https://scholarsbank.uoregon.edu/xmlui/handle/1794/26334 (p. 50-53).
[11] Ozgun Kaan, Ian Wier and Debra Cushing, "Optimal Electricity Distribution Framework for Public Space: Assessing Renewable Energy Proposals for Freshkills Park, New York City", *Sustainability*, 2015, https://www.mdpi.com/2071-1050/7/4/3753/htm.
[12] Grover, "Hyperfunctional Energy Landscapes": 11; Ozgun, "Towards a Sustainability Assessment Model"

PRINCIPLE	HOW YOU WILL PUT THIS INTO ACTION?
6. Take ecological impacts into account. Situate your solutions in ways that minimize potential negative impacts on flora and fauna, issues often raised by conservationists. Note, however, that by bringing renewable energy production into the city and closer to home, this can reduce the impacts of similar projects in wilderness areas.[13]	
7. Integrate with the grid and the community. Don't just think of the public space as a self-sufficient island. Consider how the space might be a hub to meet the energy needs of the local community, and become a net-positive player in the system.	
8. Make it attractive. Incorporating beautiful landscape design and a public arts lens into renewable energy installations can add in the social benefits of art and design for people, building support and awareness, while expanding green energy impact. "*Renewable energy can be beautiful" says Land Art Generator*.[14]	
9. Use as a platform for education. Incorporating renewable energy into public spaces can help raise awareness and educate people on clean energy. This can enhance public engagement activities.[15]	
10. Engage the community. It is critical to authentically engage residents and stakeholders every step of the way as you develop priorities and concepts for your project. This can help to build momentum, counter concerns and resistance, build awareness and support green energy initiatives more broadly.[16] Sometimes, it is the community itself that will be bringing forward their ideas too!	

[13] Grover, "Hyperfunctional Energy Landscapes": 11; Pevzner et. al., "Power Player: Design Principles for the Energy Transition.
[14] Check out Land Art Generator's international public art + renewable energy design competition in the public realm. https://landartgenerator.org/.
[15] Dean, "Why Green Energy Innovations in Parks and Open Spaces Matter", Eco Renewable Energy, 2022, https://www.ecorenewableenergy.com.au/articles/green-energy-innovations/ ; Ozgun et. al., "Optimal Electricity Distribution".
[16] Pevzner et. al., "Power Player": Design Principles for the Energy Transition; FCM (Federation of Canadian Municipalities), *GMF Municipal Energy Roadmap*, Federation of Canadian Municipalities, 2020: 9, https://data.fcm.ca/documents/reports/GMF/2020/gmf-municipal-energy-roadmap.pdf.

There are many ways that green energy is being incorporated into public spaces, synergizing with social spaces, sustainable transportation and green infrastructure.[17] Solutions range from small to extensive, from energy production to efficiency, and everything in between. Exploring the range of solutions available can spark ideas, generate conversation and inspire bold and creative public space projects through a green energy and sustainability lens.

Innovators and leaders around the world are developing and evolving ideas all the time. Many of them are enabled by the data and connected technologies of today. For instance, energy management systems rely on sensors and data in order to optimize energy usage and measure progress.

[17] Grover, "Hyperfunctional Energy Landscapes".

ABOUT

The **Green Energy Idea Generator** highlights a range of innovative ideas that communities across Canada and around the world are deploying in their public spaces. These innovations are divided into four main areas below: greener mobility, generating energy, increasing efficiency and integrating into design. By providing high level rankings on key green aspects, along with examples, the Generator will help you and your team better assess options and select what might work for you. By exploring these ideas, you can affirm the direction you are already taking and be inspired by more.

TIPS

- ✓ Think systemically and consider how your public space initiatives can integrate with the local community, grid, sustainable transportation and more.
- ✓ Publicly-accessible spaces may be publicly or privately owned – be sure to work with private landowners as well to mandate, fund and incentivize green energy uses of privately owned public spaces (e.g. condo courtyards).
- ✓ Consider the full costs for installation and capital as well as operating, and then consider the full return-on-investment for the long-run – including economic, social and environmental aspects.
- ✓ Always keep equity and accessibility in mind, prioritizing needs of the underserved.
- ✓ Combine energy reduction and efficiency with energy production. Kevin Boutilier in Halifax notes that "It's important to reduce energy use and emissions first, and switch from [dirty energy] to cleaner electricity. Solar can be important here".

Climate Awnings in Halifax

Through a small granting program called "Climate Action Challenge", Halifax, Nova Scotia funded several community projects including the installation of solar awnings in the market garden of Hope Blooms, a social enterprise that creates opportunities for marginalized youth in Halifax's North End. Hope Blooms will use the awnings to inspire and educate youth around climate change while allowing people to "plug in" to charge their devices when enjoying the public space. These new technologies will be a platform for workshops and empowerment for community members. Halifax, a leader in climate change action, uses initiatives like the Climate Action Challenge to enable communities to participate in their ambitious climate change plan, *HalifACT – Acting on Climate Together*.

An Urban Wind Turbine in Toronto

More than 20 years ago, a community effort in Toronto, Ontario led to the installation of North America's first urban wind turbine along the central waterfront. The turbine positioned Toronto on the global stage and has become an icon for a greener future. It is surrounded by a range of public spaces and parks and is a platform for education and engagement, including tours. It has saved 3,425 tonnes of CO2 emissions to date.

District Energy Explained[18]

District energy systems are centralized thermal grids that distribute thermal energy to multiple buildings in a neighbourhood to provide heating and sometimes cooling. Heat is taken from a centralized source (or several) and distributed through a network of interconnected underground pipes that connect to heat exchangers at each building ("Energy Transfer Stations"). When used for cooling, heat is removed from the buildings and transferred to a heat sink like a borehole or lake. In some cases, there are combined heat and power systems to also supply electricity through a local microgrid.

District energy, on various scales, is rapidly emerging as a key strategy for communities to reduce their GHG emissions and improve energy resilience, when powered by low-carbon energy sources like geothermal, municipal waste, waste heat or solar thermal. There are many additional benefits including reliability, significant cost savings, local economic development and safety. Systems may be owned through a municipal utility, public-private partnerships or privately. With the need to install piping to connect the system, public space (including roadways and pathways) is an important resource to leverage for district energy.

Diverse district energy examples can be found across Canada:
— Combined Heat and Power in Toronto, Ontario
— Biomass District Energy in Yellowknife, North West Territories
— Geothermal Heating and Cooling in Ritchot, Manitoba
— Wastewater district energy in New Westminster, British Columbia

[18] For more details see FCM, Municipal Energy Roadmap: 174-188 and Creative Energy, "District Energy", Creative Energy, accessed Feb. 7, 2023,

GREEN ENERGY IDEA GENERATOR
Innovative Green Energy Technologies

Review the green energy innovations below to generate a suite of ideas for green energy in your public space. Be sure to collaborate with your team and stakeholders to align and enrich your ideas. The innovations explore four main themes, and include a brief explanation and examples:

Generating Energy

"The design of renewable energy deployments should prioritize the sharing of land uses. Energy production need not be the only output for land devoted to renewable energy systems, and it should be multifunctional whenever possible."[19]

Increasing Efficiency

"The cleanest and most environmentally-friendly kind of electricity is the kind that is never needed or used."[20]

Integrating into Design

"As cities develop new interventions for climate change mitigation, incorporating renewable energy in urban public spaces becomes a common norm to address sustainability objectives."[21]

Greener Mobility

"How could renewable energy synergize with social space, green infrastructure, and sustainable transportation in urban public space to create hyperfunctional energy landscapes?"[22]

[19] Pevzner et. al., "Power Player".
[20] Ferry and Monoian, *A Field Guide to Renewable Energy*: 167.
[21] Kaan, "Towards a Sustainability Assessment Model": Abstract
[22] Grover, "Hyperfunctional Energy Landscapes": 11.

Primary impact factors are also identified for each innovation as follows:

- **Tech-forward** identifies newer and emerging ideas at the forefront of green energy in public space.
- **Energy Production** innovations generate green energy in public space.
- **Sustainable Transportation** innovations support and benefit from low-carbon mobility.
- **Efficiency & Conservation** solutions focus on reducing energy usage and loss, reducing energy needs while lowering costs.
- **Education** highlights innovations that have a public information, climate literacy and engagement component.
- **Energy Storage** innovations involve storing power from renewable sources for use later.
- **Energy Resilience** shows solutions that support energy availability during disruptions like extreme weather.

GREEN ENERGY INNOVATION for public space	Tech-forward	Energy Production	Sustainable Transportation	Efficiency & Conservation	Education	Energy Storage	Energy Resilience	EXAMPLES
GENERATING ENERGY								
Rooftop Solar Mounting solar on any public space building, whether big or small, can help produce green energy onsite and even feed the grid.		✓					✓	Solar energy projects on school rooftops in Ottawa. A public library in Varennes, Quebec boasts a large solar PV array on the roof.
Ground Source Heat Pumps Drilling vertical or horizontal bore holes in the earth in public space, hidden underground, provides heat to then convert into heating and cooling through heat pump technology.	✓	✓		✓		✓	✓	A combined geo-solar thermal heating and cooling system is used at Evergreen Brick Works in Toronto, Ontario. Boreholes in parks in Dundee and Edinburgh, Scotland extract heat underground to convert to electricity with heat pumps.
Compact Wind Turbines New forms of wind turbines are smaller and often vertical in design, allowing for use in public space, and closer together.	✓	✓			✓		✓	Ridge-mounted wind turbines being tested in London, Ontario. Micro-wind with the whimsical WindTree in Paris, France.

GREEN ENERGY INNOVATION for public space	Tech-forward	Energy Production	Sustainable Transportation	Efficiency & Conservation	Education	Energy Storage	Energy Resilience	EXAMPLES
Micro-hydro in parks Public spaces with flowing water (e.g. streams, rapids) allow for small-scale "run-of-river" hydro generation onsite.								Micro-hydro at Quance Mill Park in Delhi, Ontario. Saughton Park in Edinburgh, Scotland features micro-hydro to meet on-site needs.
Energy from waste Using waste materials to produce energy such as heat from sewage or biogas from animal or other biomass waste, used to produce electricity, heat and even fertilizer.								A wastewater energy transfer program (WET) in Toronto, Ontario. The Zooshare Biogas plant at the Toronto Zoo, Ontario converts zoo poo to energy.
INCREASING EFFICIENCY								
Zero Carbon Ice Rinks[23] Transforming energy-hungry indoor ice rinks (40% of municipal corporate building GHG emissions), to reduce emissions through heat recovery, better refrigerants, and eliminating fossil fuel use.								A 4-pad arena in Bedford, Nova Scotia reuses waste heat from producing ice to meet all on-site heat and hot water needs. Arena upgrades with heat recovery in Winnipeg, Manitoba heating nearby buildings.
Micro-grids Community-level grid to meet local needs, usually including energy generation, storage and management. They can operate alone or connected to the larger grid and can provide backup energy during emergencies.								A community microgrid in Lac Mégantic, Québec integrates solar production and battery storage through public buildings. A community energy park in North Bay, Ontario connects community facilities and a local park to meet energy and heat needs.

[23] FCM, Municipal Energy Roadmap: 161- 173.

GREEN ENERGY INNOVATION for public space	Tech-forward	Energy Production	Sustainable Transportation	Efficiency & Conservation	Education	Energy Storage	Energy Resilience	EXAMPLES
Smart Grids & Demand Management[24] Using digital and connected technologies to manage energy generation and demand in real time, as it fluctuates, across the interconnected system, helping the grid operate more smoothly and efficiently.								The Slemon Park Microgrid in PEI meets local needs independently with solar and batteries. The remote Gull Lake First Nation in Ontario has installed a microgrid with solar and battery to minimize diesel usage locally.
Small Scale Energy Storage[25] Storing energy in public space includes thermal storage, chemical batteries and compressed gas or water to greatly optimize renewable energy usage.								Waterton, Alberta, with frequent power outages, showcases innovation and value through an energy storage project.
INTEGRATING INTO DESIGN								
Solar Public Art Incorporating solar PVs into creative and attractive installations in public space, from small to big, bringing green energy to everyone.								Solar Murals are a new canvas where artists can create visual images on solar PVs. Land Art Generator Initiative promotes creative renewable energy installations that add value to public space, inspire and educate.

[24] Evans, Simon, "How do our analogue energy systems become data-powered innovators?", ARUP, Accessed Feb. 7, 2023, https://www.arup.com/perspectives/how-do-our-analogue-energy-systems-become-data-powered-innovators.
[25] FCM, *Municipal Energy Roadmap*: 173-183.

GREEN ENERGY INNOVATION for public space	Tech-forward	Energy Production	Sustainable Transportation	Efficiency & Conservation	Education	Energy Storage	Energy Resilience	EXAMPLES
Green Lighting Improving efficiency of lighting across public spaces like streets and parks, through better controls, using efficient LED (light emitting diode) lighting and only using it when and where it is needed.								Off-grid solar lighting in New Maryland, New Brunswick. Laval, Quebec is converting 37,000 street lights to LED with smart controls, to reduce energy consumption and maintenance costs.
Energy-generating playgrounds Meeting a play space's energy needs through renewable technologies and even capturing the energy of children!								A solar powered splash pad in Ottawa, Ontario reduces energy usage. In Dordrecht, Netherlands, the energy carousel captures kids' energy for.
Solar shelters and shade Integrating solar arrays into all forms of shelter and shade in public spaces – from parking lots to picnic areas.								Solar canopies in New York's Botanical Garden use innovative solar-powered fabric. Burnaby, BC is exploring solar panels above their city hall parking lot.
Smart street furniture Using renewable and connected technologies for equipment in public spaces.								Solar-powered benches in Newmarket, Ontario charge people's devices while collecting valuable data. Compacting solar garbage bins in Winnipeg, Manitoba.
Solar surfacing New hardened solar PVs allow solar to be installed on roads, pavements and other surfaces that are able to withstand weight and extreme weather.								Hardened solar panels demonstration at Thomson Rivers University in Kamloops – the "solar compass".

GREEN ENERGY INNOVATION for public space	Tech-forward	Energy Production	Sustainable Transportation	Efficiency & Conservation	Education	Energy Storage	Energy Resilience	EXAMPLES
GREENER MOBILITY								
Electric Vehicle (EV) Charging Providing charging stations for electric vehicles in public spaces, tapping into green energy when possible. Residents can be encouraged to use EVs while also enjoying these public spaces (e.g. parks, libraries, arenas). This helps promotes EV usage.								Solar EV Charging Pilot (with battery storage) in Cobourg, Ontario. Parks Canada provides free EV Charging in select Parks Canada sites. Wind-powered EV charging in New York City.
Micro-mobility Charging Charging stations for electric micro-mobility options like e-bikes and e-scooters, whether shared or individually owned, supporting zero-emissions transportation.								Electric bike charging at Salt Spring Island Park, British Columbia. Wind and solar-powered, off-grid e-bike charging along a popular cycle route in Tyneside, England.
Vehicle to Grid Using EV car batteries to feed the grid as needed, as a "crowd-sourced battery", through reversible recharging infrastructure.								Bidirectional EV charging stations in the parking garage at UBC's Renewable Energy Hub (also powered by rooftop solar), in Vancouver, BC.

Congratulations! You have now deepened your understanding of the possibilities for Green Energy in Public Space, learned some key guidelines and been inspired by a range of innovations. With this foundation, you and your team can be better equipped to bring exciting and innovative ideas for green energy into your community and projects. We hope that this toolkit has been an informative and valuable resources as you work towards a low carbon future.

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GLOSSARY

Climate Adaptation in a climate change context means any measures taken with the intent of reducing the negative effects of climate change on built, natural and social systems, to cope with the consequences, or to take advantage of the positive effects.

Climate Change is measurable changes in weather patterns over a long time (decades), and may be due to natural or human causes. Changes occur in the composition of the atmosphere, when greenhouse gases build up and get trapped.

Climate Mitigation is any action or response intended to reduce or prevent greenhouse gas emissions, or to enhance sinks that capture or store carbon, usually towards long term benefits.

Electrification is about switching from fossil fuel energy sources, such as coal and gas, to electricity for energy, which may come from various electricity generation sources.

Green Energy is a broad term used here to describe a range of approaches and solutions used to reduce emissions and mitigate climate change. These may include various renewable energy applications, increase efficiency and conservation, and moves away from fossil fuel energy production, often towards electrification. (reducing energy usage).

Greenhouse gas emissions (GHGs) are gases in the atmosphere that trap energy from the sun and cause the Earth's temperature to rise. The burning of fossil fuels has accelerated this effect, through the emission of large amounts of carbon dioxide, methane and nitrous oxide to the Earth's atmosphere.

Net Zero is used to describe strategies and targets aimed at eliminating the emissions of greenhouse gases (zero carbon) in various regions around the world.

Renewable energy is energy derived from natural processes that are replenished at the same (or faster) rate than they are consumed. Sometimes called clean energy, renewable resources such as wind, sun or moving water get converted into usable energy such as electricity and heat, through a range of technologies including turbines and photovoltaic panels.

Resilience is capacity of individuals, communities, and institutions to design and implement solutions that allow them to adapt, grow and innovate in the face of future disruption and systemic change. Climate resilience describes the capacity to respond to resist, respond to, adapt to or cope with climate change impacts.

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