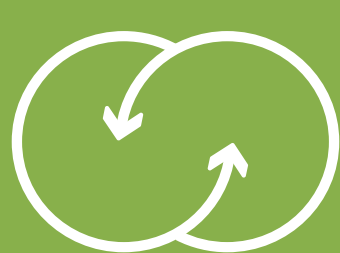


Closing the Loop

Energy and Resource Recovery in Local Government Infrastructure

A local government guide to regenerative infrastructure and integrated resource recovery.



ABOUT THIS GUIDE

“Closing the Loop” is a guide about capturing value from local government infrastructure by recovering energy and other resources from waste.

This guide builds from past work related to “Integrated Resource Recovery” (IRR), including:

1. Resources from Waste: Integrated Resource Management Study (2008)
2. [Resources from Waste: A Guide to Integrated Resource Recovery \(IRR\) \(2009\)](#)
3. [Integrated Resource Recovery Inventory \(2010\)](#)

In the ten years since the original study, many local governments have demonstrated that IRR technologies can use solid and liquid waste to create energy, reduce greenhouse gas emissions, conserve water, and recover nutrients, while saving money and potentially generating revenue.

“Closing the Loop” places IRR into a broader approach we are calling “regenerative infrastructure”. The approach, and its name, is inspired by the concept of regenerative design, which mimics nature’s processes. In nature, there is no waste, as all resources cycle through closed loop systems and serve a purpose.

This guide has four sections:

In Section One we introduce the regenerative infrastructure approach and its four categories of strategies, connect the approach to local government climate action, the circular economy, and other related movements, and outline six guiding principles for infrastructure planning and development.

Section Two presents tools and technologies organized according to the four categories of strategies in the regenerative infrastructure approach: Integrate policy and planning; Design with Nature; Recover Water and Materials; and Recover and Generate Energy and Heat. The latter two encompass Integrated Resource Recovery technologies.

Section Three presents nine Integrated Resource Recovery case studies from around B.C. that link back to the tools and technologies in Section Two with icons.

Section Four is all about “Bringing it Home” to your community. This section outlines a methodology for identifying and supporting regenerative infrastructure opportunities, provides links to related regulatory requirements, and Federal and Provincial policies and funding opportunities. It concludes with advice on winning a grant application.

This PDF is a preliminary preview version of an online resource currently under development.
Check back to www.closingtheloop.ca for updates and a future interactive web resource with enhanced content.
Do you have comments or suggestions for the web resource? Email us at info@communityenergy.bc.ca



ACKNOWLEDGMENTS

This guide was compiled by the Community Energy Association (CEA) with the generous support of the Province of B.C. - Ministry of Municipal Affairs and Housing.

The foundation of much of the content in the Tools and Technologies section is from the original Integrated Resource Recovery (IRR) Guide, Resources from Waste (2009), authored by Stephen Salter and the Province of B.C.

Community Energy Association is grateful to the project advisory committee who guided the direction of the project and provided helpful review and suggestions.





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SECTION ONE: TAKING INSPIRATION FROM NATURE



Connecting Climate, Energy, Water, and Waste – And Building Better Local Infrastructure

- > What is Regenerative Infrastructure?
- > Waste as a Resource
- > Benefits of Regenerative Infrastructure
- > Part of Climate Action

A Regenerative Infrastructure Approach

- > Four Strategies
- > Inspirations and Interconnections
- > Guiding Principles



There is no waste in nature.

This guide explores the value local governments can gain when taking inspiration from nature's regenerative system.



CONNECTING CLIMATE, ENERGY, WATER, AND WASTE – AND BUILDING BETTER LOCAL INFRASTRUCTURE

There is no waste in nature. Energy, water and nutrients continuously cycle through nature’s systems – When no longer in use by one organism or process, they become valuable resources elsewhere.

What value can municipalities gain when taking inspiration from nature’s regenerative systems?

Increasingly, local governments in BC and beyond are facing the challenge of balancing multiple priorities: providing much-needed community services and amenities, contributing to resilient and healthy communities, enabling local economic development, and meeting climate action commitments. Meanwhile, they are also facing challenges of aging infrastructure and financial constraints.

What is Regenerative infrastructure?

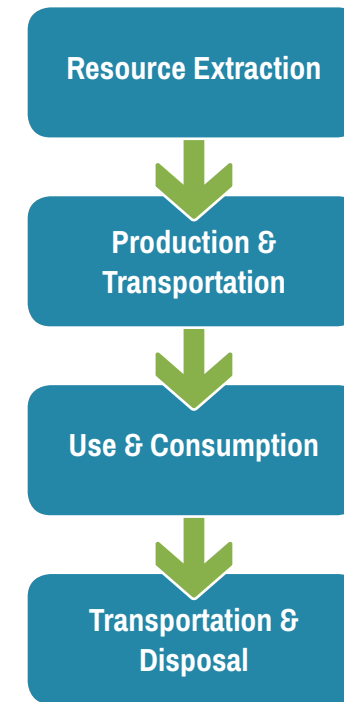
Regenerative Infrastructure is an approach to local government service delivery that addresses these challenges and brings value to the community by integrating land-use planning and infrastructure decisions, working with and enhancing nature’s systems, and utilizing Integrated Resource Recovery (IRR) technologies to recover energy and other resources previously wasted.

The Regenerative Infrastructure approach reduces operating costs, creates new revenue sources, reduces greenhouse gas emissions, and improves resiliency to climate change impacts, without compromising essential municipal services.

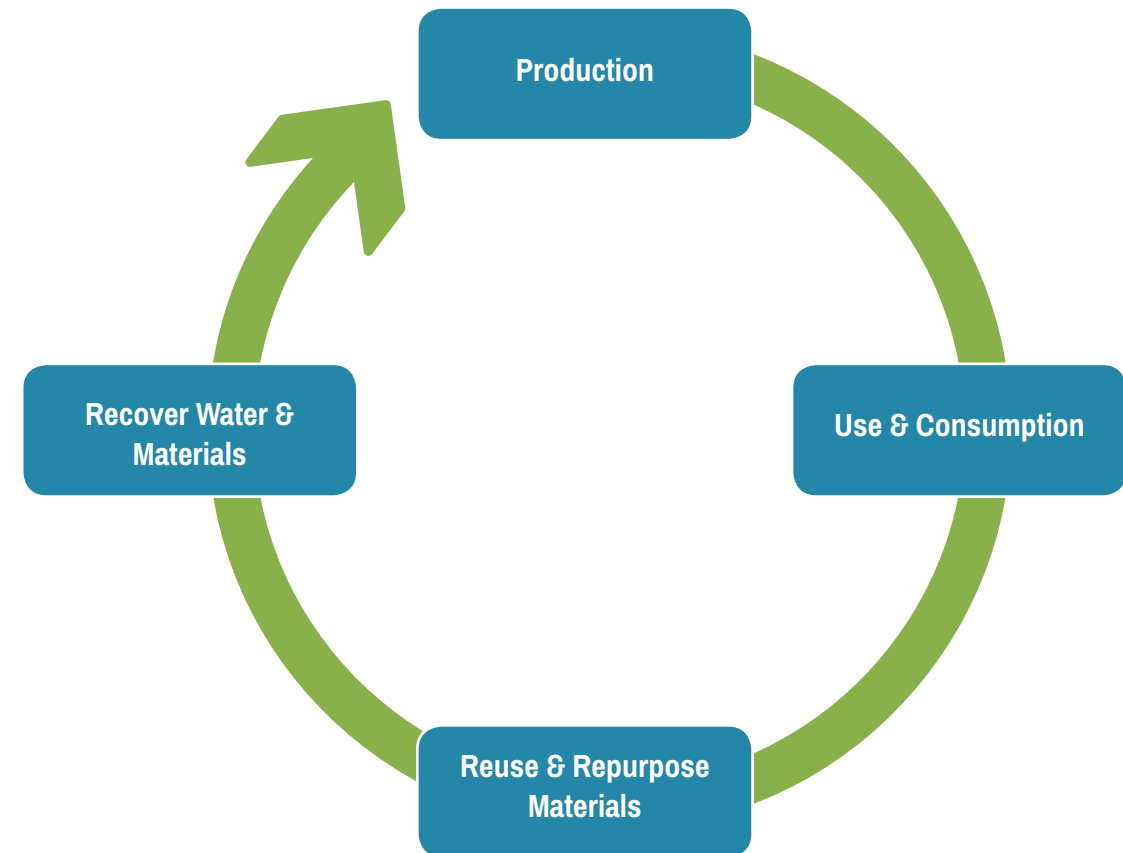
Integrating resource and energy recovery with municipal and community infrastructure requires a new way of thinking about waste and resources. At the heart of the Regenerative Infrastructure approach is a transition from linear processes towards circular systems that treat waste as a resource. The approach highlights Integrated Resource Recovery (IRR) technologies, which use outputs from municipal and industrial processes as inputs into other processes, reducing costs and creating value. This approach also recognizes the value and services provided to communities from natural systems such as aquifers and wetlands, and supports their preservation.

Closing the Loop is a guide for local government elected officials and staff who want to explore the cost savings and other benefits that can be realized by considering waste as a resource and natural systems as valuable community assets that provide services.

Conventional approach to resource and waste management



Closed loop system inspired by nature



Principles of a regenerative infrastructure approach can be applied to any project or plan, big or small.

When a regenerative infrastructure approach is used, plans for municipal infrastructure are developed in an integrated and holistic manner to maximize the recovery of “value” from what was previously considered to be waste.

Waste as a Resource

The definition of waste extends beyond solid waste, or garbage. Waste is any potential resource that is not currently reused, recycled, or recovered; it includes storm and wastewater, biosolids, wet organic waste such as food waste and agricultural waste, and dry organic waste such as yard and wood waste. It also includes process energy that is wasted when it is released as unused heat, such as from the wastewater treatment process. These waste products can become resources for new processes, closing the loop.

Expanding the definition further, “waste” also includes wasted opportunities to capture energy from renewable sources. While this guide does not explore all stand-alone renewable energy opportunities such as solar and wind energy, it does include consideration of opportunities for capturing energy generated as a by-product of municipal processes and infrastructure.

Benefits of Regenerative Infrastructure

The regenerative infrastructure approach has potential to contribute financial value by reducing operational costs and generating revenue by developing new, marketable products.

However, the value of regenerative infrastructure is not limited to financial gain. Capturing value from waste includes other quantifiable benefits – such as reduced energy consumption and lowered greenhouse gas emissions, less garbage in the landfill and improved air quality. It also includes other community benefits such as improved community health and resiliency to climate change impacts.

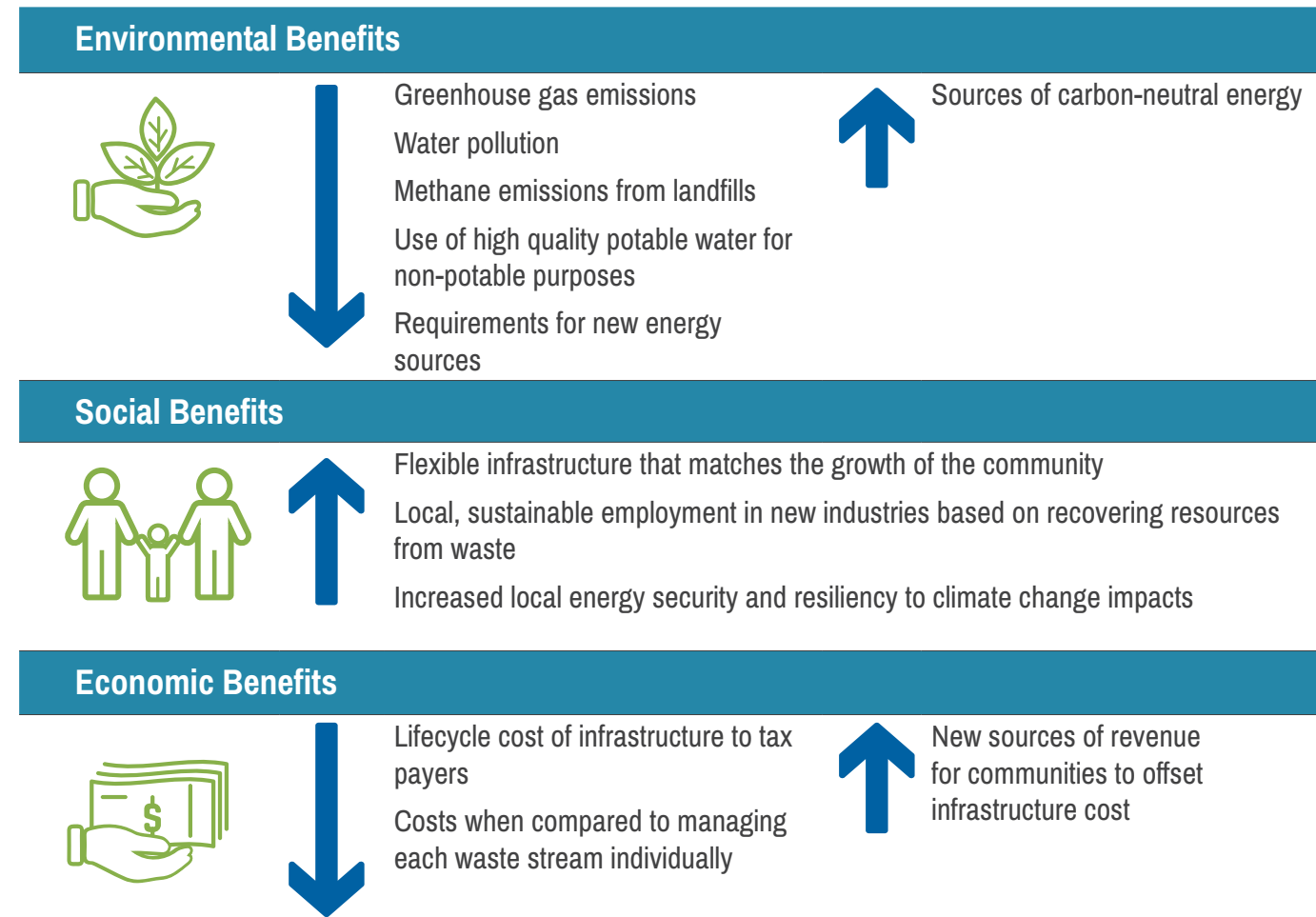
Part of Climate Action

Changing the way we think about and manage “waste” has direct influence on energy and water systems, and on the environment and climate change. Likewise, the effects of climate change – including shifting patterns of precipitation and drought, extreme temperatures and weather events, threats to ecosystem health, and others – impact community resilience and pose new challenges to our energy, water and waste management systems.

Climate change is a complex problem without a singular solution. Mitigating climate change by reducing greenhouse gas emissions and improving resiliency through climate change adaptation needs to be tackled by collaborative teams at all levels of government. The Bringing it Home section includes links to Provincial and Federal initiatives that support local government climate action and green infrastructure, including integrated resource recovery projects.

The regenerative infrastructure approach and the tools and technologies presented in this guide are just some of the ways that local governments can reduce greenhouse gas emissions from their operations and enable the same for industry, residents and businesses.

Applying the regenerative infrastructure approach can be a component of local government climate change adaptation. By working with nature’s systems and implementing integrated resource recovery projects, communities can better withstand challenges posed by climate change, such as energy grid stability during extreme weather events and water shortages caused by drought and a reduced snow pack.



Regenerative Infrastructure – A small part of a big shift

Locally and globally, growing awareness of the complexity of climate change is sparking new ways of thinking about waste, energy and water. There is local and international momentum shifting our linear waste systems to circular, closed loop systems where waste is viewed as a resource. Complementing this trajectory is a shift from centralized energy systems to distributed energy systems based on renewable energy and resource recovery.



FRAMEWORK FOR REGENERATIVE INFRASTRUCTURE

Four Strategies

This guide provides a framework that local governments can use to apply a regenerative infrastructure approach work with natural systems and manage energy, water and waste. Strategies, tools and technologies are organized into four broad categories:

 **Integrate Policy and Planning**

 **Design with Nature**

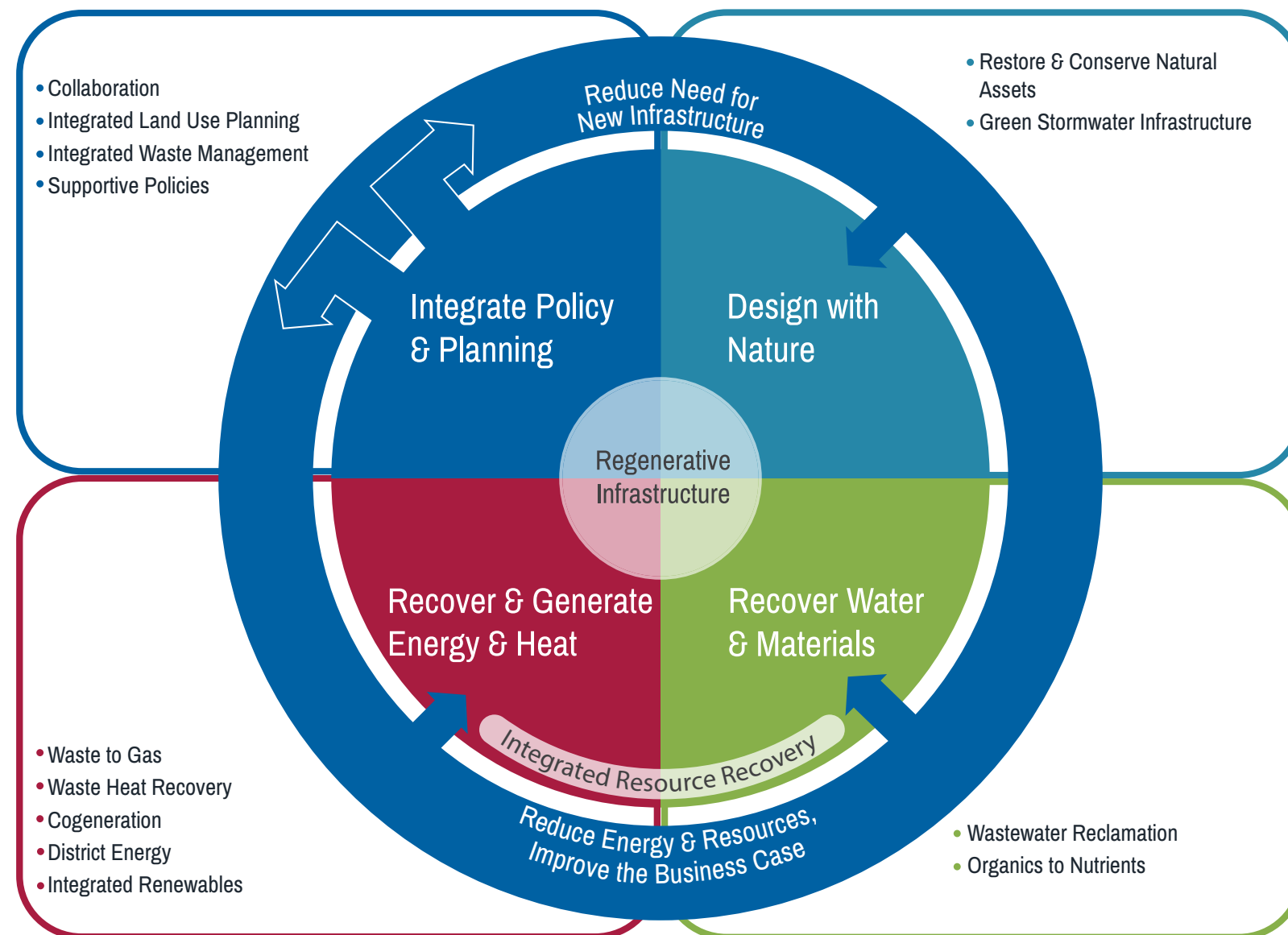
 **Recover Water and Materials**

 **Recover and Generate Energy and Heat**

The first category, **integrate policy and planning**, provides a foundation for the entire approach by ensuring that high-level direction and support exists for action at the operational and community levels.

The second category, **design with nature**, includes strategies for recognizing the value provided by natural systems and for managing them to reduce the need for building new conventional hard/grey infrastructure. Strategies in this category blur the boundaries between natural and human-made systems.

The majority of strategies discussed in this guide are considered Integrated Resource Recovery (IRR) technologies, and are included in the categories **recover water and materials** and **recover and generate energy and heat**. These strategies improve the business case for infrastructure projects while reducing waste and enabling new community benefits.





One of the strategies within the "Integrate Policy and Planning" category is increased collaboration. New opportunities can be revealed by increasing opportunities for departments to collaborate. For example, a planned water or wastewater pipe upgrade could be a good opportunity to expand a district energy distribution network under the roadway.



INSPIRATIONS & INTERCONNECTIONS

- The regenerative infrastructure approach is not a stand-alone concept – it intersects with other initiatives within BC and globally. The approach:
- Shares a foundation with the circular economy and concept of zero waste
 - Is a step along the path towards regenerative communities
 - Aligns with national initiatives supporting the integration of natural capital into asset management
 - Aligns with the BC Framework for Sustainable Service Delivery in terms of process and decision-making

Zero Waste and the Circular Economy

The goal of the circular economy is to transition away from a linear model of waste management towards closed circular systems that use waste as resources. The end goal is a system modeled after nature: one with zero waste.

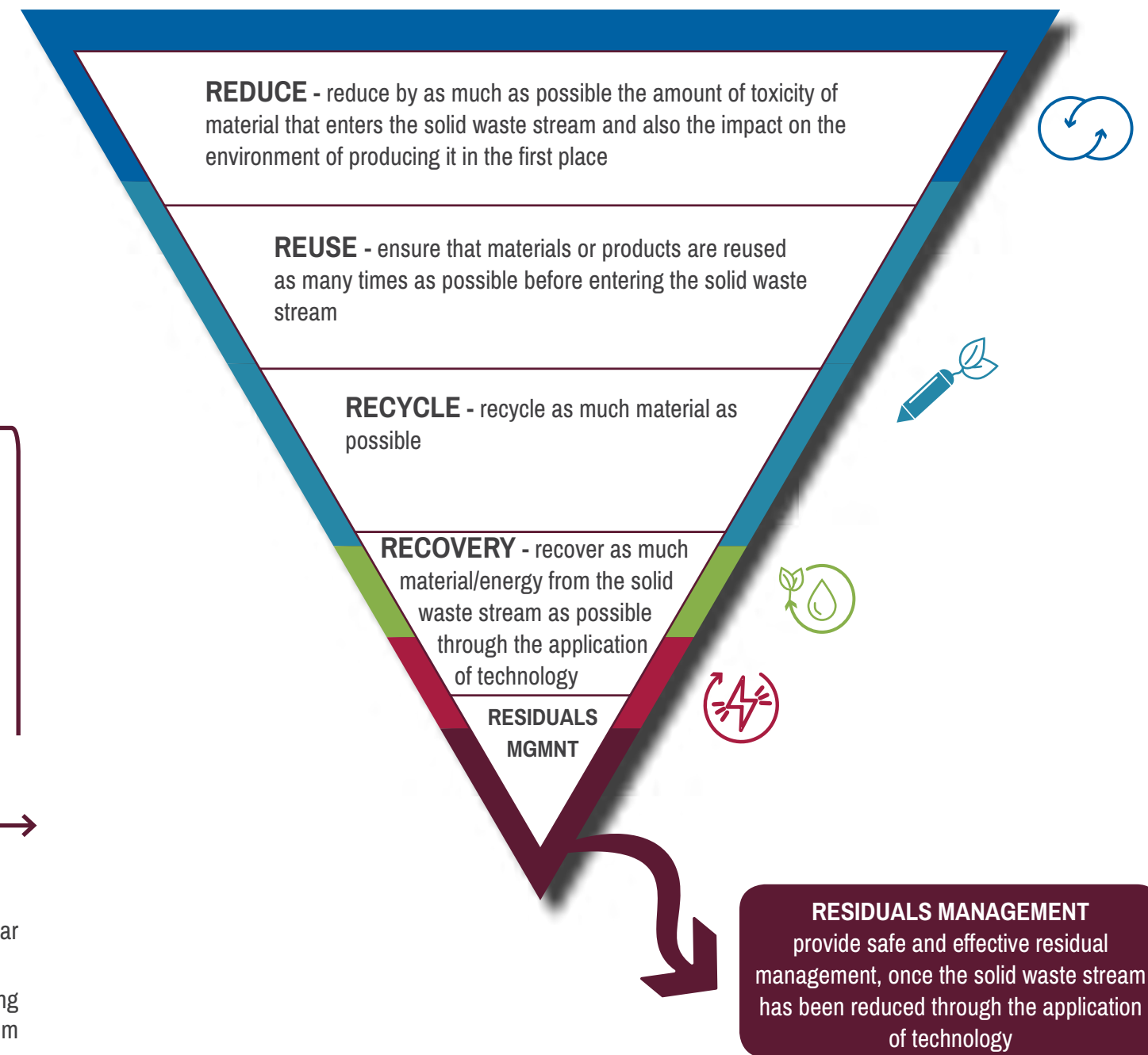
Principles and goals of the circular economy can be applied to any product, service, or process. The focus is on preventing waste disposal and capturing the full value of every resource. Waste prevention starts with rethinking product and system design, then re-using, recycling and recovering materials and other resources.

Jurisdictions around the world are advancing the transition towards a circular economy and are seeing the benefits of reduced operating costs, new revenue sources, and an effective way of reducing greenhouse gas emissions.

The government of British Columbia has committed to building a strong, sustainable, innovative economy, and has committed to reducing greenhouse gas emissions to 80% below 2007 levels by 2050, along with legislated interim reduction targets. In 2017, building on its past climate actions, the Province established a Clean Growth and Climate Solutions Advisory Council to provide strategic advice on how to reach these goals while growing the economy. Details on the policies and programs adopted by the Province are available on the [Climate Action Secretariat's website](#).

Future actions may include developing a waste-to-resource strategy and further increasing organics diversion from landfills. The concepts, tools and techniques presented in this guide represent some of the ways local governments can contribute to a province-wide waste-to-resource strategy that is part of the shift towards a thriving circular economy.

The Pollution Prevention Hierarchy - The 5 R's



The “5 R” pollution prevention hierarchy prioritizes waste management actions that lead to zero waste. It goes beyond the familiar 3 R’s of Reduce, Reuse, Recycle to include Recovery and Residuals Management. Most strategies in this guide are within the 4th R: Recovery. The tools and techniques featured in this guide recover materials and energy from waste resource streams to produce new value.

At the same time, the scope of this guide moves beyond the 4th R, by providing examples of systems that capture “wasted opportunities”, such as the electricity generation potential within drinking water supply systems. (link to case study).



Terrace, BC
Photo courtesy RE/MAX Cost
Mountains, Terrace

Regenerative Cities

The World Future Council's Regenerative Cities program seeks to transform the operation of cities from an inefficient and wasteful linear system into a resource-efficient and circular system. Going beyond simply maintaining the environment, regenerative cities enhance and restore natural systems within and beyond urban boundaries. Regenerative cities not only minimize their environmental impact, they actively improve and regenerate the ecosystems on which they depend.

Communities of all sizes can adopt the vision of Regenerative Cities, which includes shifting from a linear “metabolism” to a circular one by finding value in outputs conventionally regarded as waste.

Regenerative cities close resource loops by:

- » Reintroducing treated water into the hydrological cycle
- » Sourcing food from local producers
- » Capturing nutrients from sewage and waste and applying them to surrounding agricultural land
- » Dramatically reducing dependence on fossil fuels and boosting the deployment of renewable energy sources

Closing resource loops in a municipality's own operations and infrastructure is just one part of the pathway towards a regenerative community.

However, focusing on eliminating and capturing waste from local government-owned infrastructure is often the first and easiest step a municipality can take, and one that immediately results in new value to the community.



GUIDING PRINCIPLES OF THE REGENERATIVE INFRASTRUCTURE APPROACH

← Applying a whole-systems approach to decision-making is foundational to all regenerative infrastructure projects, whether owned and operated by the municipality or enabled in the community. →

1. Follow the pollution prevention hierarchy

First, prevent, then reduce, reuse and recycle waste. Next, recover waste resources for the benefit of the community that produced them, as close as possible to the source to avoid unnecessary transportation costs and emissions.

2. View every waste as a potential resource

Almost all waste has the potential to create value, whether recycled into a new material, processed to extract nutrients, or converted to a source of energy.

3. Use each resource for its highest value

Waste can be recycled (e.g. metal cans back into cans), down-cycled (e.g. glass used as road base) or up-cycled (e.g. kitchen waste digested to biomethane). The value gained from each of these processes should be analyzed to determine which is most appropriate, and should expand beyond monetary value. There may be other needs of the community that should factor in to how resources are used.

4. Use each resource more than once

Resource streams can provide benefits. After using a resource for its highest value, there may still be an opportunity to extract further value.

5. Integrate system boundaries

Options for harnessing value from waste increase when system boundaries are viewed more broadly. Boundaries include those between natural and human-made systems, private and public assets, and internal organizational divisions. Understanding how one system integrates with others is key to a regenerative infrastructure approach.

6. Consider the entire system lifecycle

The business case of a potential infrastructure project can become more favourable when the potential to generate revenue is analysed in addition to the capital and operating costs of the project. The entire lifecycle of the infrastructure project should be analysed in terms of economic, environmental, and social impact.

SECTION TWO: TOOLS & TECHNOLOGIES



Integrate Policy and Planning



Design with Nature



Recover Water and Materials

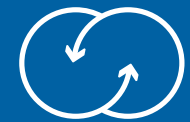
- > Wastewater Reclamation
- > Nutrients from Wet Organic Waste
 - >> Aerobic Composting
 - >> Anaerobic Digestion
- > Nutrients from Wastewater



Recover and Generate Energy

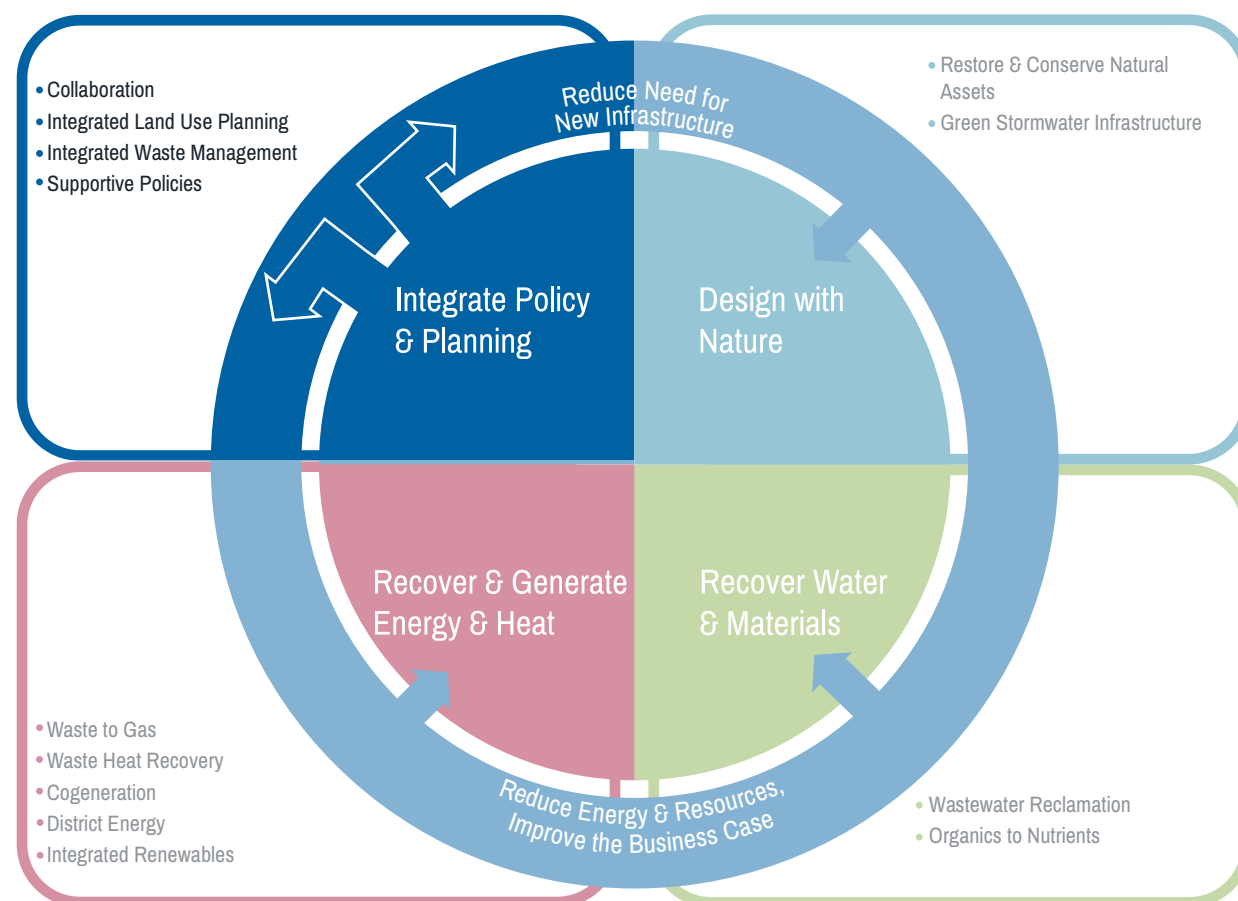
- > Waste Heat Recovery
 - >> Wastewater Heat Recovery
 - >> Sewer Heat Recovery
- > Waste to Gas – Landfill Gas Utilization
- > Waste to Gas – Biogas from Anaerobic Digestion
- > Combustion of Dry Organic Waste
 - >> Combustion of Wood Waste
 - >> Incineration – Waste to Energy
 - >> Gasification
- > Cogeneration
- > District Energy
- > Integrated Renewables





INTEGRATE POLICY & PLANNING

Minimize the need for new infrastructure and maximize community investment by integrating planning and infrastructure decisions and by increasing collaboration.



Expanding Scope and Increasing Collaboration

The regenerative infrastructure approach involves broadening geographical scales (e.g. the entire community rather than a single waste management facility) and time scales (e.g. considering the costs and benefits over several generations). This wider perspective provides the opportunity to look at make infrastructure decisions that provide increased value to the community well into the future.

Waste management infrastructure, water and wastewater infrastructure, and energy utility planning can all benefit from integrated resource recovery technologies, which provides uses for recovered resources, offer new partnership opportunities, and create new revenue to offset infrastructure investment.

The needs of major energy and water consumers in a community (e.g. hospitals and universities) can be taken into account when locating new wastewater treatment or waste-to-energy facilities. These institutions can then use the heat or fuel from these new facilities at a lower cost. The fees that are paid for the heat or fuel can be used to offset the cost of infrastructure and operations. This is an example of principle 5 integrating system boundaries.

In a conventional approach to municipal asset management, different departments are responsible for the management of water, waste, energy, transportation, and community planning. These traditional local government “silos” can result in missed opportunities for finding efficiencies and new innovative approaches that bring new value to the community.

Increased collaboration among municipal departments, with senior levels of government, institutions, and the private sector can reveal new opportunities for integrated resource recovery (IRR) in infrastructure.

Why Integrated Land Use and Infrastructure Planning?

Much of the infrastructure in B.C.’s communities is ageing, and requires replacement or upgrading.

Infrastructure upgrades and replacements provide opportunities to rethink traditional modes of land use and infrastructure planning. Local governments can ensure appropriate zoning is in place for IRR, and consider suitable sites and land use patterns for resource recovery and utilization when revising or updating Official Community Plans or Regional Growth Strategies.

Taking a regenerative infrastructure approach can reduce the need for new waste management infrastructure such as landfills, pipes, and sewage treatment plants. For example, reclaiming wastewater for non-potable purposes reduces the treatment plant’s capacity requirements, and therefore plant size and life cycle cost. It could delay or prevent the need for adding capacity or building a new treatment plant in the future.

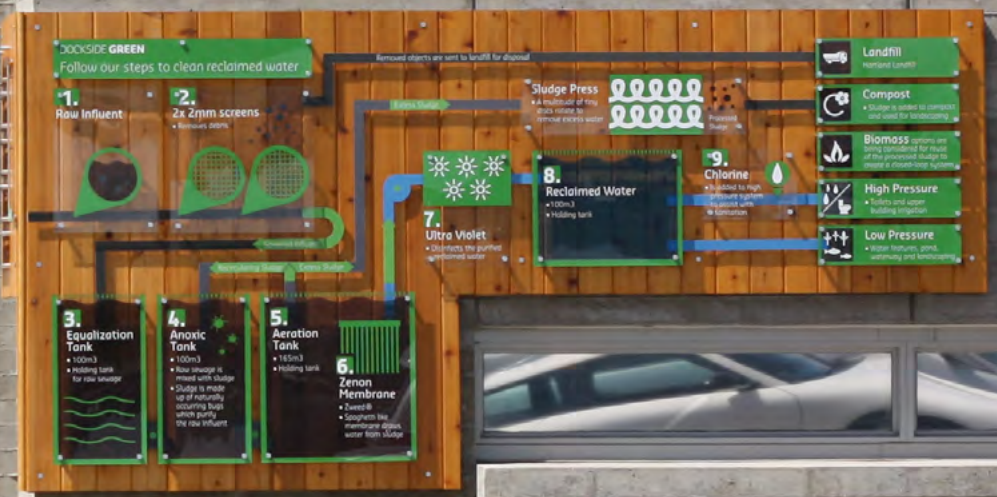
By incorporating infrastructure planning with land-use planning, local governments may choose to build smaller distributed treatment plants instead of centralized plants, which can be tailored to meet the diverse needs of the community as it grows or changes.



Section 4 – Bringing it Home – outlines strategies and steps to take to ensure that policy and planning supports integrated resource recovery and regenerative infrastructure for municipal operations.



DOCKSIDE GREEN WASTE WATER TREATMENT PLANT 390 HARBOUR ROAD



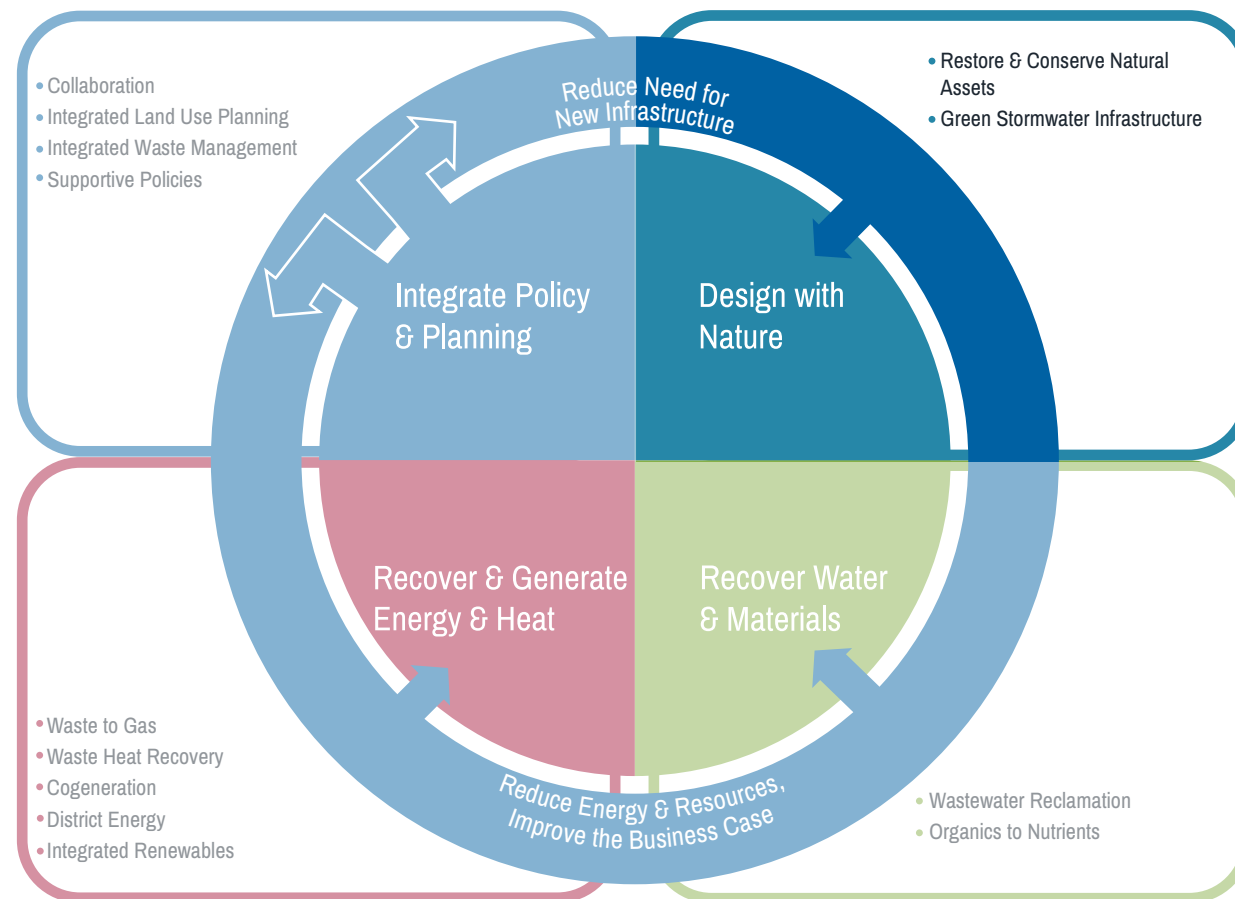
The Dockside Green development in Victoria is an example of integrating land use planning with infrastructure planning. The development has on-site waste water treatment facility, which treats and filters 100% of the sewage and grey water generated by residents and businesses. The reclaimed water is reused on-site for flushing toilets and irrigating the roof top gardens and landscaping.





DESIGN WITH NATURE

Designing infrastructure to work with nature’s processes can improve efficiency, reduce infrastructure costs, and help restore natural systems. For example, directing storm water to permeable surfaces or bioswales rather than to waterways through pipes and pumps requires less infrastructure, less energy, and helps to recharge groundwater.



Restore, Conserve and Account for Natural Assets

Natural assets, such as forests, aquifers, waterways, and wetlands, provide valuable services to communities including, but not limited to drinking water, stormwater management, protection against extreme weather, maintaining air quality, and carbon sequestration. By incorporating natural asset management with overall asset management, local governments can assign value to natural assets, and understand nature’s important role in service delivery.

Natural assets, particularly wetlands and riparian areas, are essential for managing rainwater, protecting water quality, preventing floods, and conserving soil. By absorbing rain and snow, these natural assets recharge aquifers and slowly release stored water into watercourses. Natural assets filter pollutants and sediments out of surface water, buffer developed areas from flooding, and prevent soil erosion.

Work with Nature for Green Stormwater Infrastructure

In nature, most rainwater is absorbed into the pervious soil where it is stored for use by plants and microorganisms, replenishes streams and recharges underground aquifers. During periods of heavy rain, streams and rivers handle excess flow. Urban areas, on the other hand, have large portions of impervious surfaces that do not allow water to be absorbed, and may have structures that constrain rivers from following natural flooding patterns. The conventional approach to managing stormwater is “grey” infrastructure, consisting of a network of curbs, gutters and underground piping systems designed to quickly convey rainwater away from urban areas. Typically the water is discharged into nearby watercourses, bringing with it pollutants and resulting in streambank erosion and damage to ecosystems. Green stormwater infrastructure (GSI) is an alternative to conventional pipe-and-convey “grey” infrastructure. GSI includes decentralized infrastructure that slows down water during heavy rain events and allows water to infiltrate into the ground, minimizing surface runoff and pollutants entering watercourses.

Green stormwater infrastructure includes:

- Bioswales
- Rain gardens
- Green roofs
- Pervious paving
- Infiltration trenches



The Fraser Basin Council’s 2016 report, [Showcasing Successful Green Stormwater Infrastructure](#) – Lessons from Implementation profiles successful implementation of green stormwater infrastructure in Metro Vancouver and Victoria.

The economic benefits of natural assets and green infrastructure include:¹

- » Preserving water quality—natural wetlands in the lower Fraser Valley provide at least \$230 million worth of waste-cleansing services each year, without taking into account the cost of replacing the wetlands with engineered infrastructure if they were lost
- » Maintaining air quality—over the past 25 years, the Puget Sound region has lost 37 percent of its tree canopy and high vegetation. This lost tree cover would have removed approximately 35 million pounds of pollutants annually at a value of \$95 million
- » Managing rainwater—the lost tree cover in Puget Sound has resulted in a 29 percent increase in the rainwater runoff during peak events. Using reservoirs and engineered solutions to replace this lost rainwater would cost \$2.4 billion (\$2 per cubic foot)
- » Reducing flood impacts—Canada’s wetlands provide flood control worth \$2.7 billion annually. A Washington State study estimated the value of wetlands for flood control at \$89,000 to \$126,000 per hectare per year.¹⁰ Local governments in Massachusetts saved \$90 million by protecting 3,400 hectares of wetland as a natural storage area for flood control. The cost was \$10 million, compared with the \$100 million it would have cost to construct dams and levees.
- » Recharging aquifers—Many BC communities rely on groundwater for drinking water supplies.

Get Started:

The [Municipal Natural Assets Initiative](#) provides resources and support to municipalities in identifying, valuing and accounting for natural assets in their financial planning and asset management programs, and in developing leading-edge, sustainable and climate resilient infrastructure.

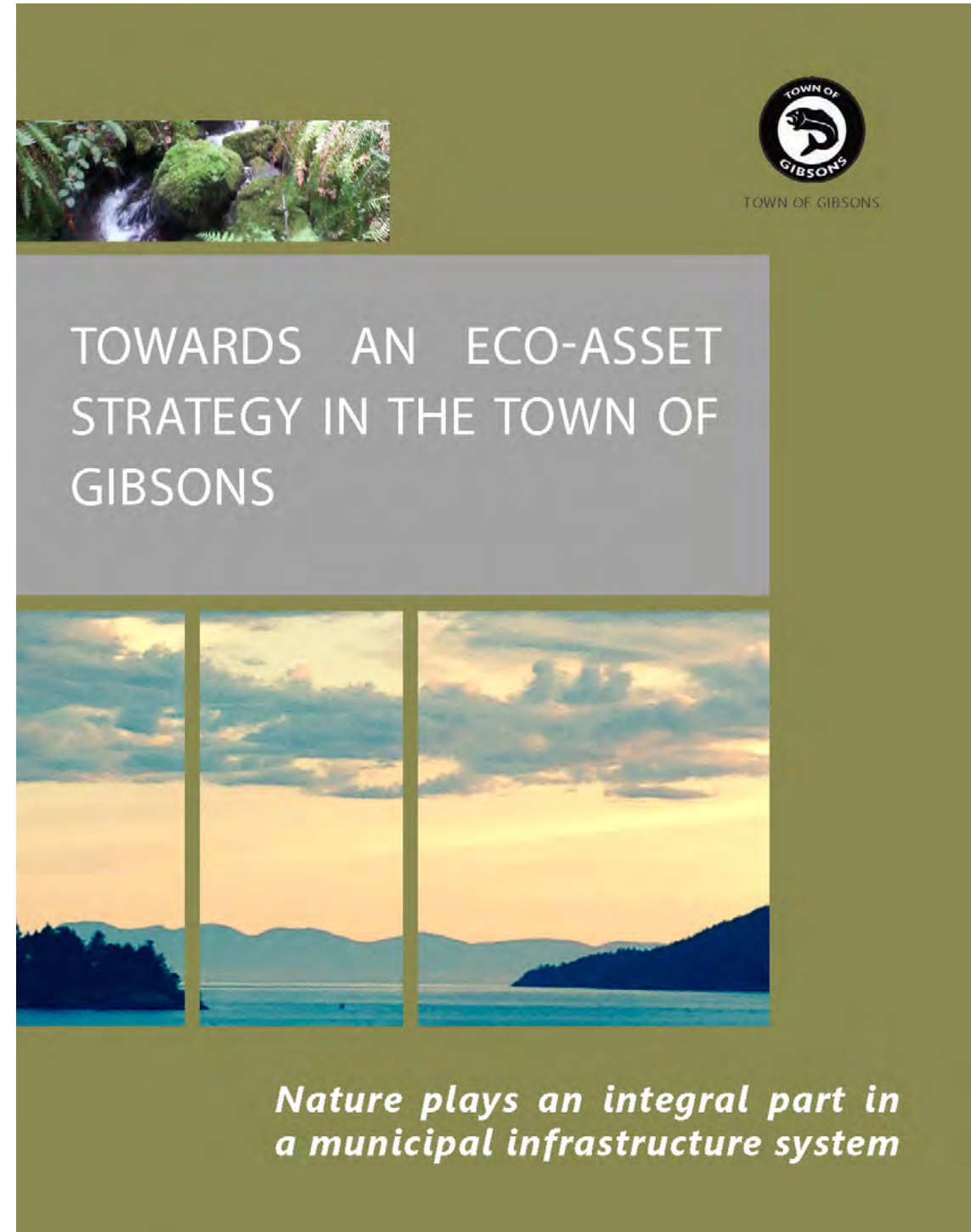


¹Olewer, N. (2004). [The Value of Natural Capital in Settled Areas of Canada](#). Published by Ducks Unlimited Canada and the Nature Conservancy of Canada

Example: [Gibsons Aquifer Mapping Program](#)

The Town of Gibsons is a leader in understanding and communicating the value of natural capital. With limited resources for infrastructure maintenance and replacement, the Town is increasingly focusing on natural capital as a cost effective alternative.

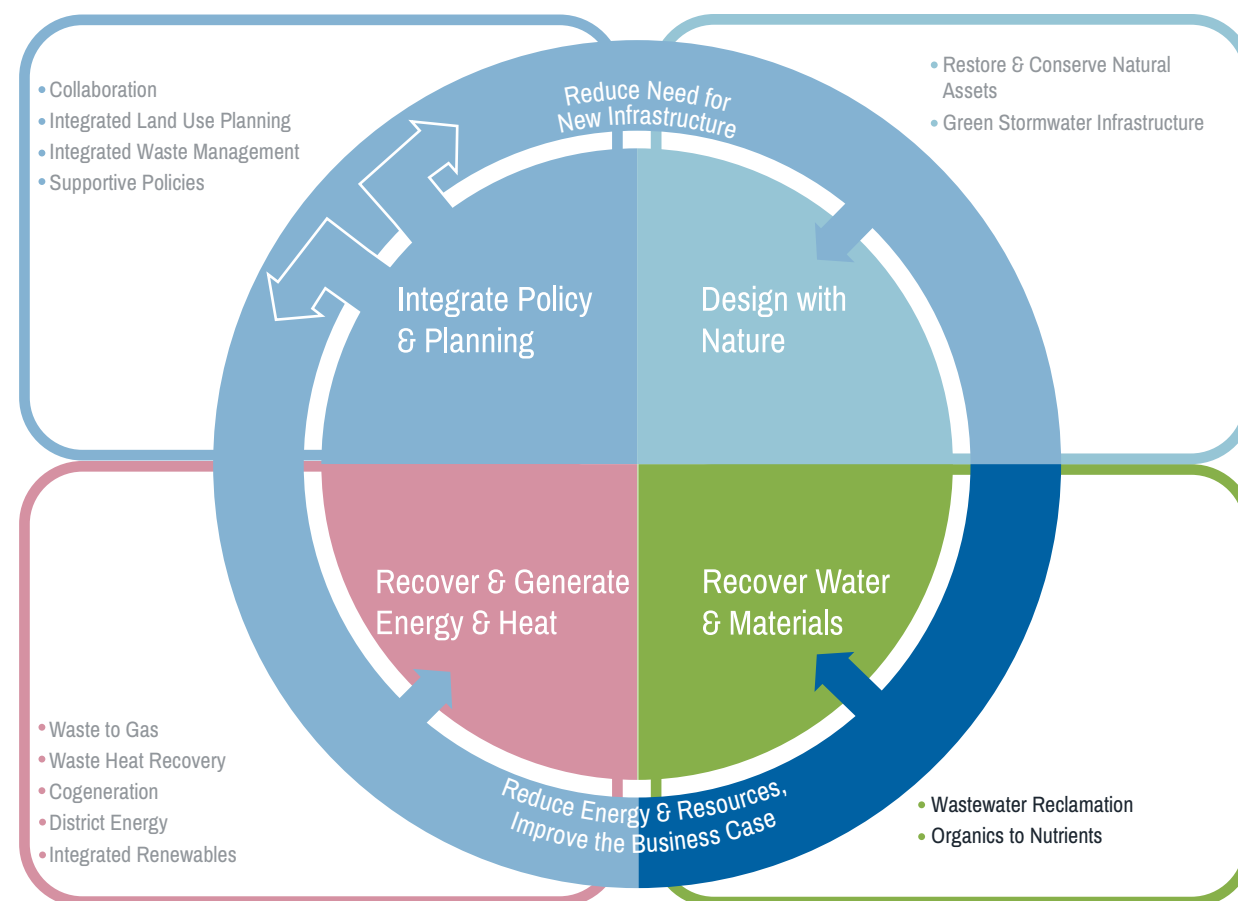
The Town is developing an [Eco-Asset Strategy](#), which outlines its pioneering approach to value the services provided by nature and place natural assets at the core of the Town’s municipal infrastructure system.





RECOVER WATER & MATERIALS

Recover usable resources from waste at the highest value.



The approaches described in this section improve can improve business cases for infrastructure projects by reducing operating costs or in some cases generating revenue from infrastructure projects, while reducing waste and enabling new community benefits.

Remember the guiding principles of the regenerative infrastructure approach. Almost all waste has the potential to create value, whether recycled into a new material, processed to extract nutrients, or converted to a source of energy. Waste can be recycled (e.g. metal cans back into cans), down-cycled (e.g. glass used as road base) or up-cycled (e.g. kitchen waste digested to biomethane).

The value gained from each of these processes should be analyzed to determine which is most appropriate, and should expand beyond monetary value. There may be other needs of the community that should factor in to how resources are used.

Prevent, then reduce, reuse and recycle waste. Then recover waste resources for the benefit of the community that produced them, as close as possible to the source to avoid unnecessary transportation costs and emissions.

Options for harnessing value from waste increase when system boundaries can be viewed more broadly. Boundaries include those between natural and human-made systems, private and public assets, and internal organizational divisions. Understanding how one system integrates with others is key to a regenerative infrastructure approach.

The business case of a potential infrastructure project can become more favourable when the potential to generate revenue is analysed in addition to the capital and operating cost of the project. The entire lifecycle of the infrastructure project should be analysed in terms of economic, environmental, and social impact.

This section addresses opportunities related to:

- > Wastewater Reclamation
- > Nutrients from Wet Organic Waste
 - >> Aerobic Composting
 - >> Anaerobic Digestion
- > Extracting Nutrients from Wastewater

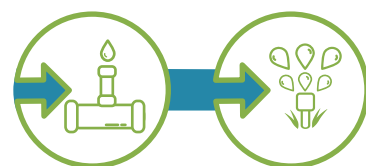
Remember these guiding principles:

- ▶ Follow the pollution prevention hierarchy
- ▶ View every waste as a potential resource
- ▶ Use each resource more than once
- ▶ Use each resource for its highest value
- ▶ Integrate system boundaries
- ▶ Consider the entire system lifecycle





Wastewater Reclamation



Environmental Benefits



Less surface runoff to nearby natural water bodies.
* Less water pollution and eutrophication (excess nutrients in water that causes an imbalance of algae and plants)



Use reclaimed water to:

- Recharge groundwater supplies
- Augment stream flows during dry periods for fish protection

Social Benefits



Use reclaimed water to:

- Create water features that provide community meeting spaces and public art
- Irrigate green spaces that add social and ecological value
- * These green spaces serve as natural cooling cells during periods of extreme heat and can reduce the need for air conditioning in adjacent buildings

Economic Benefits



Reduce pumping costs for potable water and wastewater
Reduce potable water demand
* Delay an expansion of potable water supplies and distribution systems



Use reclaimed water for:

- Irrigation
- Street cleaning
- Water features

Resource

Wastewater from residents, industry and municipal systems

When is it Waste?

When it reaches collection systems

Conventional Approach

Collect, treat, and discharge to a receiving environment

Regenerative Approach

Collect, treat, and reuse water for regulator-approved non-potable purposes, such as landscape irrigation and flushing toilets.

How it Works

AWastewater can be treated and disinfected to produce useable non-potable water. Water recovered from wastewater is commonly referred to as "reclaimed" water. Reclaimed water used for irrigation is conveyed in purple pipe.

But First

Encourage water conservation through community outreach and education.
Reduce the amount of rainwater/stormwater entering the municipal liquid waste stream by enhancing green stormwater infrastructure.

What are the Costs?

Costs for reclaimed water increase with the degree of treatment used. Taking an integrated approach, it is possible for the extra cost to be offset by reduced infrastructure costs and increased value in the community.

Where is it Happening?

Cranbrook Effluent Spray Irrigation



Spray-irrigation systems can convert semi-arid, dry land into lush farmland for growing crops or raising cattle.

Considerations for Implementation

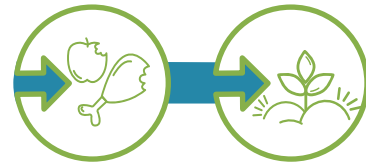
To fully explore the costs and benefits of water reclamation and reuse, take an integrated, long-term approach and include the capital and operating costs of potable water infrastructure and treatment, wastewater infrastructure and treatment, and the benefits of re-use in any feasibility or cost/benefit analysis.

For example, if treated wastewater can be reused, the analysis would need to account for the cost savings of the reduced demand on potable water infrastructure and reduced demand on sewer infrastructure.

Concerns related to public health concerns need to be addressed and public and stakeholder consultation should be early and ongoing. Treated water must comply with applicable regulations, including the B.C. Building Code, the *Drinking Water Protection Act* and the Reclaimed Water Guideline (2013) under the [Municipal Wastewater Regulation](#) and the *Environmental Management Act*.



Nutrients from Wet Organic Material



Resource

Wet Organic Waste from residential, commercial and agricultural uses

When is it Waste?

When produced by farming and food production, retail, preparation and consumption

Conventional Approach

Collect and landfill

Regenerative Approach

Recover nutrients through regulator-approved use of residuals
Collect and divert to aerobic composting
Collect and divert to anaerobic digestion to produce biomethane (waste to gas) and compost
Collect and divert to appropriate treatment before use as a supplemental nutrient source in agricultural settings

Aerobic Composting

How it Works

Aerobic composting of wet organic waste (including residential kitchen waste, restaurant waste, food processing waste, wastewater treatment plant biosolids, and manure) is a common practice and considered a traditional method of resource recovery. Diverting wet organic waste from landfills and aerobic composting can result in a significant reduction in greenhouse gas emissions (methane) from landfills. Composting also recovers nutrients and soil-building materials for agriculture.

In aerobic composting, micro-organisms digest the organic materials, giving off metabolic heat and carbon dioxide (CO2). Since the CO2 is from atmospheric rather than fossil sources, it is considered greenhouse gas-neutral. The goal in composting is to expose organic materials to air as effectively as possible, in order to accelerate the decomposition process and to prevent anaerobic decomposition.

Local governments can set up community curbside organic waste collection and divert it to a centralized composting facility.

But First

Encourage localized, onsite backyard composting by subsidizing composting bins and providing community education and outreach about the benefits of backyard composting.

What are the Costs?

Adding curbside collection of organic waste to existing solid waste collection systems can be achieved at incremental costs. The resulting compost can be used in municipal landscaping and/or sold to generate revenue that offsets these incremental costs.

Where is it Happening?

Regional District of Kitimat Stikine Compostable Waste Collection

Anaerobic Digestion

How it Works

In anaerobic digestion, waste decomposes without oxygen in an anaerobic digester. Like in aerobic composting, the nutrients are still concentrated in the residues to produce compost. In aerobic composting, chemical energy in the organic matter is lost as heat in the process, whereas in anaerobic digestion the absence of oxygen results in bacteria converting the waste into "biogas" (more in the **Recover Energy** section).

But First

Communities have two options for recovering nutrients from organic waste: aerobic composting or anaerobic digestion. Aerobic and anaerobic digestion both recover nutrients and divert organic waste away from landfills; anaerobic digestion has the added benefit of providing greenhouse gas-neutral energy. The digestate from anaerobic digestion typically takes the form of wet slurry, while the residuals from composting contain less water and are therefore less costly to dewater and transport.

What are the Costs?

Capital costs depend on the technology, size of digester, and the extent of odour control measures required. Depending on the project, there is a minimum amount of feedstock required on an ongoing basis to ensure the anaerobic digester is economically viable. Another cost consideration is that to achieve adequate inputs for a digester, curbside collection of organic waste will likely be necessary.

Where is it Happening?

Surrey Biofuel Facility



Surrey Biofuel Processing Facility

Photo courtesy Peter Robinson

Environmental Benefits



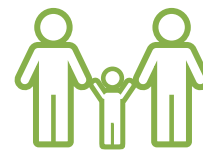
Diversion of organic waste from landfill

- * Reduced methane emissions, the most potent greenhouse gas
- * Reduced leachate
- * Reduced need for land for landfill expansion



Production of compost for application to landscaping and in some cases food production

Social Benefits



Production of compost for use in residential applications and for reclamation use in areas with limited nutrient sources such as remediation sites. Compost can be sold at a reduced cost back to residents.

Economic Benefits



Offset costs of curbside waste collection for lower overall system cost

In many cases, curbside collection of organic waste is cheaper than garbage collection

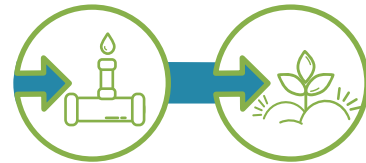


New revenue source from sale of compost

Production of compost that can be used in municipal landscaping instead of purchasing compost from external source



» Nutrients from Wastewater



Environmental Benefits



- Slow release fertilizers have less surface runoff
- * Less water pollution and eutrophication (excess nutrients in water that causes an imbalance of algae and plants)
- Reduced need for artificial and mineral fertilizers
- * Reduced GHG emissions
- * Reduced use of phosphorous

Social Benefits



Availability of locally produced soil amendments for community amenities, and commercial and residential landscaping

Economic Benefits



- Reduced total operating costs of recovery equipment
- Reduced maintenance costs due to removing particulate from wastewater treatment plants that accumulates in pipes



Revenue from sales of soil amendments

Resource

Biosolids in Wastewater

When is it Waste?

When produced by wastewater treatment plants

Conventional Approach

Collect and landfill, or apply to industrial landscaping

Regenerative Approach

Recover nutrients through regulator-approved use of residuals OR collect and divert to composting or anaerobic digestion

How it Works

Nutrients can be recovered from wastewater with chemical and/or physical processes to yield stable commercial fertilizers. Another approach is to integrate biogas digesters with wastewater treatment plants to generate energy.

But First

Reduce the amount of rainwater/stormwater entering the municipal liquid waste stream by enhancing [green stormwater infrastructure](#). Since sewage biosolids can be dewatered and used as a feedstock in a [biogas plant](#) or [gasification plant](#), it is worth considering if they can be used as a source of energy.

What are the Costs?

Costs for reclaiming nutrients from wastewater vary depending on the degree of wastewater treatment used. The capital expenditure needs to be weighed against future reduced maintenance costs and revenue from sales of soil amendments.

Where is it Happening?

Comox Valley Regional District Composting from Wastewater Biosolids

Comox Valley Regional District

WATER POLLUTION CONTROL CENTRE

Project Summary

The Comox Valley Water Pollution Control Centre processes wastewater from 40,000 households in the Comox Valley region. Solids are removed by screening and degritting, then the water undergoes aeration to ensure it is meeting safety standards before being discharged. Biosolids from the treatment process are transported to CVRD's compost facility at the Comox Valley Waste Management Centre. The resulting compost, SkyRocket, is sold as a soil amendment for large-scale landscaping and planting projects as well as residential uses.

SkyRocket is a high-nitrogen soil amendment that is composed of wood chips and bio-solids and cured over time. Biosolids have organic matter and are nutrient rich, which helps to replenish soil and retain its moisture. Due to its high nitrogen content, the most appropriate use of SkyRocket is as a soil conditioner or supplement rather than a topsoil or fertilizer. It can be applied to orchards, flower gardens, lawns and landscaping projects. SkyRocket undergoes frequent testing to ensure it meets the regulations for Class A compost, the most stringent level for compost production.

The Comox Valley Water Pollution Control Centre has been in operation since 1984, and originally included on-site composting. A history of odour complaints resulted in several odour controls measures over the years and the relocation of the composting facility in 2002. In 2014, the Regional District initiated an evaluation of odour control equipment and a review of available technologies. The Comox Valley Sewage commission approved additional upgrades to the Water Pollution Control Centre in 2017 and work began in 2018. The Regional District will continue composting biosolids at the Waste Management Centre.



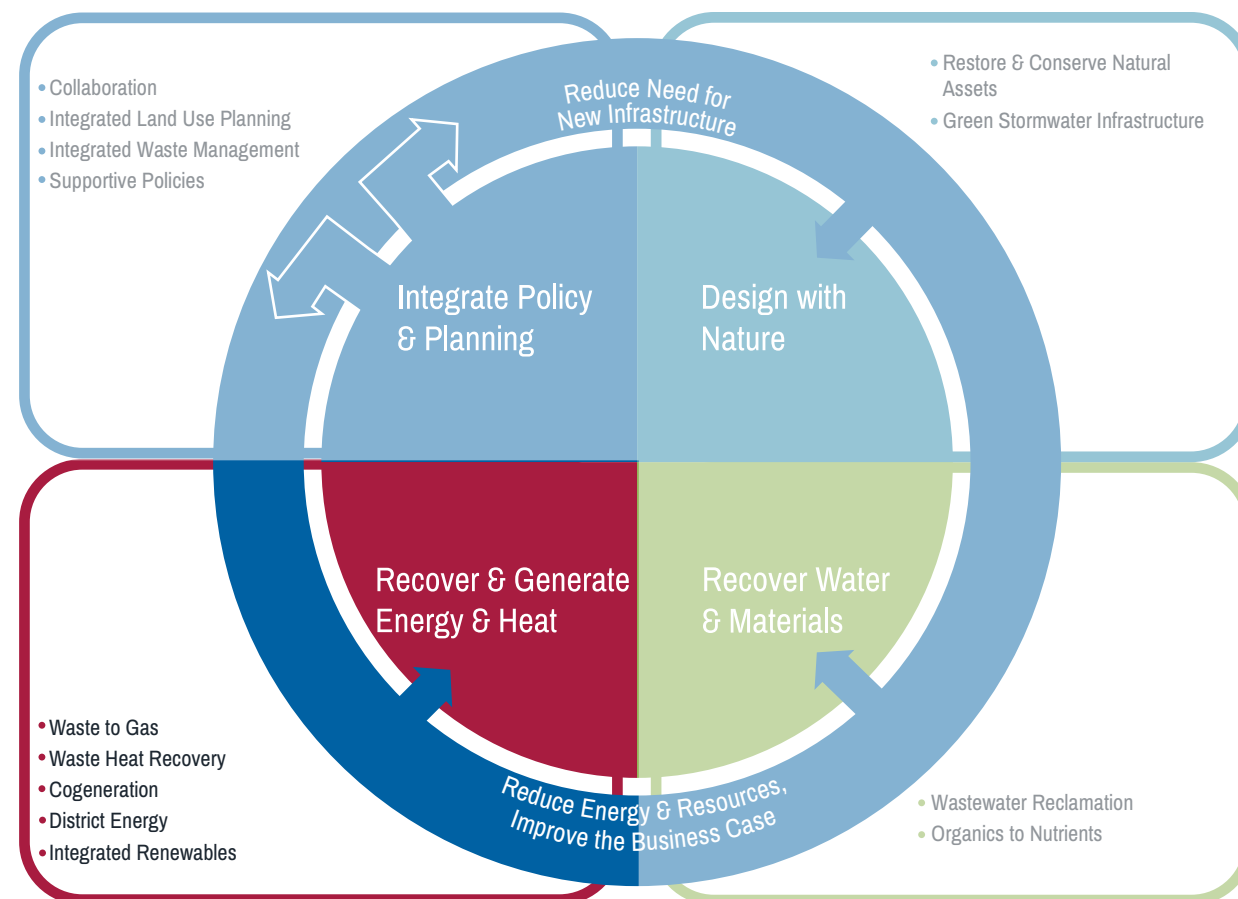
Wastewater nutrients are reclaimed by removing biosolids during the wastewater treatment process and composting them along with wood chips to produce a high-nitrogen soil amendment.

Photo: <https://www.comoxvalleyrd.ca/services/sewer/sewage-treatment-plant>



RECOVER AND GENERATE ENERGY & HEAT

Recover and make use of wasted energy and integrate energy generation with infrastructure.



A Systems-Approach to Energy

There are numerous opportunities for recovering waste energy in local government operations. Waste heat can be recovered, and other forms of energy can be available, such as landfill gas. Energy recovery systems capture energy otherwise lost as an output and transfer it as a useful input back to the same or a different process: **Taking a systems approach closes the energy loop as much as is feasible.**

Strategies:

- » Recover heat energy that would otherwise be wasted (waste heat recovery, wastewater and sewer heat recovery)
- » Capture and utilize gas produced by waste (landfill gas utilization)
- » Capture potential energy in waste by converting it to useable fuel (biogas from anaerobic digestion)
- » Release potential energy in waste through combustion (biomass, incineration, gasification)
- » Recover heat energy from electricity production (cogeneration)
- » Apply energy recovery and deliver low carbon energy to the community (district energy)
- » Generate energy from infrastructure and processes that serve a different primary purpose (integrated renewables such as energy from municipal water supply)

This section addresses opportunities related to:

- > Waste Heat Recovery
 - >> Wastewater Heat Recovery
 - >> Sewer Heat Recovery
- > Waste to Gas – Landfill Gas Utilization
- > Waste to Gas – Biogas from Anaerobic Digestion
- > Combustion of Dry Organic Waste
 - >> Combustion of Wood Waste
 - >> Incineration – Waste to Energy
 - >> Gasification
- > Cogeneration
- > District Energy
- > Integrated Renewables

City of Campbell River, Strathcona Regional District

STRATHCONA GARDENS RECREATION CENTRE ENERGY RECOVERY LOOP

← **An energy recovery loop transfers waste heat from the arena cooling plant to the swimming pool water heating system.** →



Location: Campbell River, BC

Owner: Strathcona Gardens Recreation Commission (City of Campbell River, Strathcona RD)

Operator: Strathcona Regional District

Year Installed: 2014

Project Summary

Waste heat is produced during the ice making process in the ammonia compressor room, and not far away there is a demand for heat energy to heat water for the pools. The energy recovery system consists of 600 feet of glycol-filled pipe that runs in a continuous loop from the arena condensing tower to the heat pumps located near the pools and then back to the arena.

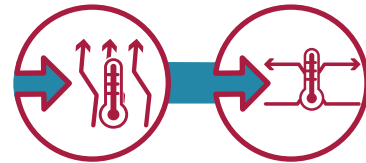
The system is configured in a way that enables future expansion opportunities, such as air handling units for space heating and preheating domestic hot water for showers.

Energy Reduction	11,000 – 13,000 GJ of natural gas
GHG Reduction	547,000 – 647,000 kg of CO2 reduction
Annual Cost Savings	\$50,000 - \$60,000
Total Project Cost	\$310,000
Funding Source	Gas Tax Fund (\$99, 750) and Strathcona RD

Heat Exchanger and Piping:
The heat exchanger shows where the waste heat from the condenser is captured and then circulated in the pipes going up the side of the building.



Waste Heat Recovery



Environmental Benefits



Net reduction of greenhouse gas emissions when natural gas is replaced by heat recovery from treated wastewater or sewer lines. Heat pumps consume electricity, so the “upstream” emissions of electricity production need to be factored in.

Social Benefits



Reliable low-carbon energy source for the community.

Economic Benefits



Reduced overall cost of wastewater treatment plant due to revenue source.

Heat pumps have a lower cost than other heat sources over the lifecycle of the systems.

Less fluctuation and energy price increases than fossil fuels.



Revenue from energy subscribers paying for heat.

Potential for heat storage and demand charge savings

* Operate heat pumps when electricity demand is lower, then heated water can be stored for use during peak heating demand hours

Resource

Waste Heat

- Industrial processes
- Refrigeration and cooling
- Wastewater
- Vented indoor air

When is it Waste?

When produced as a by-product of other processes

Conventional Approach

Allow heat to dissipate into surrounding environment

Regenerative Approach

Recover heat energy and apply to other processes and uses

How it Works

Waste heat recovery is possible in most systems that have an exhaust stream or another waste stream in either gas or liquid form. The captured thermal energy can be used within the same system it came from or transferred to a new system. In either case, the waste heat is used to pre-heat air or water for space or water heating, or industrial processes.

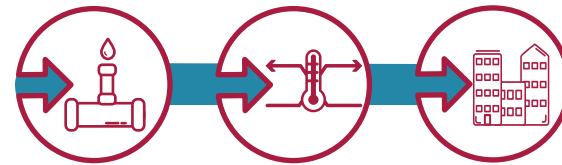
Waste heat recovery has many applications and is common in industry and buildings. Examples include heat recovery ventilation and drain water heat recovery in buildings, extracting heat from flue gases in industrial processes, and capturing heat from water used in cooling processes.

Waste heat is recovered with heat exchangers (such as in heat recovery ventilation) or with heat pumps. Heat exchangers capture a portion of the waste heat and transfer it, whereas heat pumps use electricity to recover low temperature heat and make this heat available at suitable temperatures for heating and for hot water systems. For every unit of electricity consumed by heat pumps, they typically produce three to four units of higher temperature heat.

An innovative example in local government operations is capturing heat produced as an output from ice rink cooling and using it to preheat water for a swimming pool or space heating in the recreation centre. This application of waste heat recovery reduces the need for new energy sources to heat the pool and building.



Wastewater Heat Recovery



How it Works

Heat pumps are used to extract heat from treated wastewater, which is transferred to nearby buildings for space and/or water heating. The cooled treated water can then be used for air conditioning or refrigeration. Treated wastewater is significantly warmer than other sources of energy for heat pumps (e.g. air during the winter, ground-sources, lakes or the ocean), so energy can be recovered from wastewater more efficiently. Treated wastewater from local plants can be delivered through ordinary pipes to heat pumps located in buildings near treatment plants.

What are the Costs?

Heating systems in buildings would need to be adapted to use this form of energy. Conversion costs would include the capital and operating costs of the heat pumps, heat exchangers, and any necessary modifications to the building's heating system. Heat pumps normally require replacement every twenty years. New developments close to a source of wastewater heat recovery could be constructed with heat transfer technology.

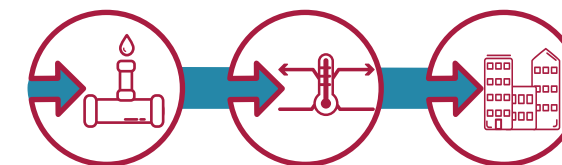
Either the community or a local energy company could pay for the cost of infrastructure such as the water piping required to deliver the treated water to heat pumps.

The economics of heat pumps are strongly affected by the temperature of the heat source. The higher the temperature, the lower the capital and operating costs, as the heat pumps can be smaller in size. With rising temperatures, more heat is also available.

Where is it Happening?

Saanich Peninsula Wastewater Treatment Plant Heat Recovery System

Sewer Heat Recovery



How it Works

Rather than extract heat from treated wastewater at the wastewater treatment plant, sewer heat recovery involves transferring heat directly from untreated sewage in the sewer line using heat pumps. While more common in Europe, this technology is relatively new in Canada.

Where is it Happening?

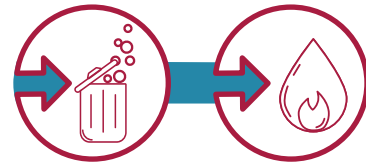
Southeast False Creek Neighbourhood Energy Utility

Considerations for Implementation:

If the needs of buildings for energy and reclaimed water are taken into account when communities plan for wastewater treatment infrastructure, then treatment plants can be sized and located to deliver the greatest amount of energy (and even reclaimed water) to the greatest number of buildings. The reverse is also true: new developments or community buildings close to wastewater infrastructure can be designed to take advantage of waste heat. This approach tends to favour a network of distributed small treatment plants over the more traditional option of large centralized plants. Locating decentralized wastewater treatment plants near clients for heat energy will require a different approach to planning on the part of local governments than the current system of fewer, centralized plants.



Waste to Gas - Landfill Gas Utilization



Environmental Benefits



- Reduced greenhouse gas emissions directly emitted by landfill
- Reduced greenhouse gas emissions from replacing conventional natural gas with landfill gas
- Decrease pollution by managing landfill leachate

Social Benefits



Create jobs related to system set-up, maintenance, and processing fuel

Economic Benefits



Reduced overall system maintenance costs



New revenue source from sale of treated landfill gas

Resource

Landfill Gas

When is it Waste?

When produced and emitted from degrading garbage in landfills

Conventional Approach

Allow to escape into atmosphere as a potent greenhouse gas, or collect and flare off gas to reduce impact

Regenerative Approach

Capture, process, and utilize methane from landfills as biogas or to produce electricity and heat through cogeneration

How it Works

Landfill gas is produced through the degradation of garbage and decomposition of biodegradable organic waste by microorganisms. Typically, landfills have anaerobic conditions (lack of oxygen), so the primary gas produced is methane, followed by CO2 (proportions depend on the composition of waste in the landfill).

Landfill gas is collected in both open and closed landfills by installing horizontal or vertical wells into the body of the landfill or by horizontal trenches that channel the gas to a collector where it is flared or treated.

Landfill gas can undergo a range of treatments depending on the intended use. It can be used directly as a heating fuel in place of natural gas in boilers and other heaters, provide heat to greenhouses and other processes, or be used to generate electricity. In some cases, landfill gas can be upgraded to pipeline quality renewable natural gas (RNG) for piping into the natural gas distribution network.

But First

Divert food waste and other biodegradable waste (paper and cardboard) from landfills through composting, recycling or anaerobic digestion to produce nutrients and biogas.

What are the Costs?

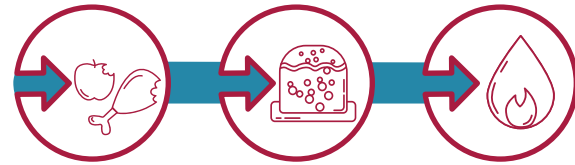
Costs of landfill gas capture depend on the size and composition of the landfill and degree of treatment.

Where is it Happening?

Salmon Arm Landfill Gas Capture Project



Waste to Gas - Biogas from Anaerobic Digestion



Environmental Benefits



Diversion of organic waste from landfill, resulting in:

- * Reduced greenhouse gas emissions
- * Reduced leachate
- * Reduced need for land for landfill expansion

Reduced greenhouse gas emissions from replacing conventional fossil fuels with GHG-neutral fuel

Production of compost for application to landscaping and in some cases food production

Production of greenhouse gas neutral energy

Economic Benefits



Offset costs of curbside waste collection for lower overall system cost

In many cases, curbside collection of organic waste is cheaper than garbage collection

New revenue source from sale of biofuel, tipping fees, and greenhouse gas credits

Resource

Wet Organic Waste

Residential and Commercial Food Waste
Agricultural Waste
Sewage Biosolids
Manure

When is it Waste?

When produced by farming and food production, retail, preparation and consumption

Conventional Approach

Collect and landfill

Regenerative Approach

Collect and divert to anaerobic digestion to produce biomethane and nutrients

How it Works

In anaerobic composting, waste decomposes without oxygen in an anaerobic digester, resulting in bacteria converting the waste into "biogas", which is rich in methane. Similar to landfill gas, biogas can undergo a variety of treatments to produce fuel for vehicles or to generate heat and electricity.

There are different types of anaerobic digesters based on the types of materials they process (food and agricultural waste, sewage biosolids, manure) and are categorized depending on operational temperature.

Yields of biogas from organic waste depend on a large number of factors including moisture content, composition of the waste, the method used to prepare the waste for digestion, and the type of digestion process used. Fortunately, biogas digesters operate more efficiently on a "mixed diet", in which the ratio of carbon to nitrogen is balanced.

Where is it Happening?

Surrey Biofuel Facility

Get started by:

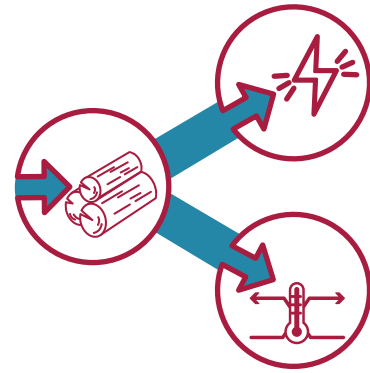
Completing an inventory of waste streams, such as all organic solid waste from homes, food factories, and agriculture. An analysis of resource needs could then be undertaken, such as a need for greenhouse gas-neutral transit fuel. This information could then be used to develop business cases for the infrastructure required to recover waste from resources.

A local government could increase the productivity or capacity of its wastewater treatment plant digestion process, and could also divert organic solid waste from landfills by undertaking anaerobic digestion in separate vessels at the wastewater treatment plant.

If the community does not have a biogas digester, it could study the costs and benefits of building one. Existing municipal land and assets, as well as industrial sites, could be considered as locations for a new biogas digester.



➤ **Combustion of Dry Organic Waste**



Resource

Dry Organic Waste

- Wood Residuals
- Yard Waste
- Non-Recyclable Paper
- Construction and Demolition waste

When is it Waste?

After initial use

Conventional Approach

Collect and landfill

Regenerative Approach

Collect and divert to composting or to energy production through combustion

➤ **Combustion of Wood Waste**

How it Works

When mixed with wet organic waste, dry organic waste can be composted, however the low moisture content makes it difficult for microorganisms to digest the material through biological treatment. Instead, dry organic waste is suitable for thermal treatment.

Wood residuals, such as waste from sawmills, is burned as a fuel to produce heat. The heat can be delivered to nearby users through a district energy system.

Where is it Happening?

Prince George Downtown District Energy System

➤ **Waste to Energy**

How it Works

Incineration of municipal solid waste in conventional mass burn systems is an old waste management practice that alone is not an integrated resource recovery approach; However, there are methods of generating energy from combustion of municipal solid waste that use newer technologies to harness energy and provide other benefits over conventional garbage incineration such as enhanced pollutant and particulate control.

In some Waste to Energy combustion facilities, sorted dry waste such as non-recyclable paper, cardboard, and wood residues undergoes combustion to generate heat and electricity. These facilities also recover and recycle other materials from the waste stream such as metals and reduce air pollution through advanced scrubbing and filtering technology.

But First

Reduce solid waste through diversion programs.

Waste-to-Energy facilities should be built to an appropriate scale, sited beside a customer that could benefit from the energy collected, and accept other waste streams to make it viable.

Where is it Happening?

The Burnaby Waste-to-Energy facility, operating as Covanta Burnaby Renewable Energy, converts post-recycled solid waste and other waste to steam and electricity through cogeneration.

» Gasification

How it Works

During gasification, the waste is heated in a vessel with limited amounts of oxygen. The waste decomposes to ash and "synthesis gas" ("syngas" for short), a mixture of hydrogen, carbon monoxide, carbon dioxide, methane, and more complex hydrocarbons. Synthesis gas can be burned in a boiler for heat, or in a cogeneration plant to produce heat and electricity. It is not suitable for transmission through natural gas networks. Synthesis gas can also be reformed into liquid fuel and blended with gasoline for use in fleet vehicles.

Gasification is a cleaner process than traditional incineration, since the process can be more tightly controlled and since it presents two opportunities for removing contaminants: first from the synthesis gas stream between the gasifier and the cogeneration engine or boiler, and again from the exhaust stream from the cogeneration engine or boiler to heat or electricity.

What are the Costs?

Economic viability of gasification plants depends on their size, the composition of source waste stream, whether it receives tipping fees, whether the produced energy can be sold via cogeneration of electricity and heat, and whether greenhouse gas credits are sold. Gasification plants require less land than biogas plants.

Where is it Happening?

Kwadacha First Nation Off-grid Utility Standard Biomass Gasification-to-Electricity Project

Environmental Benefits



Diversion of organic waste from landfill, resulting in:

- * Reduced greenhouse gas emissions
- * Reduced leachate
- * Reduced need for land for landfill expansion

Diversion of dry organic waste from conventional mass burn incineration

- * Reduced air pollution



Production GHG-neutral fuel that can offset fossil fuels and be used in cogeneration plants to produce electricity

Production of cleaner ash that can be added to composting feed stocks

Social Benefits



Reduced pollutants and air particulars compared to conventional mass burn of wood residues



Revenues that stay within the community

Local job creation

Economic Benefits



Reduced overall lifecycle cost of infrastructure



New revenue source from sale of biofuel, tipping fees, and greenhouse gas credits



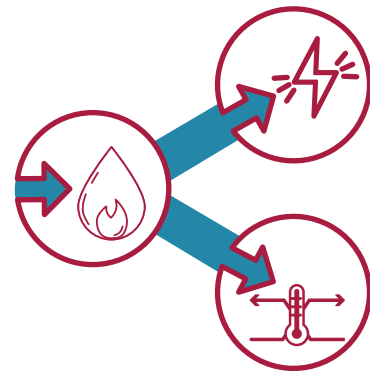
Considerations for Implementation:

Communities with wood residues which are not suitable for other uses could consider including this source with dry organic waste from the community (e.g. paper and cardboard products which cannot be recycled) as feed stock for a gasification and cogeneration plant. If the plant could be located on an existing industrial site, then capital and operating costs could be reduced by sharing operating and maintenance personnel.

This strategy is particularly well suited to a public-private partnership with an industry partner that produces a large amount of wood waste.



> Cogeneration



Resource

- Biogas from Anaerobic Digestion
- Cleaned Synthesis Gas from Gasification
- Cleaned Landfill Gas

How it Works

Cogeneration, also called combined heat and power, refers to the process of fuel being burned in a steam plant, a reciprocating engine, a gas turbine, or fuel cell to produce electricity and heat. Heat can be recovered from the engine through heat exchangers and used as a source of heat for buildings or greenhouses.

Cogeneration plants can provide high-grade heat, at 100°C or even higher (in the case of gas turbines), which is suitable for heating older buildings in cold climates. Cogeneration can also provide low-grade heat, at 70°C to 80°C, which can serve buildings which are designed to take advantage of lower-temperature sources of heat. Heat can be provided to clients through insulated underground district heating pipes.

Cogeneration plants are the link between sources of greenhouse gas-neutral fuels such as biogas digesters and gasification plants, and the district heating networks that can distribute the heat produced through cogeneration.

What are the costs?

Locating cogeneration equipment in the same facility as biogas digesters or gasification plants reduces the capital and operating costs of cogeneration. Cogeneration plants using internal combustion engines can be economically viable in capacities below one megawatt, provided the heat can be sold.

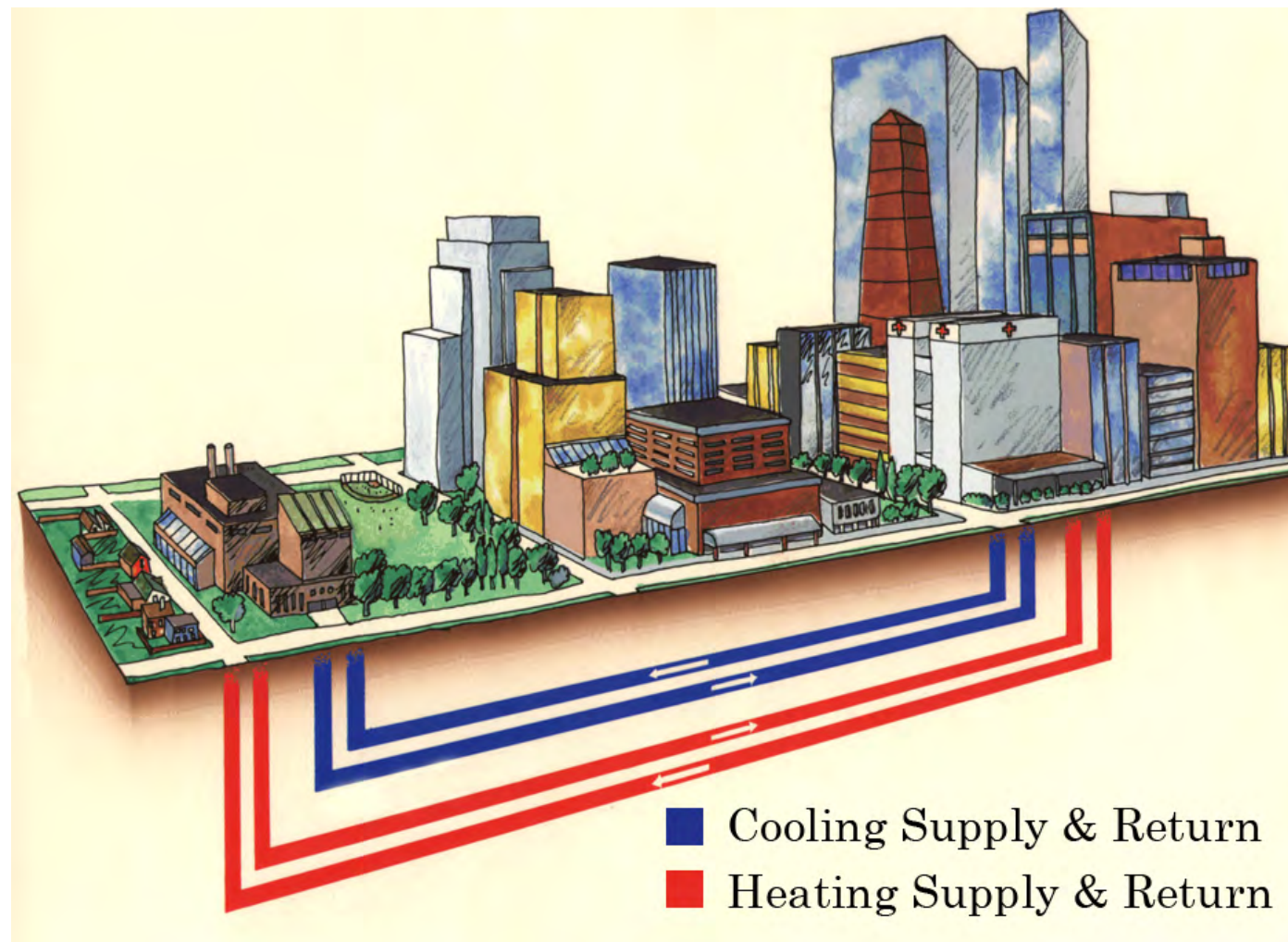
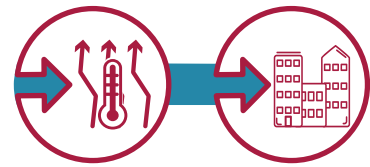
Where is it Happening?

Kwadacha First Nation Off-grid Utility Standard Biomass Gasification-to-Electricity Project





➤ District Energy



Resource

- Waste Heat from Wastewater or Other Sources
- Heat Produced by Combustion
- Heat Produced by Cogeneration

How it Works

District Energy is a method of delivering recovered heat for space and water heating to multiple end users through a distribution network of insulated underground pipes. District energy is a hydronic heating/cooling system that is connected to a series of buildings or a neighbourhood from a single centralized energy source.

District energy may use a variety of renewable and non-renewable fuel sources alone or in combination, but is particularly well suited to deliver renewable and recovered sources of heat.

District heating systems pump heated water from the heat source (boiler plant, wastewater treatment plant, or other) through the piped network to provide heating for space heating and domestic hot water. This reduces the need for both electricity and natural gas for heating in each individual building.

Similarly, district cooling systems pump chilled water (from heat pumps) through the piped network to provide cooling to customers. This reduces the need for electricity to run air conditioning and refrigeration equipment. In wastewater heat recovery, the cold treated water remaining after the heat is extracted can be used for district cooling.

One of the benefits of district energy systems is that they can simultaneously accept heat from several sources, which makes them flexible and robust.

What are the costs?

District heating and cooling pipes are insulated, buried, and include leak detection technology. Depending on the type and capacity of the pipes used, the installed costs range from \$1-\$2 million per kilometre. Maintenance of district heating and cooling pipes is technically uncomplicated, and the pipes are designed to last up to fifty years.

In order to connect to the district energy system, heat exchangers which transfer the heat (or cold) to the building's heating system are required. If the building relies on a hydronic system (e.g. hot water baseboards or hot water radiant heating), then conversion costs are relatively low. If the building uses a forced air heating system, then a "fan coil" (similar in function to a car's radiator) would have to be installed to transfer heat or cold from the community energy system to the building's ducts.

In the cases where electric baseboard heaters are required, these would need to be replaced with either a hydronic or a forced air system.

Local governments can support potential future district heating systems by encouraging the installation of hydronic heating in new buildings.

Where is it Happening?

- Saanich Peninsula Wastewater Treatment Plant Heat Recovery
- City of Prince George Downtown District Energy System



Environmental Benefits



Avoided GHG emissions due to replacing conventional fossil fuels with renewable fuels
Avoided air pollution from fossil fuel combustion



Improved efficiency from using larger source of heat energy compared to many small heating sources in individual buildings
More viable use of non-conventional, renewable or recovered fuel sources (waste heat, cogeneration heat)

Social Benefits



Revenues that stay within the community
Local job creation

Economic Benefits



Reduced system cost when district energy systems are planned before new developments are built – Integrated land use planning



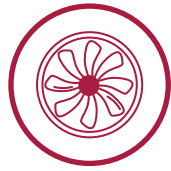
Improved energy price stability due to resilience against fossil fuel price fluctuation
New revenue source from sale of heat

Get started by:

1. Local governments can investigate their opportunities to recover waste energy from industrial or municipal sources, and to connect those sources to clients through district energy systems.
2. Local governments can consider planning for providing district heating to major energy users such as factories, residential developments, government buildings, hospitals and educational and recreational facilities.
3. Communities can investigate the possibility of extending existing systems (e.g. those in place at universities) to serve other clients.
4. Communities can encourage the construction of district energy systems through their Regional Growth Strategies and Official Community Plans, and through the development permit approval process.
5. Communities can encourage the installation of hydronic heating systems in new developments which may be served by future district heating systems.
6. Communities can consider the benefits of mixed ownership of district energy infrastructure. For example, if a source of energy will be industrial wood residues, it may make sense for the wood-fired boiler to be owned by the industrial source, and for the district heating piping to be owned by a "Municipal Energy and Resource Company" with access to financing at favourable long-term rates.
7. Local government councils and staff can visit communities which operate district energy systems, in order to better understand the costs and benefits.
8. Communities can contact the Community Energy Association (www.communityenergy.bc.ca), the Canadian District Energy Association (www.cdea.ca), or Natural Resources Canada for more information about the feasibility of implementing a community energy system in their region.



> Integrated Renewables



Resource

Energy from Infrastructure – wasted opportunities

How it Works

Some municipal infrastructure contain “wasted opportunities” to generate energy from existing or planned systems designed to deliver a service to the community. Municipal assets such as buildings, roads, water and sewer pumping systems, and street lighting systems may contain opportunities to harness energy and generate a new source of revenue that improves the overall business case of the infrastructure while bringing other community benefits.

One example is harnessing energy from the drinking water supply by using pumps as turbines. Similar to “run-of-river micro hydro projects”, “run-of-reservoir” uses the flows in municipal water supply systems to generate electricity for sale back to the grid. Pumps function in reverse and can slow down water flows, acting as turbines to generate electricity.

Another innovative technology involving municipal water systems is the application of in-pipe turbine generators. These turbines harness electricity from the water transmission network while reducing excess pressure and the work done by pressure releasing valves.

Energy from infrastructure is not limited to hydropower. Traditional renewable energy technologies such as solar photovoltaic panels and wind turbines can be integrated with municipal infrastructure to provide energy for the operation of that infrastructure. The electrical grid can be used as storage for excess electricity.

Where is it Happening?

City of Nanaimo Reservoir #1 Energy Recovery from Drinking Water Supply System
Hydrogen Assisted Renewable Power (HARP) System & Micro Grid



The City of Nanaimo's reservoir #1 generates electricity from their drinking water supply system.



While this guide does not explore all stand-alone renewable energy opportunities such as solar and wind energy, it does include consideration of opportunities for capturing energy generated as a by-product of municipal processes and infrastructure. Local governments can explore innovative models of community-owned renewable energy projects, such as community solar gardens.

Where is it done? [Nelson Solar Garden](#)

SECTION THREE: CASE STUDIES



Recover Water and Minerals

- › Cranbrook Effluent Spray Irrigation
- › Regional District of Kitimat Stikine Compostable Waste Collection
- › Comox Valley Regional District Composting from Wastewater Biosolids



Recover and Generate Energy & Heat

- › Saanich Peninsula Wastewater Treatment Plant Heat Recovery System
- › Salmon Arm Landfill Gas Capture Project
- › Surrey Biofuel Facility
- › Kwadacha First Nation Off-grid Utility Standard Biomass Gasification-to-Electricity Project
- › City of Prince George Downtown District Energy System
- › City of Nanaimo Reservoir #1 Energy Recovery from Drinking Water Supply System
- › Hydrogen Assisted Renewable Power (HARP) System & Micro Grid



City of Cranbrook

WASTEWATER IMPROVEMENT PROGRAM INCLUDING EFFLUENT SPRAY IRRIGATION



Population: 20,047

Size: Medium

Region: Kootenay

Wastewater is treated using aerated ponds and UV disinfection, and then used to irrigate forage land and a waterfowl nesting wetland that also serves as a popular recreation site.

Project Summary

The City of Cranbrook operated an effluent spray irrigation system since the 1970's as part of its wastewater treatment facility. A 2009 legal ruling from the BC Environmental Appeal Board mandated that the effluent storage ponds could not exceed a certain level, lowering its storage capacity and triggering the need for an upgrade. To identify a solution, city staff and consultants conducted a SWOB exercise (strengths, weaknesses, opportunities and barriers) before engaging with a Value Improvement Specialist. The specialist led a 3 day session that brought together experienced engineering, groundwater and environmental professionals to determine possible practical solutions to the issue and a vision.

After receiving the support of city council, Jamie Hodge, the Director of Engineering Services, led the upgrades to the City's wastewater treatment system in 2010. The improvements included a new storage pond, two new disinfection facilities and enhancements to its aerated lagoon. At the same time, the City decided to retrofit an agricultural irrigation system that reuses the wastewater on agricultural land. To enhance the quality of water, fine bubble aeration and UV disinfection are used to lower total suspended solids, biochemical oxygen demand and phosphorus levels.

To improve the energy efficiency of its water treatment plant, the City of Cranbrook installed low pressure irrigation heads, eliminated pipeline restrictions to minimize pumping energy, and added automated monitoring pivot irrigation systems.

Lessons Learned

It is important to create a long-term vision and review the entire system when making upgrades to wastewater treatment systems. In order to garner support for the vision and project from city council and various stakeholder groups, it is essential to engage with council and the community early, broadly and extensively including with First Nations, provincial agencies, general public, and businesses.

The use of proven products and technologies in innovative ways in addition to thinking differently from generally accepted or conventional approaches can be valuable when instituting improvements to these systems based on the city's experience. The City of Cranbrook also conducted a value engineering exercise at the design stage to establish an optimal return on investment as well as performed extensive research (e.g. feasibility and pre-engineering studies). It encourages other local governments to do the same.



Energy Savings / GHG Reductions

- Reduces energy use by 750 to 1,000 MWs per year, enough to power 160 – 190 homes.
- Energy recovery will reduce the waterworks total GHG production to 9 tonnes CO2e, a reduction of over 60%.



Business Case

- BC Environmental Appeal Board issued order that the level of one of its effluent storage ponds not exceed a certain level, which lowered its storage capacity. A solution was needed.
- Prepared for 100 years of effluent disposal
- Upgraded wastewater treatment plant can accommodate population growth and commercial / industrial development for at least 20 yrs.
- Lower annual maintenance costs
- Residential sewer use fees have declined (e.g. \$20/month in 2016)
- 600 cow-calf pairs forage on the irrigated land from May to November.
- The land produces 3,600 tonnes of hay a year, which sold in 2017 for \$690,000. Ranchers and the municipality share this revenue, with the City receiving 35-40%



Co-benefits

- Meeting the Canadian Council of Ministers of the Environment (CCME) guidelines for discharge of treated sewage to surface water
- Lower water consumption due to use of high efficiency spray nozzles
- Higher quality effluent better protects wildlife, aquatic life and vegetation
- Reduced odour due to use of fine bubble diffusers in lagoons, resulting in less public complaints
- New spray technology waters nearly 1800 acres of feedstock fields, which raises crop production and supports beef cattle production
- Irrigation site is popular for recreation activities (e.g. walking/hiking and bird watching)
- School and public tours showcase the science and how the site works with nature



Project Cost and Financing

Total project cost: \$28 million

Funding sources:

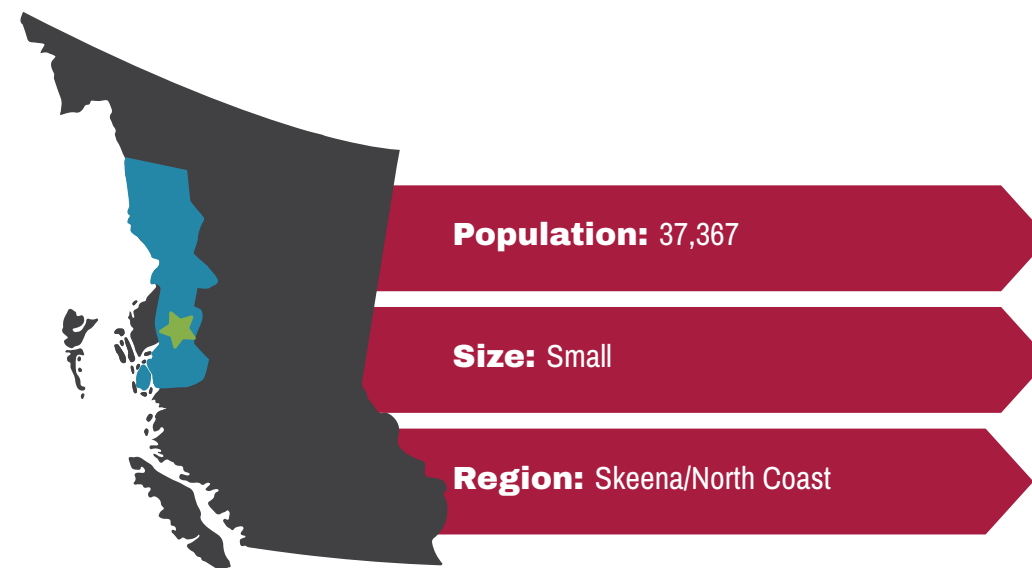
- \$9.6 million from Infrastructure Stimulus Funds from the federal and provincial governments
- \$8.5 million from the Gas Tax Fund
- \$9.2 million from the City
- \$660,000 grant from FCM's Green Municipal Fund and a loan through its low interest rate program



Regional District of Kitimat-Stikine

TERRACE AREA INTEGRATED SOLID WASTE MANAGEMENT PROGRAM: REGION-WIDE CURBSIDE PICKUP AND ORGANIC WASTE COMPOSTING

Two aging landfills approaching capacity sparked a long-term planning exercise that resulted in an integrated solid waste management program that benefits the community and local economy, and reduces impact on the environment.



Project Summary

The Terrace Area Integrated Solid Waste Management Program (TAISWMP) was generated following more than twenty years of planning, development, and community and stakeholder engagement after the creation of the Solid Waste Management Plan in 1995. The Regional District of Kitimat-Stikine (RDKS) Board was the main driver of this program and maintained a strong vision over sixteen Board compositions. The Board wanted to set a strong example with respect to solid waste management infrastructure, and put in place a sustainable, long-term waste management facility with low environmental risk that would co-exist well with the surrounding environment.

Curbside collection was a key component of the project to ensure that residents were conveniently serviced. The three stream residential curbside collection service for 6,738 single family homes is part of the broader Terrace Area Integrated Solid Waste Management Program. The TAISWMP also includes the Thornhill Transfer Station and Forceman Ridge Waste Management Facility (FRWMF), which collectively manage organics, residual garbage and some recyclables. Multiple private depots also manage recyclables.

The transfer station is a staging location for residential and commercial haulers. It features an organics collection area as well as a building for garbage collection for both types of haulers. Residents can also drop off various types of waste materials into different bins, including organics.

The main components of Forceman Ridge Waste Management Facility are the landfill, composting facility, septage facility, and five step leachate treatment system. The composting facility diverts organics from the landfill and converts it into class A compost, resulting in less methane gas and leachate production at the landfill. The facility uses the GORE® Cover to improve composting speed and control odours. The compost will be used in the closure of the Thornhill landfill: Instead of topsoil, the compost will support a vegetative cover, which will reduce the closure costs. Once the Regional District's need for compost is met, the remaining class A compost will be provided to the community. Dewatered septic tank and commercial grease trap materials from the septage receiving facility will also be composted for use at the landfill as final cover material or to improve phytoremediation of soils.

Lessons Learned

Extensive stakeholder engagement and public education/awareness campaigns during various stages of the TAISWMP were important for overcoming some resistance to the new three stream curbside collection service and broader TAISWMP. Engagement activities included working groups, workshops, open houses, sector specific toolkits, newspaper notices, mail outs, RDKS website updates, visits to commercial and institutional establishments, and classroom info sessions for elementary school students.

In order to successfully plan and implement this program, it was important to maintain balanced staff workloads. To achieve this, the RDKS hired subject matter experts to help with project.

A sustainable funding model was also key. Solid waste service costs are apportioned equally by taxation and user fees. Additional user fees are charged for curbside collection in Electoral Area C and E. Fees collected at the transfer station and landfill are charged per tonne and vary based on the type of waste disposed.



Waste Savings / GHG Reductions

- Processed 1363 tonnes of organics in 2017, which reduced GHG emissions by 2044 tonnes of CO₂e
- 655 tonnes of recyclable items were diverted from the landfill through curbside collection in 2017. Residents dropped off an extra 85.5 tonnes at the depot.
- Capacity to divert over 6000 tonnes of organics each year



Business Case

- Organics diversion could generate GHG offset credits with an estimated value of \$15 million throughout the life of the landfill.
- The dollar value of topsoil savings with the use of compost as a cover in the closure of the Thornhill Landfill will be \$40,680.
- Diversion programs extend the life of the landfill so RDKS can amortize costs over a long time. The goal is for the FRWMF to have a minimum 100-year life.
- The TAISWMP introduced a user pay component.



Co-benefits

- Reduced self-haul traffic flow to facilities, which decreased vehicle exhaust and increased safety.
- During construction of the waste facilities, RDKS awarded local contracts and used local suppliers when possible.
- RDKS developed an Operational Contract for the Forceman and Thornhill facilities that would not prevent local contractors from competing. The tender process did not require experienced landfill and transfer station contractors. The successful bidder received training from the RDKS and shadowed experienced facility operators. This approach enabled a \$1.1 million annual contract to remain in the area.



Project Cost and Financing

Total project cost:
\$17.5 million for
TAISWMP and
closure of Thornhill
Landfill

Funding sources:

- \$3 million from Gas Tax Fund
- \$14 million borrowed and will be paid back over a 15 year period



Capital Regional District

SAANICH PENINSULA WASTEWATER TREATMENT PLANT HEAT RECOVERY



Population: 87,177

Size: Medium

Region: Vancouver Island/Coast

A heat recovery system added to the existing wastewater treatment plant captures waste heat from wastewater that is used to heat water at the recreation centre pool.

Project Summary

The Saanich Peninsula wastewater treatment plant (SPWWTP) heat recovery system was commissioned in 2011 after approximately three years of planning, design and construction. Owned and operated by the Capital Regional District (CRD), the system recovers thermal energy from treatment plant effluent and supplies hot water to heat the Panorama Recreation Centre pool.

Heat exchangers at the wastewater treatment plant transfer heat from wastewater effluent to clean water, then the temperature of the water is increased to a useable level using a heat pump system down the line. A network of pipes and pumps distributes the heated water to the recreation centre. By displacing the need for natural gas to heat the pool, the SPWWTP lowers greenhouse gas emissions from the recreation centre and reduces energy costs due to improved energy efficiency over natural gas boilers. When the system was first commissioned, natural gas prices were higher and electricity prices were lower, resulting in more significant annual energy savings. Currently, due to lower natural gas prices and higher electricity prices, the system operates at a financial breakeven point.

The heat recovery system was designed to serve more than one customer, however several potential partners backed out of the project early on. The system has capacity for more customers, so the CRD is planning for an expansion that will extend distribution to a nearby elementary school and greenhouses at the Centre for Plant Health.

Lessons Learned

It is important to create a long-term vision and review the entire system when making. According to Larisa Hutcheson, General Manager of Parks and Environmental Services, "this pilot project has served as a catalyst for the CRD to investigate and plan for four more district energy systems that would use renewable energy generated from the region's sewer and water conveyance systems."

The project would not have been achievable without the support of internal stakeholders, including the Peninsula Recreation Commission, Saanich Peninsula Wastewater Commission, and CRD employees, including engineers and staff at the Panorama Recreation Centre and the Saanich Peninsula Wastewater Treatment Plant.

The Regional District has noted the following important lessons, which other communities could learn from if implementing similar projects:

- Consult with operators and staff to design the system
- Identify partners with a common interest in lowering energy costs and GHG emissions and make the project scalable. The CRD allowed for future expansion to two sites.
- In addition to a feasibility study, create a strong business case that articulates triple-bottom-line benefits to gain supporters and "normalize" green investments.
- Provide community outreach and education to minimize potential misunderstandings related to waste heat recovery.



Energy Savings / GHG Reductions

- 11,250 GJ of natural gas saved per year, or the equivalent consumption of about 220 Saanich residences.
- Prevents approximately 370 tonnes of GHG emissions from entering the atmosphere annually



Business Case

- Approximately \$60,000 saved in operation and maintenance costs from 2011 to 2013
- Reduced exposure to a price on carbon



Co-benefits

- Greater resiliency against increasing energy costs and service disruptions
- Catalyst for four additional district energy systems using renewable energy
- Employment during project construction
- Designed with capacity to serve a greenhouse and elementary school in the area in the future



Project Cost and Financing

Total project cost:
\$3.3 million

Funding sources:
• Nearly \$3 million from the federal Gas Tax Fund



Columbia Shuswap Regional District

SALMON ARM LANDFILL GAS CAPTURE PROJECT



Population: 17,706

Size: Medium

Region: Thompson/Okanagan

Gasses produced at the landfull are captured and processed, resulting in a source of rewable natural gas for the community.

Project Summary

When the Columbia Shuswap Regional District (CSR D) closed the first phase of the Salmon Arm landfill in 2010, it installed gas collection wells to capture methane gas at an onsite biogas plant. In partnership with FortisBC, most of the gas is upgraded to pipeline quality by removing all landfill gases except methane. The resulting “Renewable Natural Gas” (RNG) is effectively identical to normal natural gas and delivered to the FortisBC pipeline for distribution to heat homes and businesses in the city. A portion of the methane is destroyed through flaring at the landfill.

CSR D financed and led the methane capture component of this project, while FortisBC handled the upgrading of the landfill gas to RNG.

Regional government staff led this project; however, they received CSR D Board support in 2010 to develop this type of infrastructure, which aligns with the Board’s support for “green” and climate initiatives. The environmental and financial benefits were instrumental in receiving Board support, and contributed to positive news stories and community support.

Lessons Learned

For this project, it was vital to hire an experienced project manager to bring all the components of the project together. In order to lower costs, support the local economy and build internal capacity, the Regional District depended on its own staff as well as hired contractors in the region.

When implementing these types of projects, it is important that the system for methane collection and utilization be designed for the local climate, particularly winter conditions.



Energy Savings / GHG Reductions

- Between 2011 and 2017, this project removed 51,346 tonnes of CO2e emissions or an average of 7335 tonnes per year.



Business Case

- An average of nearly \$104,000 in carbon credit revenue has been generated each year to offset CSR D’s corporate emissions and achieve carbon neutrality. The credits were initially sold to Pacific Carbon Trust and now to the Climate Action Secretariat. A total revenue of \$727,068 was received between 2011 and 2017.
- More than \$65,000 in revenue from the sale of gas to FortisBC.
- CSR D’s return on investment was 8 years, which was earlier than the predicted 15 years, due to the sale of gas to FortisBC and carbon credits to the Province of BC.



Co-benefits

- Distribution of gas to residents and businesses for heating
- Treatment of about 1.1 million litres of leachate using a phytoremediation system in the project’s initial year
- Excess revenues above the initial return on investment are now supporting various solid waste management initiatives.



Project Cost and Financing

Total project cost:
\$4 million

Funding sources:

- \$1.5 million financed by CSR D using landfill user fees, reserve fund and other means
- \$2.5 million financed by FortisBC including \$200,00 from BC Bioenergy Network and \$366,000 from the Province of BC’s Innovative Clean Energy Fund



City of Surrey

SURREY BIOFUEL FACILITY



Population: 517,887

Size: Large

Region: Lower Mainland/Southwest

Organic waste collected from the community undergoes anaerobic digestion to produce biogas, which is processed and sent to FortisBC's natural gas distribution system and used to fuel the waste hauler vehicles.

Project Summary

The City of Surrey's biofuel facility, which was built as part of its Rethink Waste Program, is the first fully integrated closed-loop organic waste management system in North America. It processes curbside organic waste to biogas through anaerobic digestion. The resulting biogas is upgraded and delivered to FortisBC's distribution system as renewable natural gas (RNG). Some of the gas is compressed into compressed natural gas (CNG) and used as fuel for waste collection trucks and the fleet of operation service vehicles. Another product of the system is premium quality compost that is used to grow local crops and accelerate the growth of trees, shrubs and lawns, which eventually result in more organic waste collected to feed the closed loop system.

The biofuel facility is located next to the Surrey Transfer Station and currently processes 65,000 tonnes of organic waste collected in the community. The facility is capable of processing 115,000 tonnes of organic waste per year, which will help to meet future demand. Most waste will originate from the City's residential curbside collection program; however, some waste will also come from commercial sources and other municipalities until it reaches full capacity.

An important consideration for the project was preventing odour problems. An extensive odour mitigation system incorporated into the facility minimizes the risk of fugitive odours affecting neighbouring communities. The main feature of the system is a

powerful ventilation system, which operates under negative pressure and directs 100% of the treated air out of the facility's stack to ensure optimal dispersion.

The facility includes an Education Centre and outdoor interpretive compost garden that provides education to school groups and others who wish to learn about this innovative project. Public engagement and education was a key success factor and continues to be an important ongoing project component.

Lessons Learned

It was important to gain Council support early on in the project. Extensive research of similar facilities in Europe helped demonstrate that the technology was low risk, and a detailed business case showed that the project was feasible and cost effective for the City.

The relationship with FortisBC was important for project success and feasibility. Negotiations were extensive and eventually resulted in a positive working relationship and a 25 year agreement that suits the City's needs.



Energy Savings / GHG Reductions

- Community-wide GHG emissions are expected to be reduced by 49,000 tonnes annually, which is equal to taking 10,000 cars off the road. This reduction will also offset the City's corporate carbon footprint of 21,000 tonnes CO2e (in 2017) annually.



Business Case

- The facility was created via a public-private partnership, whereby 25% of the cost was funded by the Federal government and 75% was financed by Renewi plc. Orgaworld Canada, which is part of Renewi plc, designed and built the facility. It will also operate it on behalf of the City of Surrey for 25 years.



Co-benefits

- 115,000 tonnes of organic waste are expected to be diverted from the landfill
- Generate about 120,000 GJ of renewable natural gas and about 45,000 tonnes of compost each year
- At least 15 full-time jobs



Project Cost and Financing

Total project cost:
\$68 million

Funding sources:

- 25% through PPP Canada Fund from the Government of Canada
- 75% Renewi plc (Orgaworld)





Kwadacha First Nation

OFF-GRID UTILITY STANDARD BIOMASS GASIFICATION-TO-ELECTRICITY PROJECT



Population: 610

Size: Small

Region: Northeast

Wood chips from local standing dead pine undergo gasification to produce biogas, which is burned in cogeneration boilers to produce heat for a district heating system and electricity.

Project Summary

The Kwadacha First Nation developed this project under the leadership of Chief Donny Van Somer to reduce the consumption of diesel generated electricity in the community.

The project, which began operating in 2017, uses wood chips from timber destroyed by the mountain pine beetle as its fuel source. The chips originate from the sawmill on the First Nation reserve as well as other local forest products. The community has access to an abundant supply of standing dead pine in the region: Four million cubic metres are situated within 30 km of Fort Ware and 50m of roads, which equates to a 400-year supply.

The chips undergo gasification in three vessels to generate wood gas, which is then cooled and filtered before entering three internal combustion engine generators. Each combined heat and power (CHP) biomass generator produces 45 kW of electricity and 108 kW of heat in the form of hot water. When selecting its equipment, the community chose commercial technology that already had many successful installations in Europe.

The heat from the units is used in a district heating system for the local school and greenhouses in cooler months. In warmer months, the heat is used to dry wood chips.

Lessons Learned

When implementing renewable energy projects using wood as the fuel source, it is essential to have a large enough wood supply to make the project viable over the long term. In the case of this project, it was also important to research the wood waste available from the plant.

In order to proceed with this type of project, enough funding needs to be secured in advance and funding agencies should be actively involved. Successful negotiations with BC Hydro is also key to sell power from community based projects to the power grid.



Energy Savings / GHG Reductions

- About 400 tonnes of GHG emissions reduced annually through reducing consumption of diesel generated electricity and propane for heating



Business Case

- Kwadacha sells power from this project to BC Hydro to reduce consumption of electricity from the diesel generators.



Co-benefits

- Reduces community's reliance on diesel generated electricity by an anticipated 20-25%
- Displaces propane use for heating, a more expensive fuel source
- Creates ongoing employment for a few community members and offered jobs during construction
- Economic opportunities for local forestry companies
- Community is more self-sustainable



Project Cost and Financing

Total project cost:

About \$4 million

Funding sources:

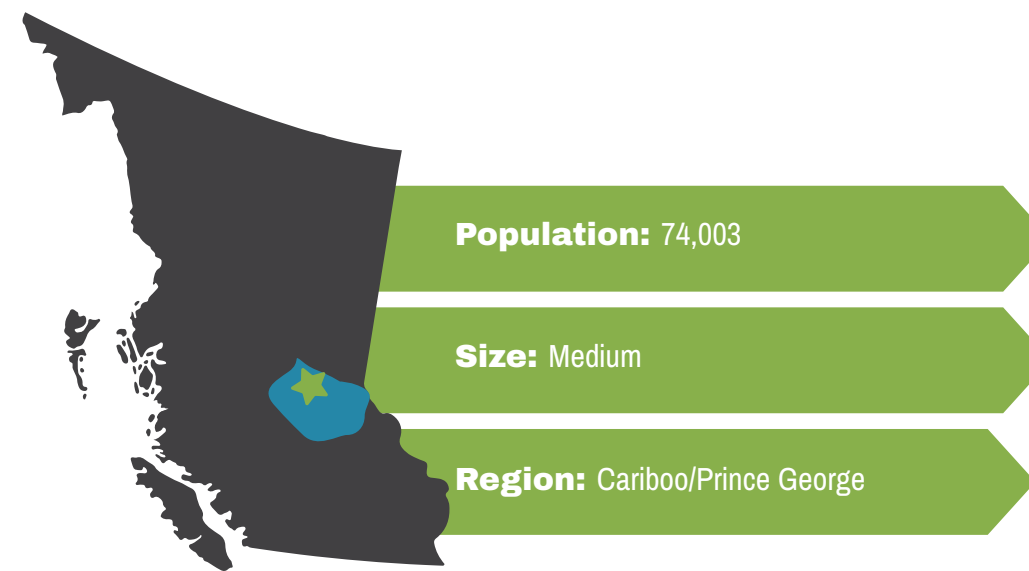
- Fraser Basin Council
- Indigenous & Northern Affairs Canada
- Natural Resources Canada's Indigenous Forestry Initiative
- BC Ministry of Energy, Mines & Petroleum Resources' Community Energy Leadership Program
- \$410,000 from the community



City of Prince George

WOODFIBRE DOWNTOWN DISTRICT ENERGY SYSTEM

Waste heat from a local sawmill is recovered and distributed to several buildings in the downtown core through a district energy system.



Project Summary

The City of Prince George's wood fibre-based district energy system (DES), commissioned in 2012, provides carbon-neutral energy to buildings in downtown Prince George. The early drivers for the project included reducing energy costs for civic buildings at a time when natural gas prices were high, reducing particulate emissions, and utilizing wood waste from pine beetle infestation.

A boiler system extracts heat from sawmill residues at Lakeland Mills, which is the closest sawmill to the downtown core. The heated water is distributed through approximately 2.7km of insulated pipes through the downtown, where it is used by a dozen buildings for space heating and domestic hot water.

Each connected building has an Energy Transfer Station (ETS), which utilizes heat exchangers to transfer thermal energy from the DES to the building system. The efficiency of these heat exchangers is 99.9% compared to traditional natural gas boilers that have an average efficiency of 80%. The efficiency of the DES is 92.5%, which includes the piping, ETS's, pumps, and backup boilers. Once heat is recovered, the water returns to the sawmill via 2.7km of return piping to be reheated.

The City of Prince George commissioned the district energy system in 2012. The system includes the main plant at Lakeland Mills and the Peaking Backup Energy

Centre, and a network of pipes and pumps. At time of commissioning, customers included City Hall, the Conference and Civic Centre, Rolling Mix Concrete Arena (formerly the Coliseum), Four Seasons Pool, main branch of the library, and Two Rivers Art Gallery. Since then, four new customers joined the system: the RCMP detachment and Wood Innovation and Design Centre in 2014, and the BC Law Courts and Plaza 400 (a Provincial government office building) in 2017. The City anticipates new connections in 2019.

As part of this project, current technology at the mill was upgraded to lower emissions and more sophisticated environmental equipment was purchased to help the boiler system operate more efficiently. The Peaking Backup Energy Centre, which contains distribution pumps and backup natural gas-fired boilers, was constructed to supply hot water to the DES when Lakeland Mills is shut down for maintenance or when there is high demand for heat during colder days.

The Prince George DES is currently peaking at 2.2 MWh and is designed to produce 5 MWh. Future expansion is possible: The current facility is able to accommodate additional equipment to increase to 10 MWh back-up as the system expands.

The City entered into a long-term energy supply agreement with Lakeland Mills for the supply of heat to the DES. The agreement will provide stable pricing for 10 years and there is an option to extend the agreement for a further 10 years.

Lessons Learned

Every project will have a different set of drivers, which may change over time. For some communities the driver for a similar project may be improving air quality, while for another it may be to retain and support the local forest industry, create jobs, or improve local energy security.

The City operates this system within existing City departmental structures, rather than a City-owned utility. This approach helped to build internal capacity, embedded the system within City operations and integrated it with other utilities, engineering and public works. If taking this approach, the City recommends that other internal roles be identified, including Economic Development and Communications, to build relationships with industry and the public.

District energy systems are generally invisible once they are operational. Ongoing public education is important to ensure there is political will to continue with a project and to build profile that will help attract new customers.



The City of Prince George has embedded operations of the District Energy System into existing departments. Here is Steven Mercedes, Supervisor of Wastewater and District Energy in the Peaking Energy Centre.



Energy Savings / GHG Reductions

- As of 2017 (with addition of the two newest customers) the estimated GHG emissions reduction is 2150 tonnes/year



Business Case

- Possibility for generating non-tax revenue and/or reducing heating and operational costs for City facilities
- Avoids capital costs of facility upgrades in the future
- Ongoing infrastructure improvements and operations are funded through a combination of user fees and contributions from the City's General Operating Fund



Co-benefits

- Lowers particulate emissions in air shed by 100.7 tonnes each year (estimated during project design)
- Reduces dependence on fossil fuels and helps to foster energy security and price certainty
- Positions the community as a leader in bioenergy
- Helps to renew the downtown core by attracting businesses
- Supports the forestry industry
- Ensures energy dollars remain in the community



Project Cost and Financing

- | | |
|-------------------------------------|--|
| Total project cost: | Funding sources included: |
| Total project cost was \$14 million | <ul style="list-style-type: none">• \$5.3 million from Municipal Rural Infrastructure Fund• \$4.3 million from Community Works Fund• \$460,000 from FCM's Green Municipal Fund |



City of Nanaimo

RESERVOIR NO.1 ENERGY RECOVERY FROM DRINKING WATER SUPPLY SYSTEM



Population: 92,004

Size: Large

Region: Vancouver Island/Coast

Construction of a new reservoir presented an opportunity to integrate energy recovery by using hydroelectric turbines instead of pressure reducing valves to dissipate excess energy and sell it back to the grid.

Project Summary

As part of significant upgrades to its drinking water supply system, the City of Nanaimo constructed a new reinforced concrete storage reservoir. Commissioned in 2015, the new Reservoir No.1 replaced a 100-year old open-air raw water reservoir in order to receive treated water from its new membrane filtration plant. The City's main water supply is from the Jump Creek Reservoir, which is at higher elevation than the water treatment plant and Reservoir No. 1. The upgraded water supply system takes advantage of the area's topography and hydraulics, since the elevation difference allows water to reach the treatment plant and subsequently Reservoir No.1 without using pumps. Reservoir No.1 is 110 meters below the elevation of the new water treatment plant so there is a significant amount of potential energy available.

Gravity systems such as this one usually use control valves and pressure reducing valves (PRVs) to manage flow and dissipate excess pressure, which is potential energy that is typically wasted. The City of Nanaimo system uses hydroelectric turbines instead of PRVs to dissipate excess energy while filling the reservoir, and recovers it in the form of electricity to be sold to the grid through a 20-year Electricity Purchase Agreement under BC Hydro's Standing Offer Program.

Lessons Learned

Collaboration contributed to the success of this project. The City's Mayor and Council showed strong leadership and had a vision of a sustainable community. During the project's development and implementation, Council continued to be supportive and

enthusiastic due to the innovative technology and direction towards energy resiliency.

BC Hydro was also a valuable partner for the project. In addition to purchasing the electricity, BC Hydro provided guidance during the early phases of the project while the City undertook feasibility studies and project design.

The City was primed for this project because staff previously considered recovering wasted energy at the old reservoir, and conducted a feasibility study to respond to a BC Hydro call for power in 2001. While unsuccessful, it meant that the City had a better understanding of the technology and was ready when the right opportunity presented itself, at rates that are more favourable.

In the three years since commissioning, operations staff have optimized the energy recovery facility to generate higher revenue without compromising service delivery, primarily by running the turbines during peak periods. Revenue has increased steadily since 2015, even though water consumption has decreased.

This successful project has opened the door to future projects. Council is enthusiastic to explore further opportunities and staff have an improved understanding of the technology. The "water experts" are now also "energy experts".

Typical boxy water and sewer infrastructure buildings are nothing to show off; however, the striking wood building of Reservoir No.1, in a beautiful setting, shows off the infrastructure within and is a destination for the public and a source of pride for the City and community.



Energy Savings / GHG Reductions

- Reduces energy use by 750 to 1,000 MWh per year, which is enough to power about 60 – 80 City of Nanaimo residences
- Energy recovery will lower the waterworks department's total GHG production to 9 tonnes CO₂e, a reduction of over 60%



Business Case

- Since the energy recovery facility and new reservoir began operation in 2014, the City of Nanaimo has generated between \$70,000 and \$100,000 in extra annual revenue by selling energy to BC Hydro
- Project payback is under 10 years and project operation is 50 years.



Co-benefits

- Created short-term design and construction jobs
- New facility ensures continued access to safe drinking water
- Contributes to community sustainability by increasing the cost efficiency of the water supply system
- New reservoir offers provision of fire protection between Chase River and Departure Bay as well as emergency storage



Project Cost and Financing

Total project cost:
\$11.2 million

Funding sources:

- \$7.68 million from the Gas Tax Fund
- \$3.5 million covered by the City Water Fund



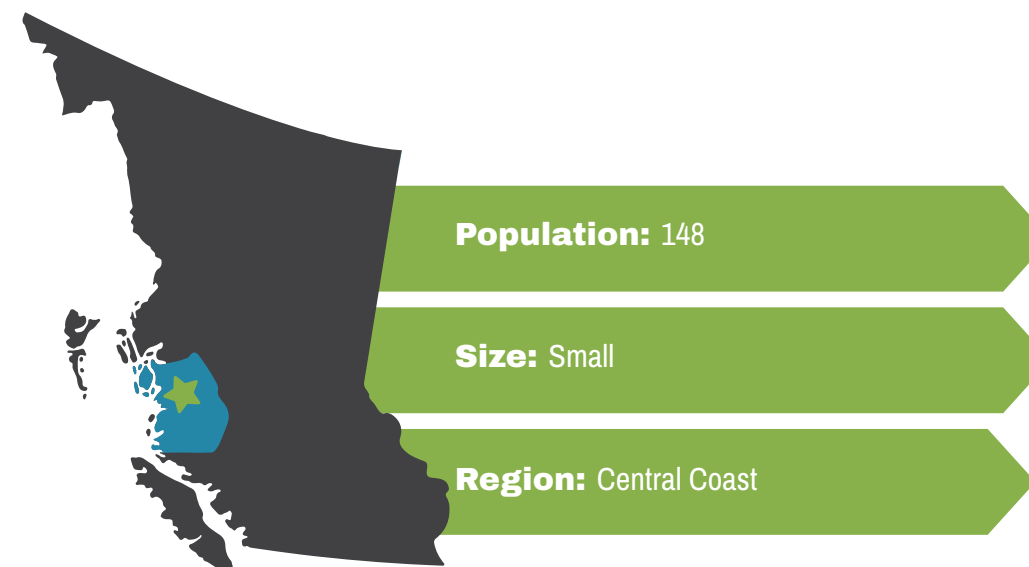
The City of Nanaimo's Reservoir #1 water pumping system generates electricity that is sold back to the grid. The building was designed to be a source of pride for the community and hosts tours for the public and others interested in learning about this innovative technology.



Community of Bella Coola

HYDROGEN ASSISTED RENEWABLE POWER (HARP) SYSTEM & MICRO GRID

Utility and private sector partners came together for a demonstration project in a remote community that stored excess energy from a run of river generator using emerging hydrogen storage technology.



Project Summary

Bella Coola, which is not connected to the provincial electrical grid, has been and continues to be powered by diesel generators and a run of river power facility at Clayton Falls. In 2010, new storage technology became available to optimize the use of the run of river generator, which led to the development of the Hydrogen Assisted Renewable Power (HARP) system demonstration project in Bella Coola.

This project was a partnership between BC Hydro, Powertech Labs and General Electric. Powertech Labs managed the project as well as built and tested the equipment, BC Hydro owned and operated the HARP system, and General Electric supplied the microgrid controller. The system operated in Bella Coola from early 2010 to the end of 2011. The main purpose of the demonstration project was to showcase new technology and assess the feasibility of storing surplus renewable energy in a remote community in order to minimize reliance on diesel generators.

Electricity was stored in two ways: Electrolysers created hydrogen by electrolysis, using surplus power during non-peak periods. The hydrogen was then compressed and stored as a gas in high pressure tanks. Secondly, a vanadium redox flow battery stored energy. During peak demand, the hydrogen was used in a 200 kW fuel cell to generate electricity, which was accompanied by a 125 kW flow battery. A microgrid controller and related software monitored the energy outputs and consumption rates to ensure

efficient energy management as well as to balance the electrical loads between the run of river facility, diesel generator and power from the fuel cells. See Figure 1 for a schematic of the HARP and its integration into the local grid.

During the project, the partner organizations shared project information with the community, including First Nations, to expand engagement and discuss how to scale up if the demonstration project was successful.

Lessons Learned

When the technology was deployed in Bella Coola, technical issues related to the local climate and accessibility became apparent. Significant rainfall in Bella Coola caused the facility to be inundated with water. With the equipment lying idle and water pooling, it created a hospitable environment for animals and insects alike. This could have been remediated with sills to divert the water, and mothballing to deter habitation. Ramp up to generate H₂ took up to 30 minutes, reducing energy storage capacity. Without a full set of spare equipment available on-site, technicians needed to travel to Bella Coola to fix the equipment and bring in new parts to do so.

Since 2010, the technology has matured significantly, component costs have declined, and reliability has improved. Equipment that is more suitable could be deployed in Bella Coola if the project operated today. The demonstration project and recent developments suggest that, in communities where there is excess renewable energy

that can be stored in the form of hydrogen, this solution is highly viable and should be considered.

While the HARP system can perform in any environment, there is a slight benefit in using it in colder environments. Hydrogen needs to be compressed and it needs low temperatures to do this. In warmer climates, energy is spent to cool hydrogen.

Lastly, the technology has the ability to be scaled up considerably. Energy is stored in hydrogen tanks. Scaling up is easy by simply increasing the number of tanks utilized.



Energy Savings / GHG Reductions

- Reduction of 200,000 litres of diesel each year (10% of electrical demand)
- Approximately 600 tonnes fewer GHG emissions annually



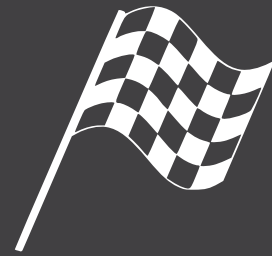
Project Cost and Financing

Total project cost:
\$5.3 million

Funding sources included:

- BC Hydro – \$1.8 million
- Powertech Labs – \$500,000 in kind contribution
- General Electric – \$1 million in kind contribution
- Province of BC's ICE Fund – \$200,000
- Sustainable Development Technology Canada – \$1.8 million

SECTION FOUR: BRINGING IT HOME



Identifying and Supporting Opportunities

- › Build Organizational Capacity & Engage the Community
- › Identify & Complete Municipal IRR Projects
- › Preserve Green Infrastructure & Support Low Impact Development
- › Working with Industry



Meeting Regulatory Requirements



Federal and Provincial Policy and Funding

- › Government of Canada
- › Province of BC



Steps to Winning a Grant Application



IDENTIFYING AND SUPPORTING OPPORTUNITIES

This section separates the development of IRR projects involving municipally owned and operated assets from the planning policy and bylaw support a municipality can provide to protect or enhance community-based environmental assets and private sector low impact development. The table below lists typical municipally owned and operated assets on the left and community based environmental assets and plans, policies and bylaws that can be used to protect natural assets and support private sector low impact development on the right.



There are three steps that a municipality can follow to implement the four strategies within the Regenerative Infrastructure Approach outlined in Section 1.4 of this guide to identify and implement resource recovery opportunities. These three steps are:

- > Build Organizational Capacity & Engage the Community
- > Use a Sustainable Asset Management Approach to Support IRR Projects
- > Preserve Environmental Assets & Support Low Impact Development

Regenerative Infrastructure Opportunities at the Municipal Level

Municipally Owned/Operated Assets		Community-Based Assets	
Typical Facilities & Assets <ul style="list-style-type: none"> • Airports • Arenas • Libraries • Civic lands • Infrastructure (water, waste-water, solid waste, recycling) • Recreational assets • Transit • Fleets • Social housing • Streets & sidewalks • Traffic control • Fire/Police Stations 	Other Infrastructure & Services <ul style="list-style-type: none"> • Heat • Electricity 	Environmental Assets <ul style="list-style-type: none"> • Stream preservation • Aquifer management • Tree management • Water conservation • Invasive species • Parks & other public land management 	Support for Low Impact Development <ul style="list-style-type: none"> • Official community plan • Zoning • Subdivision control • Development permits • Transportation planning • Development cost charges • Design guidelines • Energy & emissions plans • Watershed management plans • Input on provincial facilities • Strategic plans



Build Organizational Capacity & Engage the Community

Policy direction and implementation actions will vary according to the kinds of opportunities that are available to each community. However, an important step for all communities is to begin a process of building organizational capacity to provide support for the policy reviews and budget requests needed to support integrated resource recovery projects and other service delivery activities.

Integrated resource recovery policies and projects can require input and support from several different municipal departments. Functional divisions between these departments occur not only at the local government level but also in provincial and federal governments and consulting firms that provide advisory services. For example, one consultant may be asked to prepare plans for greenhouse gas reductions, while another prepares plans for upgrading wastewater treatment facilities, and yet another prepares a report on managing organic waste. An integrated approach would involve looking for synergies between these three opportunities instead of viewing them separately.

Note, while building capacity and engaging the community is illustrated in the figure on the right at the beginning of the process, a cultural change might be more easily achieved after a successful project has been completed and benefits have been demonstrated.

Building institutional capacity involves²

1. As an organization, formally recognizing the benefits of seeking resource recovery opportunities as part of facility and community planning.
2. Establishing a corporate mindset of avoiding functional divisions (silos) when seeking resource recovery opportunities.
3. Developing municipal asset management plans from the bottom up and setting policy/vision at the top.
4. Training staff in finance, engineering, operations and community planning to develop asset management plans and integrate these requirements into long-term financial planning.
5. Combining best practices in accounting, engineering, financial planning and sustainability performance measurement to support resource recovery outcomes.

Institutional capacity can be increased by:

- Holding joint staff training workshops that include participation from experienced staff from other jurisdictions

- Providing training across different municipal functional divisions to build corporate alignment and commitment to resource recovery and continuous improvement
- Using broader staff information sessions (for staff not directly involved in projects or plans) to foster a municipal culture of conservation and innovation
- Amending reporting structures (reports to council or other internal reports), so that staff must report on how new projects and policies are promoting resource conservation, preservation, generation and recovery
- Engaging council (or regional boards) through workshops or other means on the sustainability benefits of asset management and resource recovery

Functional divisions can be reduced or removed by:

- Establishing an internal committee to guide projects and review policy
- Supporting this internal committee with a staff person who has a coordinating and/or outreach role
- Requiring consultants to review all relevant plans (and make recommendations for cross-plan supportive changes) when preparing reports

Public support can be fostered by:

- Developing basic outreach information about the opportunities and benefits of integrated resource recovery that can be included in press releases, mail outs, websites, social media and public open house displays on an ongoing basis
- Including questions about the environmental, social, and economic benefits of resource recovery in citizen surveys (provide examples to make the concept easier to grasp)
- Conducting early and ongoing public consultation for new resource recovery projects
- Ensure that public consultation, project proposals and plans include consideration of how to mitigate possible project impacts such as increased truck traffic, noise, particulate emissions and odour.

Use the case studies in this guide to help make a business case for change.



² Based in part on District of North Van "The Sustainable Foundation: https://www.assetmanagementbc.ca/wp-content/uploads/Asset_Management_for_Sustainable_Service_Delivery_-_A_BC_Framework-Asset_Management_BC-September_16_2015.pdf



➤ Using Sustainable Asset Management to Support Regenerative Infrastructure Projects

Resource recovery projects that involve municipal owned and operated assets can benefit from using an asset management framework. Organizational processes in asset management practice help to establish a way of doing business that allows for the wider benefits of IRR projects (economic, environmental, and social as well as direct financial benefits) to be recognized and considered in decisions.

Asset Management for Sustainable Service Delivery: A BC Framework, provides detailed guidance on developing asset management practices. Asset management is an integrated process, bringing together skills, expertise, and activities of people, with Information about a community's physical assets and finances, so that informed decisions can support sustainable service delivery. The BC Framework identifies three stages of asset management:

1. Assessing capacity, current practices and asset status
2. Developing asset management policy and creating asset management strategies and plans
3. Implementing asset management practices, measuring results and reporting out

Following a sustainable asset management approach is an effective way to identify and implement municipal IRR projects. Asset management is becoming a recommended approach across Canada, supported or required by funding programs such as those offered by the Federation of Canadian Municipalities. The Province of B.C.'s recommended approach to asset management is summarized in this section to provide an overview of the approach. More detailed guidance is available through the Asset Management BC website.

Identifying IRR opportunities may be achieved either as part a detailed sustainable asset management strategy or as an IRR exploration exercise that follows the broad asset management framework outlined below.

Assess Capacity, Current Practices and Asset Status

Prepare inventories and operational audits

In this stage, an organization should collect and analyze information that assesses an its ability to undertake asset management as an ongoing corporate function.

A community should complete high-level assessments of four key elements – staff, information, assets and finances – to form the basis for policy, strategy, plan development, project completion, and monitoring.

Assess staff resources:

- Assess capacity to form a cross functional team (i.e. the right staff in the right places)
- Evaluate the current level of knowledge and skills around asset management and resource recovery
- Review roles and responsibilities and recommend changes that will support improved asset management and new opportunities for resource recovery

Identify existing policies and systems

- Review internal and community based policies, strategies, plans and management systems to determine which of these may be used to support resource recovery opportunities
- Identify any existing asset management functions or systems within the organization

Take inventory and audit assets

To support decisions and create a baseline for monitoring, complete an inventory and audit of municipal capital assets and asset-related services, including:

- All capital assets and their age and physical condition,
- Defined customer and technical levels of service, and
- Operational and service delivery risks
- Any resources that might be recovered if capital or processes were updated
- An assessment of potential markets for energy, reclaimed water, and nutrients and any other by-products of current operations.

Evaluate financial systems

- Review policies and practices related to long-term financial planning and finance tracking related to infrastructure demand, cost recovery, reserves and debt.

Set a schedule for inventory updates

Assessing the current state of assets should not be a one-time activity completed at the outset of building asset management practices. It is important that information about assets is updated as assets are added, repaired, replaced or retired. Information gathered should include:

- What assets are owned, their replacement value, age, risk, and role in service delivery
- Current and expected future replacement costs
- Anticipated changes in community's service needs
- New opportunities arising from the availability of new equipment or reduced pricing
- Evolving markets for system by-products

An asset registry is a powerful tool that can inform decision-making about day-to-day activities or long-term plans, but must be kept up-to-date to continue to add value to the organization.

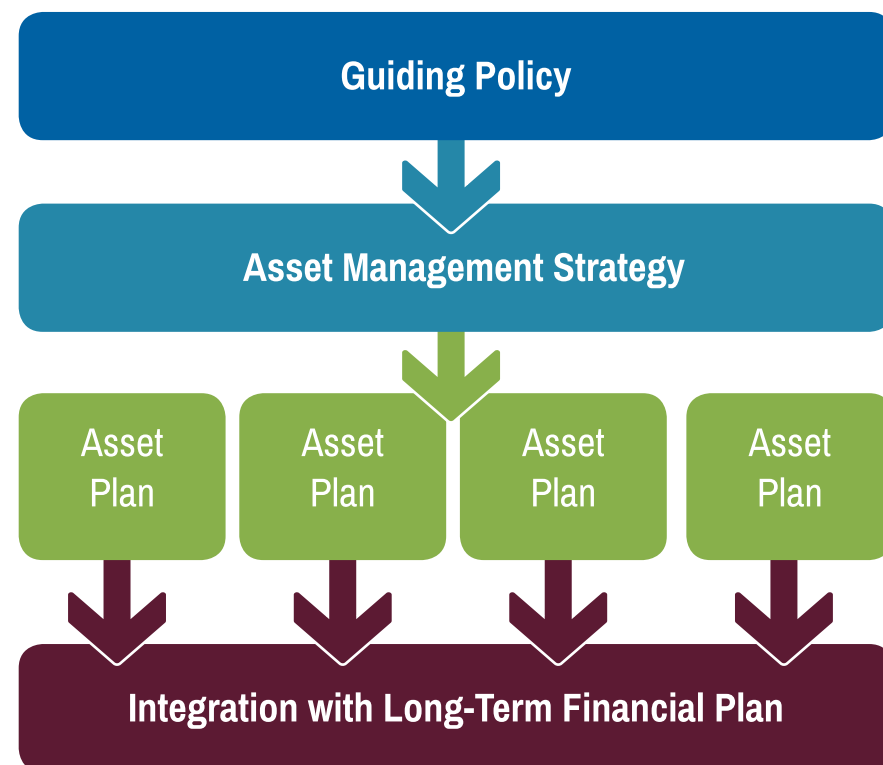
Address risk

A certain level of risk aversion in the design and planning of infrastructure is both necessary and responsible. Although resource recovery facilities may initially entail a greater degree of economic and social risk than conventional infrastructure approaches, local governments can learn from other communities that have already implemented resource recovery projects. The case studies included in this guide can provide peer level guidance on getting started.



Plan: Identify and Prioritize Opportunities

After inventories and audits have been prepared and possible resource recovery opportunities have been identified, the next step is to develop the policy, strategy and plans that will establish the basis for moving forward, prioritize opportunities and support implementation.



Develop Guiding Policy

Policy to guide the recovery of resources from municipally owned and operated assets can be developed as part of an [overall asset management approach](#) or as a separate policy that supports sustainable development, resource efficiency or energy related goals.

This internal policy will formalize a community's commitment to resource recovery by:

- Defining integrated resource recovery and identify the connection between other community goals and objectives around sustainable development, efficiency, or energy
- Embedding resource recovery into asset management processes
- Articulating principles to guide decision-making about resource recovery
- Outlining the organization's financial and systems approach to asset renewal and resource recovery
- Establishing clear guidance for council and staff on resource recovery and asset management processes



A policy example:

Asset management plans will be developed for major service/asset categories. These plans will be informed by community consultation consistent with engagement strategies and activities; *land use planning, opportunities for integrated resource recovery*, financial planning and reporting. Annual budget deliberations will be informed by asset renewal alternative options, along with operating, maintenance and capital budget impacts. Service and risk consequences of asset renewal alternative options will be made clear in both asset management plans and budget documentation.

Source: Asset Management for Sustainable Service Delivery: A BC Framework (text in italics added)

Amend or Develop an Overall Strategy

Resource recovery can be included in an existing asset management strategy, become part of a new strategy or be developed as a separate strategy focused on sustainability, resource efficiency or energy.

A resource recovery strategy (on its own or as part of an asset management strategy) provides the link between the policy level of the organization and day-to-day operations and embeds resource recovery into other corporate initiatives.

The strategy should be a corporate-level document that summarizes how organizational objectives relate to the development of resource recovery and asset management objectives, and how the organization will approach the development of practices and plans to achieve these objectives. Federation of Canadian Municipalities offers a [free guide](#) on developing an asset management policy and strategy. More information can also be found through the [Asset Management BC website](#).

Strategies should identify the current state of assets (e.g. replacement values, conditions, risk and levels of service, by-products and resource recovery opportunities) and current asset management practices and guide each department in their roles and responsibilities. Aligning objectives, priorities, approach, and organization risks is an effective and efficient use of assets, staff time, and financial resources.

While various guides on developing an asset management strategy include concepts and case studies supportive of lifecycle analysis and sustainability, it is more difficult to find examples specifically noting that opportunities for resource recovery will be actively pursued



IDENTIFYING AND SUPPORTING OPPORTUNITIES

Using Sustainable Asset Management to Support Regenerative Infrastructure Projects

It makes sense to incorporate resource recovery opportunities into new or existing asset management strategies and plans. Assessing resource recovery opportunities will be easier with a clear understanding of existing conditions and future plans for individual municipally owned assets.

Create Asset Management Plans

A local government may choose to have an asset management plan for each asset type, and/or a corporate asset management plan that addresses all of the assets owned by an organization.

Functionally, an asset management plan should:

- Be a readable and user-friendly document that is long-term in scope
- Be continuously improved and regularly incorporate new information or changing requirements
- Provide clear direction on what to do, when to do it and how much it will cost
- Identify the consequences of not moving forward

The content of an asset management plan should identify:

- Results of the inventory and audit
- Opportunities for resource recovery and other efficiencies
- Assessments of potential markets for system resource by-products
- Describe practices, projects, and programs required to meet organizational asset management objectives developed in the strategy, manage risks, and achieve a desired level of service in the most cost effective way
- Staff and financial resources required and a timeline for implementation
- Necessary future improvements to the plan

Integration with Long-term Financial Plan

The integration of asset management or resource recovery plans with a community's long-term financial plan is essential to sustainable service delivery.

Integrating asset management plans with the financial planning process provides the basis for developing, reviewing, updating, and implementing financial strategies for sustainability. Integration may:

- Identify inconsistencies between desired service levels and available funding
- Translate an asset management plan from a wish list to an actionable plan
- Stabilize costs over the long-term
- Ensure the organization is on track to manage and reduce any infrastructure deficits
- Justify financial support from higher levels of government
- Provide a basis for evaluating alternative models of service delivery (e.g. Public Private Partnerships), reduced levels of service or service/asset elimination
- Help prioritize competing projects
- Support ongoing implementation as financial plans are reviewed

Implement Plans, Measure Results & Report Out

Implementation, measuring results and reporting out are the next steps in this process. Completing the earlier steps in this process (inventory, audit, strategy and financial plan integration) should ensure that projects have been prioritized, implementation timelines developed and that there are staff capacity and financial resources to complete projects.

Best practices in progress measurement use high-level, corporate-wide indicators expressed in output or financial terms as overall indicators of progress. These indicators are clear and measurable, and can help to highlight the connection between cost and service, and performance trends over time.

Reporting demonstrates measurable progress towards resource recovery and asset management goals and objectives. Annual and financial reports should include progress against these goals and objectives, including performance on selected indicators.

Asset Management BC provides a link to a [service sustainability assessment tool](#) (developed by the City of Grand Forks, B.C.) that will help municipalities measure sustainability performance and generate reports for staff, management and Council.

Other possible progress indicators can be identified by reviewing the case studies provided in this guide.



➤ Preserve Environmental Assets & Support Low Impact Development

Thinking about natural assets as an integral part of community infrastructure recognizes the value provided to communities from existing natural systems and helps make the case to preserve them.

Private sector low impact development can replicate environmental assets - for example, by building swales, permeable paving or green roofs to absorb stormwater runoff - or by designing new neighbourhoods in a way that preserves existing natural systems.

Both of these approaches require a relatively new way of thinking about environmental assets and their benefits, and in some cases, can require consideration of revisions to existing bylaws that require a traditional, centralized approach to the delivery and use of resources (such as water) and management of waste products (such as waste water).

This section presents an approach that local governments can follow to preserve environmental assets (also known as green infrastructure or natural capital) and to support low impact development.

Preserve Environmental Assets

Community-based environmental assets include:

Municipally Owned/Operated Assets	Goods & Services Provided
Water resources such as lakes, streams, rivers, aquifers and wetlands	Water supply and treatment, food production, recreation, cultural, habitat
Vegetation, including forests, parks, riparian zones, private tree cover, and grasslands	Carbon storage, water regulation, soil formation, recreational, cultural, air quality, stormwater control, raw material (biomass), erosion control, pollination
Soils and infiltration areas	Water regulation, stormwater control, water supply and treatment, food production
Airshed (atmosphere)	Habitat, respiration

One way to approach encourage preservation of environmental assets is to assign value to them. The destruction of environmental assets leads to the need to find replacement services for the ones they provide - services in the form of water purification, waste assimilation, cleansing of the atmosphere, mitigation of greenhouse gas emissions, flood prevention, soil retention, fertility enhancement, alternative recreational services, and much more. Assessing these replacement costs is one way to assign value.

More information on valuing environmental assets can be found in [The Value of Natural Capital in Settled Areas of Canada](#).³ This report also includes a case study assessing the value of natural capital in the Lower Fraser Valley in B.C.

Value of Goods and Services from Canadian Forests

- Market value of non-timber products (e.g., food, medicines, forage) = \$.74 per hectare per year in British Columbia.
- Willingness to pay for recreational fishing is \$3.17 per hectare per year, while that from hunting is \$12.50 per hectare per year, as estimated by contingent valuation studies.
- Canadians are willing to pay \$57.65 per hectare per year to view wildlife, and \$44.64 per hectare per year for recreational activities such as camping, hiking, and kayaking as estimated by contingent valuation studies.
- Carbon sequestered by forest biomass and soils ranges from \$15 to over \$600 per hectare per year.

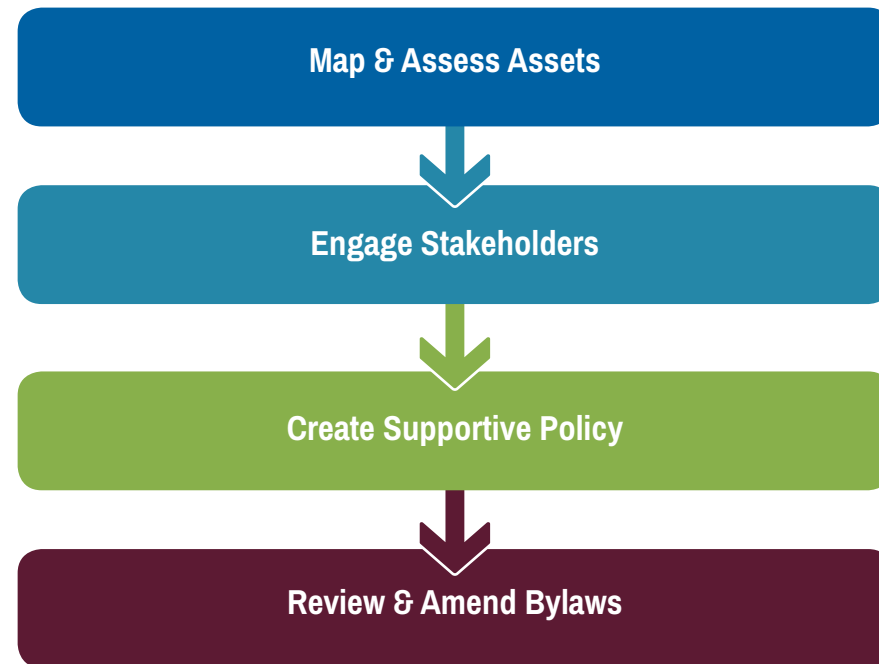
³Olewiler, N. (2004), [The Value of Natural Capital in Settled Areas of Canada](#). Published by Ducks Unlimited Canada and the Nature Conservancy of Canada





IDENTIFYING AND SUPPORTING OPPORTUNITIES

Preserve Environmental Assets & Support Low Impact Development



Map & Assess Assets

Ecosystem mapping is an essential prerequisite to understanding of the location and quality of green infrastructure located within a community. A mapping and data gathering exercise helps local governments understand which green infrastructure elements are present in their community (e.g. aquifers, forests, wetlands), their size and current condition, the value they are currently providing and whether protection, enhancement or restoration is needed. Public input can help identify assets and verify results. A periodic review will help ensure that the condition of environmental assets is well understood and that protective mechanisms are working.

A good example is provided by the [Town of Gibsons Aquifer Mapping Study \(2013\)](#).

Engage Stakeholders

It is helpful at this point to engage community stakeholders on the results of the mapping and assessment, with a goal of building support for improved approaches to managing environmental assets and achieving consensus on the value of that work. Relevant stakeholders will include those involved in recreation, preservation of natural areas, stream management and restoration and the development sector.

Create Supportive Policy

The Province of B.C. delegates powers to municipalities through the Local Government Act and the Community Charter. Some of the most important authority for environmental protection relates to land use planning and regulation. However, other powers, such as those relating to tree protection and soil deposit and removal can also play an important role.

After environmental assets have been mapped and assessed, management plans can identify actions needed to protect, enhance or restore priority features. Environmental asset maps and policy should be included in official community or regional plans and necessary amendments made to various regulatory bylaws (e.g. subdivision control, zoning, development permit), as well as any other community plans (strategic, watershed management, environmental) already in place guiding environmental assets. Staff or consultants preparing management plans should have expertise in natural sciences and understand best management practices.

When land is privately held, municipalities can provide incentives for landowners to conserve their land when the value of the natural capital from that land equals or exceeds its value in other uses.

Review and Amend Bylaws

When developing green infrastructure policies, most local governments use a combination of one or more regulatory bylaws (such as protecting watercourses and restricting the removal or deposition of soil) and the creation of development permit areas, guidelines, and policies.

Areas with high green infrastructure values can be identified and protected through land use policy and zoning regulations, for example, by establishing protection zones and setbacks. Regulations can be enforced through security deposits, covenants, fines, litigation, and/or injunctions (for development permits).

The package of bylaws and policies that a local government chooses can encourage municipal approving officers to require landowners to dedicate small sensitive ecosystems for preservation or protect them with covenants. Engineering standards can address rainwater management and erosion control during subdivision development.

The [Green Bylaws Toolkit](#), updated in 2016, outlines the value of environmental assets and provides detailed explanations for a variety of land use policies, regulatory tools and subdivision design approaches. Sample bylaws are included.

Supporting Low Impact Development

A challenging area of municipal governments is responding to highly innovative, low impact development proposals from the private or institutional sectors. In the most innovative cases, low impact development may ask to be disconnected from key municipal services by conserving and reusing water, composting solid waste, processing liquid waste on site, significantly reducing energy demand and/or generating energy.

Generally speaking, low impact development:

- incorporates energy efficient features (natural lighting and ventilation, good insulation, solar or geothermal heating, district heating, high efficiency fluorescent lighting, cool roofs) and reducing occupant dependency on cars (bicycle parking, showers for bicycle commuters);
- incorporates water efficient features (collecting rainwater, using waterless urinals, low-flow faucets and toilets and/or composting toilets, green roofs, recycling grey water);
- re-uses existing building structures and/or building materials; reduces and recycles waste materials;
- preserves natural vegetation, and reduces disturbance to landscapes and habitats to maintain biodiversity and preserve ecological integrity (e.g. cluster development);
- incorporates sustainable, healthy, locally made or harvested non-toxic materials and features into buildings and furnishings (e.g. certified sustainable or recycled wood, low volatile organic compound emissions carpet, paint and composite wood products, previously used or recycled materials).

From a land use planning perspective, low impact development might be:

- located on brownfields or redevelopment sites and away from sensitive habitats (maximizing urban land use)
- clustered near urban centres, contributing to density, supporting low impact transportation (transit) and connected to existing municipal services (maximizing infrastructure use)
- integrated into sustainable and smart growth communities.

Tools to Support Innovation

As regulators and policy makers, local governments can encourage developers to think about green building design and practices that can be accommodated within existing codes and regulations. The Green Buildings Guide (Tools for Local Governments to Promote Site Sustainability) provides a good overview of regulatory and policy tools to increase private sector low impact development.

From an energy efficiency perspective, as of 2018, B.C. municipalities have the choice to incent or require higher building energy performance for Part 3 (high-rise)



and Part 9 (low rise and single family) buildings. The BC Energy Step Code is a voluntary provincial standard enacted in April 2017 that provides an incremental and consistent approach to achieving more energy-efficient buildings that go beyond the requirements of the base BC Building Code. It does so by establishing a series of measurable, performance-based energy-efficiency requirements for construction that builders can choose to build to, and communities may voluntarily choose to adopt in bylaws and policies.

Review Plans & Bylaws and Remove Barriers

One way to encourage low impact development is to review plans and bylaws to 1) remove barriers and 2) create supportive policy. Local governments can:

- Introduce resource recovery into their Regional Growth Strategies, Official Community Plans, Community Energy Plans, and Sustainability Plans
- Ensure the processes for revising Liquid Waste Management Plans, Solid Waste Management Plans, development permit processes, building codes, zoning processes, bylaws, tax incentives, and financial grant programs encourage rather than hinder resource recovery
- Consider the many regulations which apply to the environment, water, and energy against community goals. It will be helpful if these regulations are not weakened, but are coordinated by regulators to facilitate an integrated approach to resource recovery
- Identify and remove policy barriers. For example, do regulations and local policies make it easier or harder for communities and developments to be sustainable, treat sewage on-site, or to recover resources from waste? Do building codes and related bylaws make it easier or harder to implement community energy systems?
- Seek opportunities to reduce energy and water consumption in the community
- Examine trends in water supply, including drought management plans
- Identify industries which can provide waste or receive recovered resources

Accommodating Innovative, Net Zero Design

Developments that sit at the cutting edge set the benchmark for what is possible and may inspire others to create more livable, sustainable communities. Local governments that collaborate with developers to facilitate out-of-the-box proposals ease the way not only for extremely innovative projects, but also for more modest green projects that follow in the footsteps of green leaders. A local government's support of innovation, and a willingness to find and develop solutions for alternative approaches, lends confidence and support to the green development community.

A partnership approach by the local government is one of the keys to success: without the local government's agreement to work with the developer to find equivalencies to the Building Code, innovative projects would be unable to proceed from a regulatory perspective. For example, the Eco-Sense Residence in Victoria was built to the Living Building Challenge standard. Features include passive solar design, solar PV with grid tie, net zero electricity, energy and water conservation, solar thermal hot water, composting (no flush) toilets, rain water harvesting, grey water re-use, a living roof, earthen floors and natural finishes. Regulatory negotiation was required to allow construction on a previously damaged site, to accommodate the concept of net zero in the zoning bylaw, and to prepare a flush toilet ready policy and composting toilet alternative solutions.

Other B.C. Examples

Within B.C., two other recent innovative projects are the Dockside Green project in Victoria and the Centre for Interactive Research in Sustainability (CIRS) project in Vancouver.

The former is an initiative of the City, which issued a Request for Proposals in selling some land and thereby secured sustainability features through the sale and a master development agreement; the latter project is a joint venture of a number of educational institutions.

These developments have been facilitated in large measure by the willingness of the local governments to embrace the initiatives for their contribution to the City's understanding of sustainability, and to approve having planning/building staff work pro-actively and flexibly with the developers to identify and review City bylaws and Building Code equivalencies to meet sustainability, health and safety standards.

Dockside Green	Centre for Interactive Research on Sustainability
<ul style="list-style-type: none"> • Recycling of waste products – waste is food concept, closed loop, triple bottom line approach; buildings will have recycling rooms for composting, and strategic local partnerships to use waste will be encouraged; • Reduction in use of potable water through tertiary on-site sewage treatment and reuse of waste water for toilets and streams; • The finding of eco-efficiencies in an innovative mix of industrial, commercial and residential uses; • Establishment of a local mini-transit system using bio-diesel or hybrid vehicles as well as a ferry shuttle. 	<p>Sustainable design goals for the CIRS project include:</p> <ul style="list-style-type: none"> • 100 per cent daylighting, for productivity, health and energy savings; • Net energy generator; no mechanical cooling; greenhouse gas neutral; • Water: 100 per cent rainwater; no external supply; on-site treatment of all liquid waste; no storm water runoff from site; • Waste: no solid or liquid waste leaving site; maximize building utilization; sustainable building materials; • A centre for learning in sustainable technology: educate, train and demonstrate sustainable design in action; • Performance monitoring, commissioning and adaptive management principles.

Dockside Green, Victoria, BC
Photo Courtesy of Peter Robinson





> Working with Industry

Partnerships with industry can enhance outcomes and accelerate progress on project. Involving private sector partners can:

- Provide access to capital for initial construction and system expansion
- Participate in pilot projects to test new technology
- Contribute technical knowledge not available elsewhere
- Reduce risk to municipal and First Nation partners
- Allow longer periods to overcome start-up costs by spreading costs over larger project portfolios

The City of Surrey partnered with Orgaworld (Renewi) – a publicly listed waste-to-product company that treats municipal, commercial and hazardous waste. Orgaworld provided project financing and designed and built the biofuel facility. The company will operate and maintain the facility over a period of 25 years. Working with Orgaworld also allowed Surrey to access the federal P3 Canada Fund to provide further financial support for the project.

Surrey is also working with FortisBC to produce biogas at the facility, which will then be captured and upgraded to renewable natural gas. This gas will be used to power Surrey's waste collection trucks as well as the City's growing fleet of natural gas fuelled vehicles. Once fully operational, the Surrey Biofuel Facility will produce approximately 100,000 gigajoules of renewable natural gas, which is enough energy to heat more than 1,100 homes for a year.

The Columbia Shuswap Regional District is also working with FortisBC to upgrade biogas derived from landfill gas and inject it into the local natural gas distribution system. FortisBC owns and operates the biogas upgrading plant – removing risk and reducing costs for the regional district by providing their expertise and financial resources.

FortisBC has received approval from the BC Utilities Commission for an additional renewable natural gas purchase agreement that will result in a new RNG production facility at the Lulu Island Wastewater Treatment Plant owned by the Metro Vancouver Regional District.

There may also be some downsides to involving private partners:

- Reduced ability to be responsive to local conditions and goals
- Reduced alignment with public interest
- Increased complexity in financing and operational structures

For more information on working with private sector partners, consult [Investing in Green Energy Projects and Utilities](#) (Volume 1: Investment Guide and Volume 2: Case Studies).



MEETING REGULATORY REQUIREMENTS

Municipal infrastructure projects must meet a variety of regulatory requirements, depending on their potential impact on the natural and human environment. Both federal and provincial governments have legislation and regulations to reduce project impacts on land, air and water. In some cases, local government bylaws may also apply.

The wide variety of possible resources that can be recovered and reclaimed (water, wastewater, solid waste, waste heat, biomass) and their potential end uses (combustion, discharges to water, applications to land) means that the scope of regulatory measures that may apply to a resource recovery project is broad. Legislation, regulations and policies that may apply to a regenerative infrastructure project are listed and described below.

Remember that laws are dynamic and always evolving and the following is not an exhaustive list. It is the responsibility of municipal governments to fully assess legislative and regulatory requirements and contact relevant Provincial and Federal departments.

Canadian Environmental Assessment Act

A federal environmental assessment is required for projects on federal lands and projects that affect the environment in a significant way. Municipalities can discover which types of projects are designated by consulting [Regulations Designating Physical Activities](#). Projects on the designated project list or projects designated by the Minister because of potential for environmental effects or public concerns will require a federal environmental assessment. Proponents are encouraged to contact relevant federal departments or provincial ministries (e.g., Fisheries & Oceans Canada, Environment Canada - Canadian Wildlife Service or BC Ministry of Environment). A proactive discussion with the appropriate agencies during project planning will identify potential environmental impacts and necessary mitigation measures.

Air Quality Management System

The Canadian Council of Ministers of the Environment (CCME) has implemented a new Air Quality Management System (AQMS) to guide Canadian projects that emit pollutants to the air. AQMS provides a comprehensive approach for improving and publicly reporting on air quality in Canada. CCME announced new Canadian ambient air quality standards (CAAQS) for nitrogen dioxide in 2017 and for sulphur dioxide in 2016. CCME is currently reviewing the CAAQS for ground level ozone.

B.C. Environmental Assessment Act

The Environmental Assessment Act (EAA) establishes a comprehensive process for the identification of potential environmental effects of major projects in British Columbia. Reviewable projects must undergo an environmental assessment and cannot proceed without an environmental assessment certificate. Both the Minister and the Executive Director of the Environmental Assessment Office may exempt a project from the requirement for a certificate, if they consider that an otherwise reviewable project will not have a significant adverse environmental, economic, social, heritage or health effect. Proposed projects or modifications to existing projects are listed in the Environmental Assessment Reviewable Project Regulations by project type, design capacity, and diversion or extraction rate. [Review a copy of the regulations](#) for information on projects that may be subject to the BCEAA.

The B.C. Environmental Assessment (EA) process, as of 2018, is under review to ensure the legal rights of First Nations are respected and the public's expectation of a strong transparent process is met. More information can be found [here](#).

B.C. Environmental Management Act

The Environmental Management Act (EMA) regulates industrial and municipal waste discharge, pollution, hazardous waste and contaminated site remediation. EMA provides the authority for introducing wastes into the environment, while protecting

public health and the environment. Permits, regulations and codes of practice guide discharges to the environment. Enforcement options, such as administrative penalties, orders and fines, encourage compliance.

Waste is broadly defined to include air contaminants, litter, effluent, refuse, biomedical waste, hazardous waste and any other substance designated by the provincial Cabinet, whether or not the waste has any commercial value or is capable of being utilized for a useful purpose. Guidelines and objectives for water quality are also included under the EMA.

- The Waste Discharge Regulation defines what industries, activities and operations require authorizations to discharge or release waste to the air, water, and land. The Waste Discharge Regulation prescribes the activities that may operate under a Code of Practice, as well as those that must have a permit. Over the past few years, the Ministry has developed several Codes of Practice, and a number of others currently under development.
- The Municipal Wastewater Regulation establishes municipal effluent quality requirements and applies to discharges to the ground larger than 22.7 m³/day*, sewer system or combination of sewer systems, and to water and to all uses of reclaimed water. It prohibits the discharge of non-domestic waste to a municipal wastewater facility unless the pre-discharge quality of the waste meets the standard or is within the range specified in the Hazardous Waste Regulation.
 - Facilities discharging less than 22.7 m³/day* are regulated under the Ministry of Health's Sewage System Regulation.

[The Greenhouse Gas Reduction \(Renewable and Low Carbon Fuel Requirements\) Act](#)

This Act allows the government to set standards for the amount of renewable fuel that must be contained in B.C.'s transportation fuel blends, reduce the carbon



intensity of transportation fuels, and meet its commitment to adopt a new low carbon fuel standard.

[The Greenhouse Gas Reduction \(Emissions Standards\) Statutes Amendment Act](#)

This Act requires owners or operators of waste management facilities of certain classes to manage GHGs produced from waste handled in their facilities.

[The Riparian Areas Protection Act](#)

This Act provides authority to the government to establish regulations regarding the protection of riparian areas that may be subject to residential, commercial or industrial development. The Riparian Areas Regulation (RAR) establishes a system of site-specific assessment of the effect of proposed development on fish habitat on prescribed areas of the province.

[Community Forest Agreements \(Forest Act\)](#)

A community forest agreement (CFA) is an area-based forest licence managed by a local government, community group, First Nation, or combination of local governments, First Nations and community groups, for the benefit of the entire community. Communities are directly invited to apply for a community forest agreement without competition. Community forest agreements are for a term of 25-99 years and are replaceable every 10 years. Harvesting operations can support local priorities and community initiatives. Harvest rates and exact locations within the tenure can be set to meet locally determined objectives and interests.

[The Species at Risk Act \(SARA\)](#)

SARA lists wildlife species considered at risk and prohibits a number of specific activities related to listed species, including the destruction of critical habitat. Plans required under the Act include recovery strategies and action plans for endangered or threatened species and management plans for species of concern.

[The Heritage Conservation Act \(HCA\)](#)

The HCA creates a mechanism for the identification and conservation of sites of heritage or archaeological value. Sites included on the Heritage Site Registry established under the HCA are protected from alteration or damage without a permit and the HCA contains specific conditions for the handling of aboriginal artefacts and sites. Under the HCA, the government may issue orders to stop work on any property that has, or may have, heritage value.

[The Water Sustainability Act \(WSA\)](#)

The WSA establishes B.C.'s water licensing scheme and provides for the protection of the province's fresh water bodies, to ensure long-term sustainability of B.C. water resources. The WSA requires any changes to be made in and about a stream to be approved by the Ministry of Forests, Lands and Natural Resource Operations and Rural Development. Applicants are required to submit detailed plans that include measures to mitigate harm to the environment. The WSA is

the principal law for managing the diversion and use of water resources. The following regulations maintain core water management functions:

- [Water Sustainability Regulation](#)
- [Groundwater Protection Regulation](#)
- [Water District Regulation](#)

[Fisheries Act \(Under review in 2018\)](#)

The primary purpose of the Fisheries Act is to protect Canada's fisheries as a natural resource by safeguarding both fish and fish habitat. The Act applies to both coastal and inland waters, and is administered by the Fisheries and Oceans Canada (DFO), although the environmental protection parts of the Act are administered by Environment and Climate Change Canada. It is an offence for anyone to deposit or permit the deposit of any type of deleterious substance in water frequented by fish without a permit or under a regulation. There are a number of regulations under the Act that limit wastewater or effluent discharges from certain industrial facilities including pulp and paper mills, petroleum refineries and meat and poultry processing plants. It is also an offence for anyone to carry on a work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or aboriginal fishery, or to fish that support such a fishery.

[The Drinking Water Protection Act \(DWPA\)](#)

The DWPA protects drinking water and public health in British Columbia by regulating water supply systems, establishing mechanisms for source protection and providing for greater public accountability of water suppliers. The DWPA and the Drinking Water Protection Regulation define water suppliers as owners of systems which supply domestic water. Water suppliers must provide potable water, obtain construction and operating permits, meet qualification standards for operators, have emergency response and contingency plans, follow monitoring requirements, and report threats to drinking water. The Regulation provides exemptions to these requirements for small systems. The legislation is outcome based - by recognizing that different water suppliers and drinking water systems have different needs, it allows for some variation in determining what a water supplier needs to do in order to achieve these requirements.

[Utilities Commission Act](#)

The British Columbia Utilities Commission (BCUC) is an independent regulatory agency that operates under, and administers, the Utilities Commission Act. The BCUC's responsibilities include the regulation of British Columbia's natural gas and electricity utilities.

Energy utility services provided by a local government within its own boundaries may be excluded from the definition of public utility, but not necessarily. The only entities that can benefit from the municipal exclusion are municipalities and regional districts as defined under the Interpretation Act. If a municipality enters into an agreement with a developer or service provider to provide energy services, that does not grant the developer or service provider the same legal status as a

municipality. The developer or service provider is a separate corporate entity.

Municipalities should seek advice from the BCUC to ensure they understand their legal obligations prior to developing a district energy system.

[BC Safety Standards Act](#)

One of the most significant regulations with regards to district heating is the requirement for boiler staffing, as laid out in the BC Safety Standards Act. The regulation is fairly complex, with different certification levels based on boiler size and type, as well as a number of exemptions.

[Agricultural Land Commission Act](#)

The Agricultural Land Reserve Use, Subdivision and Procedure Regulation specifies the uses that can occur on land designated as part of the agricultural land reserve (ALR). The various land use policies provide further guidance on specific uses including (but not limited to) utility services within rights-of-ways within the ALR and the production, storage and application of Class A compost.

[Organic Matter Recycling Regulation](#)

The Organic Matter Recycling Regulation of B.C. (OMRR) governs the production, quality and land application of organic matter defined under the regulation. It provides clear guidance for local governments, as well as compost and biosolids producers, on how to use organic material while protecting soil quality and drinking water sources.

[Local Government Bylaws and Regulations](#)

B.C. municipalities may also pass bylaws regulating the environment. The Community Charter provides specific power to local governments to pass bylaws for the protection of human health or the environment and the Local Government Act conveys authority to issues arising from land use, growth, infrastructure and works. Proposed bylaws must be approved by the appropriate provincial ministry. Many local governments have such by-laws and many more are currently in the planning stages. For example, many municipalities have stream protection by-laws. Local government projects should, in good faith, conform with municipal bylaws and regulations.

[Consulting with First Nations](#)

British Columbia has a unique history in that the vast majority of its land base is subject to unresolved land claims by First Nations. As a result, any natural resource development activities in British Columbia will need to consider and address the potential impacts to aboriginal rights, which are constitutionally protected in Canada.

Governments must carry out consultation with First Nations on proposed activities on government land and, where necessary, accommodate the interests of First Nations. The scope and meaning of this will depend on the nature of the potential impact to a First Nation's rights. In addition, establishing a business relationship between First Nations and a business operator or project proponent has become integral to the successful pursuit of such an activity or project in British Columbia.



FEDERAL AND PROVINCIAL POLICY & FUNDING

Government of Canada

Pan-Canadian Framework

The Pan-Canadian Framework supports clean growth and innovation by making Canada a leader in the development and deployment of 'breakthrough' clean technologies.

In 2017, the federal government announced \$21.9 billion over 11 years for green infrastructure, including targeted investments to support greenhouse gas reductions and enable greater climate change adaptation and increased resilience.

Federal Funding

The \$2 billion Low Carbon Economy Fund supports the Framework by leveraging investments in projects that will generate clean growth, reduce greenhouse gas emissions and help meet or exceed Canada's Paris Agreement commitments. The fund has two streams – the Low Carbon Economy Leadership Fund and the Low Carbon Economy Challenge.

Low Carbon Economy Leadership Fund

This Fund provides \$1.4 billion to provinces and territories that have adopted the Framework. The funding will help them deliver on their commitments to reduce greenhouse gas emissions, including those they outlined in this Framework. This funding recognizes the key role provinces and territories play in implementing the Framework and addressing climate change. British Columbia will access up to

\$162 million through the Low Carbon Economy Leadership Fund to support energy efficiency, reforestation and organics diversion and processing. The Province of BC is also contributing additional funds accompanying the Low Carbon Economy Leadership Fund for some of these projects.

Low Carbon Economy Challenge

Over \$500M is available for the Low Carbon Economy Challenge. Funded projects will leverage ingenuity across the country to reduce emissions and generate clean growth in support of this Framework. The Challenge has two streams:

Champions Stream

The \$450 million Champions stream will provide funding to all eligible applicants (provinces and territories, municipalities, Indigenous communities and organizations, businesses and not-for-profit organizations). The deadline for submitting initial project proposals was May 14, 2018.

Partnerships Stream

The \$50M Partnerships stream is limited to Indigenous communities and organizations, small and medium-sized businesses, not-for-profit organizations and small municipalities. The Partnerships stream will help ensure a broad range of Canadians are able to participate in the Challenge. The Partnerships stream will be open for applications later in 2018.

Other Funding

For a detailed description of each of these programs, please access the [2018 Funding Guide for BC Local Governments: Funding Your Community Energy and Climate Change Initiatives](#).

[Environment & Climate Change Canada EcoAction Community Funding](#)

[Farm Credit Canada AgriSpirit Fund](#)

[Federation of Canadian Municipalities Green Municipal Fund](#)

[Federation of Canadian Municipalities Municipal Asset Management Program](#)

[Natural Resources Canada Clean Energy Innovation Program](#)

[Natural Resources Canada Clean Energy for Remote Communities Program](#)



> Province of BC

Climate Solutions and Clean Growth Advisory Council

The government of British Columbia is committed to building a strong, sustainable, innovative economy – one that works for people, creating jobs for British Columbians in every corner of the province. The Province is committed to reducing greenhouse gas emissions to 80% below 2007 levels by 2050, and has legislated interim reduction targets of 40% below 2007 levels by 2030, 60% below 2007 levels by 2040.

In 2017, building on its past climate actions, the Province established a Clean Growth and Climate Solutions Advisory Council to provide strategic advice to government on climate action and clean economic growth. It includes members from First Nations, environmental organizations, industry, academia, labour and local government. The Council supports a steady and committed approach to climate action that drives down emissions, increases economic opportunities and improves community resilience.

Details on the policies and programs adopted by the Province are available on the [Climate Action Secretariat's website](#).

Existing Funding Programs

For a detailed description of each of these programs, please access [2018 Funding Guide for BC Local Governments](#): Funding Your Community Energy and Climate Change Initiatives.

BC Bioenergy Network

BC Hydro Sustainable Communities Program

Bullitt Foundation (Metro Vancouver area only)

Columbia Basin Trust Community Development Program (Columbia River watershed only)

Climate Action Revenue Incentive Program

Local Government Infrastructure Grants

- Infrastructure Planning Grant Program
- Investing in Canada Infrastructure Program

Nechako-Kitimaat Development Fund Society Grant Program

Northern Development Initiative Trust Grants and Loans

Union of BC Municipalities Asset Management Planning Progra



New Funding Programs

Through the [Investing in Canada Infrastructure Program](#), the Canadian government will invest up to \$903 million in B.C. for Green Infrastructure. Three funding streams will be available in BC under the Green Infrastructure funding category:

1. Environmental Quality

The Green Infrastructure – Environmental Quality Program

On May 31, 2018 the Canadian and British Columbian governments committed up to \$243 million towards an initial intake of the Green Infrastructure – Environmental Quality Program to support cost-sharing of infrastructure projects in communities across the province. The Green Infrastructure – Environmental Quality Sub-Stream will fund infrastructure projects that will support quality and management improvements for drinking water, wastewater and stormwater, as well as reductions to soil and air pollutants through solid waste diversion and remediation.

A project must meet at least one of the following outcomes to be eligible:

- Increased capacity to treat and/or manage wastewater and stormwater
- Increased access to potable water
- Increased capacity to reduce and/or remediate soil and/or air pollutants

Local governments (municipal and regional) and indigenous applicants are eligible ultimate recipients for this merit-based funding.

2. Climate Change Mitigation

Further details will be available in fall 2018.

3. Adaptation, Resilience and Disaster Mitigation

Further details will be available in fall 2018.

Information about all three funding streams can be found here:

<http://www.gov.bc.ca/Investing-in-Canada-Infrastructure-Program>



STEPS TO A STRONG GRANT APPLICATION

Preparing an Application

1. Review Community Energy Association's [Funding your Community Energy and Climate Change Initiatives](#) or other funding guides to determine if programs are available to support your project.
2. Ensure a good fit. Check your project's goals and objectives against those of the funding program. Review evaluation criteria and ensure that your proposal responds directly to each, or as many as possible.
3. Contact funding agency. Describe your project and ask:
 - Does this project meet the funding program's goals and objectives?
 - What are key elements of past successful applications?
 - What are the evaluation criteria (if not listed on form)?
 - Can supporting material (such as letters of support) be submitted after the closing date?
 - Are previous applications available for review?
 - Is Council or Board endorsement of the application required?
 - If a previous application was submitted to the funding organization and was unsuccessful, can relevant feedback be obtained on that previous application?

4. Create a timeline for application preparation and an application package checklist, including:
 - Developing a budget and project scope
 - Obtaining executive committee, Council or Board endorsement, if required
 - Identifying and/or obtaining supporting funding
 - Identifying possible partners and reaching agreements
 - Writing the proposal and ensuring senior management review and final edits
 - Securing letters of support
 - Copying and filing
 - Submission deadline, format and method of delivery (postmarked document, email, etc.)
5. Review application package checklist and ensure that all requirements have been met.
6. Submit proposal on time in the required format.

Application Content

1. Follow the recommended format of proposal.
2. Focus on key elements and ensure that you clearly address evaluation criteria. Include everything you think is important, but be succinct – longer is not better.
3. List resources your agency has committed or will commit to ensure success of project.
4. Identify partners and note how you will work together to ensure success.
5. Describe any planned community engagement processes, if required. Consider using innovative approaches.
6. Facts and figures are helpful. If possible, calculate or estimate magnitude of benefits of the project.
7. A budget can be either calculated or estimated but it should not necessarily reflect the maximum amount of funding available, unless you can justify it. Provide a reasonable level of detail for costs, itemize matching funds, and mention in-kind contributions, if any.

