



SMALL-SCALE BIOMASS DISTRICT HEATING GUIDE

A Guide for BC Communities

August 2013



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About this Guide

Purpose

The purpose of this Guide is to support the growing number of small communities across British Columbia interested in making a business case for biomass district heating. There may be substantial benefits for communities that approach local energy projects having developed an integrated strategy on clean energy, energy independence, and the transition to a green economy. Small-scale biomass district heating systems can be a centerpiece of such a strategy. Primary benefits include:

- potential to reduce greenhouse gas emissions,
- local economic development through attracting investment, clean energy job creation, infrastructure development and keeping energy dollars circulating locally, and
- increased local energy reliability, resilience and security.

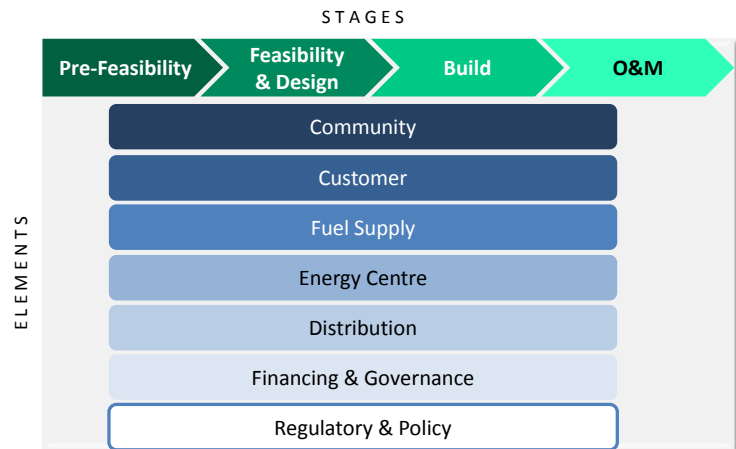
The “Small-scale Biomass District Heating Guide” is written primarily for local governments and First Nations elected officials and staff to support an active local government and band role in the development of clean energy and a green economy.

The scale of district heating being considered in this guide is approximately 150kW to 3MW.

Using this Guide

This Guide uses three orienting concepts to move the reader from the conceptual phase of a biomass DH opportunity, to the development of a utility. These concepts are:

- **STAGES:** Sequential groups of activities. Shifting from one Stage to the next is typically a significant milestone in a project and involves additional commitment from those involved.
- **ELEMENTS:** Subject matter areas that are addressed during each Stage of investigation to provide a full picture of a biomass DH system. They are inter-related.
- **STEPS:** Sequential Steps within each Stage related to one or more Elements. This is the most granular level of detail in the Guide and may be of use to ensure successful execution of each Stage of activity.



This Guide can be used by local government staff and others to develop a basic understanding of biomass district heating and its role in an integrated energy plan for the community. The Step by Step Guide can also be helpful to any community that is working to develop and realize a vision for moving towards energy independence, local economic development, and lower greenhouse gas emissions.

See the Appendices for more detailed information including explanations of terms used in this Guide.

Introduction

Communities across BC are addressing climate action, energy security, and local economic development in an increasingly integrated way. Many are experimenting with managing their energy needs at the smaller scale (e.g., neighborhood) by taking an innovative integrated approach that pulls together the traditional silos of community planning, engineering, housing and buildings, transportation, and energy generation. A core part of this integrated approach can be District Energy.

Defining the Tools

District Energy (DE) systems are defined as the provision of heating and/or cooling to more than one building and sometimes electricity.

District Heating (DH) is one type of DE which focuses exclusively on heat. DH is a proven technology; the first commercial steam system began in Lockport New York, in October 1877. Today there are many thousands of DH systems worldwide.

Energy sources used for DH systems around the world include: biomass (including wood chips, wood pellets, biogas); waste heat (e.g., from industry, arenas, wastewater infrastructure); geexchange, or other ambient sources (using heat pumps); geothermal (i.e. earth core heating sources); solar; municipal solid waste to energy; peat; and fossil fuels (natural gas, coal, propane, diesel, oil).

DH can be used as an urban planning tool, and is entirely congruent with, and can even help encourage, more compact mixed-use communities. It can help most BC communities achieve their vision and goals, particularly regarding greenhouse gas (GHG) reductions, economic development and energy independence.

Biomass DH

Many communities across BC may have access to wood chips, pellets, shavings, sawdust, community forests, and other woody material, collectively referred to in this document as 'biomass'. It is this woody fibre that provides the fuel needed for a central community or neighbourhood-based biomass district heating system. Biomass can play a key role in helping communities take control of their energy future



Figure 1 District heating system schematic. Source: Vital Energi Utilities



Figure 3 Outdoor wood boiler. Sources: Wood Waste 2 Rural Heat



Figure 3 Lillooet containerised wood pellet system. Source: Wood Waste 2 Rural Heat

while strengthening their local economy.

Biomass heating is a technology that is both familiar and unfamiliar to most Canadians. Traditional approaches for biomass combustion are familiar and involve heating in open fireplaces, old stoves, outdoor boilers, and biomass disposal in large-scale polluting beehive burners. These approaches are inefficient and often result in the production of large amounts of particulate matter. When biomass heating is referenced in this Guide, these are **not** the forms that are being considered.

The form of biomass heating referenced in this Guide takes the form of modern, efficient, clean burning biomass systems. This approach is widespread in many European countries, for example Austria, where it supports the country’s strict air quality standards with systems of high reliability and quality.

Pulling It All Together – Integration and Independence

DH systems can be the centerpiece of a community energy strategy. Taking one small community as an example, two blocks contain a health centre, a senior’s care home, a police station and civic building that could share a biomass DH system. Across town, the pool could use waste heat from the adjacent rink. The local school could be on geo-exchange. Meanwhile an incentive could be offered to individual residences and small businesses across the community to install individual pellet stoves and boilers, perhaps with the capital cost of the stove / boiler paid back over time with a slightly higher rate for pellets than wood chips, though still much less than their previous cost of propane or heating oil.

With the nucleus of an energy system in place, the community could encourage future development to take place near the DH system, constructed in a way that the buildings are ready to be ‘plugged in’ to the DH as the further development becomes more cost effective.

An efficient biomass DH system can help any community reduce the amount of propane, heating oil, and electricity it uses for heat. This can mean reduced costs to home and commercial owners, more money staying within the local economy, reduced dependence on outside energy sources for basic needs, and lower greenhouse gas emissions.



Benefits

Benefits of biomass district heating to communities are outlined in the following tables.

(Modified from “Clean Energy for A Green Economy” - Community Energy Association, 2010)

Building community capacity

New partnerships and collaboration	Clean energy projects provide opportunities to engage key people and supportive organizations, and build new partnerships and collaboration within the community, with neighbouring communities, with provincial regulatory authorities, other agencies, institutions, and businesses.
Local energy	Fossil fuels are sourced from outside a community. Biomass is often sourced within the community or region, resulting in possible new suppliers, increased investment in local industries and associated job benefits.
Energy security	The community will start to diversify the sources from which it obtains its energy leading to a more stabilised energy pricing structure.
Confidence in your future	The leadership you are showing by developing an implementation plan for your clean energy project will help articulate a direction for a local green economy, while at the same time building new expertise, experience and confidence in your community’s economic future.

Local economic development

Clean energy service network	Undertaking a clean energy project will lead to a net increase in specialized knowledge and practical experience within your community. The expertise gained can lead to the creation of a regional clean energy network, providing training, supply, maintenance, capacity-building and project management services to neighbouring communities interested in their own clean energy initiatives.
Reduced energy costs	Customers of the DH system will see stabilised and potentially reduced energy bills compared to buildings that heat with propane, diesel, heating oil, or electricity. Because biomass is considered to be ‘carbon light’ (see Greenhouse gas reduction below) it is not subject to the carbon tax, and for the public sector the extent to which it is subject to purchases of carbon offsets is reduced.
Economic development	In the pre-feasibility and feasibility Stages, there is the potential for creating new biomass-related technical expertise. Sourcing of local wood fuels may have a series of benefits: supporting the local forestry industry by adding a new revenue stream for residues; creating / supporting jobs in the delivery of biomass; reducing transportation and/or disposal costs of waste wood for local businesses; helping local wood fuel supply businesses become established which would support other local bioenergy systems; or supporting the local wood pellet / briquetting plant with a domestic market. In Operations / Maintenance too there are also opportunities to create new biomass-related technical expertise. And throughout, there is community economic development: attraction of businesses that require a high heat consumption like greenhouses, micro-breweries and even municipal or provincial amenities; increased local tax base and/or non-tax revenue stream; partnerships and collaborations with other organisations; and enhanced community profile and branding.
Local capital investment	Tens of thousands to millions of dollars of community investment are required at start-up, an attraction to private investors. Although some major components may be imported to the community, local contractors may nevertheless be used, with many other components and services sourced locally (e.g., building materials, welding, civil engineering, marketing and light fabrication). Ongoing investment will also occur with system expansions.
Attracting investment	The investment required for a clean energy project may attract business and investment capital that can be leveraged by the community. A range of funding grants and below-market loan programs are available for clean energy and energy efficiency programs. These funding

	streams can be used to attract other investment partners to your community.
Competitive advantage	Showing leadership in developing a local green economy can give your community a competitive advantage by attracting green investment and developing a green community brand. Forecasts for employment and investment growth in the clean energy sector in North America and worldwide are uniformly high for the foreseeable future. Clean energy can position your community to take part in this growing sector of the economy.
Business expansion and development	Business expansion and new business development can also result from undertaking a clean energy project and related service infrastructure upgrades, helping to diversify and strengthen the local economy and retain existing businesses. Opportunities exist for creating a specialised centre for bio-products or for specialized manufacturing and knowledge-based businesses, training and education services, as well as local suppliers of biomass goods and services.

Environmental and community health

Greenhouse gas reduction	Biomass is considered carbon light and, as such, is not subject to the carbon tax. Public Sector buildings (Province of BC, Schools, Universities, Colleges, Crowns, and Hospitals) will significantly reduce their carbon offset liability when replacing fossil fuels with biomass or other renewable fuels.
FireSmart	Biomass DH systems can help contribute to community fire risk reduction. An additional source of funding for community wildfire mitigation activities can be provided if the biomass generated can be economically transported to the DH system, possibly creating a market for logging slash piles that may otherwise represent a fire risk.
A healthier community	Efficient land use and transportation planning (that support district and renewable energy) can also promote walking and cycling opportunities, thus promoting a healthier lifestyle and viable alternatives to the automobile.

Community priorities

Municipal revenue	A successful biomass DH system owned by the local government generates a utility rate of return and provides a non-tax revenue source after initial capital is paid off in 5-20 years. A private sector system should increase or help secure tax revenue through economic development impacts, as well as from franchise fees on municipal rights of way. If wood waste is diverted from landfill, waste disposal costs can also be reduced.
Local government commitments	Biomass DH systems can help local governments meet their environmental commitments by reducing community and corporate greenhouse gas (GHG) emissions. Through the Local Government Act (Section 877 and 850), local governments are required to set GHG targets, policies, and actions in their Official Community Plans and Regional Growth Strategies. Also, the voluntary Climate Action Charter commits local governments to becoming carbon neutral in their own operations, and creating compact, energy efficient communities.
Quiet, unobtrusive, and AQ maintained	A well designed and installed DH system, using modern and clean technology will be quiet and unobtrusive when installed and have no noticeable impact on air quality. In cases where wood waste is used that would otherwise have been burnt in the open air, air quality will be markedly improved.

Barriers

On the other side of the ledger are barriers to be addressed. Three of the primary issues are:

Fuel supply long term access and consistency	Biomass is available extensively throughout many parts of BC, but presently only on a ‘spot’ basis rather than through solid long term contracts. This may pose a challenge for system financing. There can also be issues with the quality and consistency of delivered wood chip. An opportunity exists to develop a “Wood Fuel Supply Initiative” in BC to provide market transformation solutions for fuel supply in BC.
Financial cost of distribution pipe installation	To ensure long life and the lowest heat loss and therefore the maximum performance from the system, the distribution piping and its insulation is designed to exacting standards. Cost savings made by using conventional piping and wrap-around insulation is a false economy and can lead to system failure. Several suppliers exist, in North America and Europe that can provide insulated distribution pipe for \$50 - \$300 per meter. Installation in a shallow trench with appropriate backfill could increase this to \$500 to \$2,500 per meter. The low end of this range (\$500) assumes use of factory insulated flexible cross-linked polyethylene (PEX) which is easier to install but can only be used for small systems with no elevation change.
Local government capacity	Municipal government is faced with many opportunities and decisions and must weigh the benefits of one investment against those of another. Decisions are made based on their understanding of the technology and benefits. An educational program, based on this Guide and similar material, delivered to the community could assist in developing local government and public interest in DH solutions.

Lessons Learned

The experience of others who have realized benefits from biomass DH systems may help those starting out on the journey. Recommendations highlighted in recent interviews with those in charge of running DH systems and DH professionals are summarized below.

(Modified from “Green Energy Projects and Utilities: An Investment and Governance Case Study Guide for BC Local Governments and First Nations” 2012)

Community Engagement	Ground the discussion with a long-term view and be clear on the goals of the community and identify the alternative approaches to achieving those goals. Focus leadership, communication and accountability around these goals and develop win-win relationships between partners based on achieving the goals. This may entail standing firm on essential program Elements, while being otherwise flexible to suggestions from knowledgeable partners. From this an informed, confident community can be developed including youth. Financial and co-benefits can be useful at convincing council to accept the perceived risk. Local capacity and experience, especially with local suppliers, is an advantage for any project.
Planning the Solution	Do your homework, but do not overdo it. While feasibility studies are essential, they need not predict everything. Several participants noted that both bad and good luck on timing had significant impacts on projects. Investigate grants early including the potential to “stack” multiple grants to meet “matching” requirements. Subsidies and incentives have been essential to most DH projects in BC. Set rates based on Levelized Cost of Service (cost of delivering the heat to the customer over the life of the system).
Sizing and Operating	Project scale affects both affordability and benefits. Encourage potential customers to conserve energy first to avoid over-investing in capacity, which may also reduce connection costs and the customers’ billed capacity charges. Similarly, size initial plant to meet initial base load, using a fossil fuel boiler for peaking and backup, and design the flexibility to scale up as the heat load grows. Often one successful project leads to another but many projects have had financial challenges because projected load was delayed or did not materialize. When operating the system, local fuel sources can lead to economic and other benefits, but it is essential to make sure fuel sources are reliable.

Stages

Stages are sequential groups of activities. Shifting from one Stage to the next offers deeper insight into the undertaking, with each subsequent Stage providing an increased level of detail and commitment from those involved. The four Stages are described below.

STAGES	Pre-Feasibility	Vision, excitement, and possibility tempered with reality-checks define this stage. The objective is to determine if there is sufficient potential to warrant going to the next stage.
	Feasibility & Design	Precision, engineering, planning, financial analysis and detail orientation help achieve the objective of making significant long-term investment decisions.
	Build	Managing risk through construction management and contracting is the objective of this stage. Deliver on time and budget while entrenching governance, financing, and contracting.
	O&M	Utility operations are optimized to be lean, reliable, safe, and low cost. This requires repetition, quality control, established procedures, and billing efficiency.

In some circumstances, particularly for smaller systems, the pre-feasibility and feasibility Stages can be combined. Each Stage is further profiled in the table below.

	STAGE			
	Prefeasibility	Feasibility	Build	O&M
Cost	\$5-30k	\$20-200k +	\$0.5-10m	\$50-350k annual
Duration	10 days to 6 months	6-18 months	6 months to 3 years	System life 25+ years
Time drivers	<ul style="list-style-type: none"> • Complexity, detail • Basic rationale • Scan of options available • Stakeholder engagement & public relations • Assessment of community needs, ownership options and financing strategies 	<ul style="list-style-type: none"> • Complexity, detail • # and diversity of buildings • Budgeting and grant cycles • Stakeholder engagement 	<ul style="list-style-type: none"> • Regulatory & permitting • Size and complexity • Budgeting cycles • Financing turnaround times • Stakeholder engagement 	<ul style="list-style-type: none"> • N/A • Annual LG budgeting and/or investors' AGM

Elements of a Biomass District Heating System

Some key considerations are provided below, note that they are interrelated.

ELEMENTS	Community	Taking the time for dialogue on local government priorities, stakeholder considerations, and co-benefits
	Customer	Identifying, understanding, evaluating, contracting, connecting, serving, and billing customers
	Fuel Supply	Understanding and monitoring short and long term availability, type, moisture content, cost, consistency
	Energy Centre	Sizing, selecting, costing, configuring, operating and maintaining
	Distribution	Optimizing type, length, and cost of pipe and customer connection
	Finance & Governance	Grants, ownership models, decision-making and rate-setting, business case / model and risk management
	Regulatory & Policy	Protecting customers, environment (including air), and workers. Local supportive policies and regulations

See Appendix for further information on Elements and case studies of biomass DH systems.

Step by Step Guide

The framework below outlines the Stages, Elements, and Steps involved in implementing a biomass DH project. The following sections provide detail on these Steps and guidance on sequencing.

		Pre-Feasibility	Feasibility & Design	Build	O&M
		STEPS			
ELEMENTS	Community	<ul style="list-style-type: none"> Sow the seed Assess community interest in benefits and identify potential concerns 	<ul style="list-style-type: none"> Confirm project goals, and staff capacity Articulate and quantify co-benefits Conduct consultations and confirm next steps 	<ul style="list-style-type: none"> Continue engagement with stakeholders 	<ul style="list-style-type: none"> Promote the successful system Report to the community on all key aspects including benefits
	Customer	<ul style="list-style-type: none"> Identify and contact likely customers Conduct heat demand scan Estimate heat load profile 	<ul style="list-style-type: none"> Refine heat load profiles Identify connection requirements and costs Test market and develop marketing plan Soft commitment from potential customers 	<ul style="list-style-type: none"> Marketing Sign customer contracts Issue RFP & select vendors Construction Testing and commissioning 	<ul style="list-style-type: none"> Manage customer billing and support
	Fuel Supply	<ul style="list-style-type: none"> Identify waste heat Estimate fuel needs Identify biomass sources and pricing 	<ul style="list-style-type: none"> Conduct wood fuel supply analysis Soft commitment from potential fuel suppliers 	<ul style="list-style-type: none"> Confirm fuel supply First fuel delivery for testing / commissioning 	<ul style="list-style-type: none"> Manage wood fuel deliveries
	Energy Centre	<ul style="list-style-type: none"> Identify potential sites for energy centre Estimate size and type Develop ballpark pricing 	<ul style="list-style-type: none"> Refine energy centre design options and sizing of base and peaking boilers 	<ul style="list-style-type: none"> Issue RFP & select vendors Construction Testing and commissioning 	<ul style="list-style-type: none"> Manage the energy centre
	Distribution	<ul style="list-style-type: none"> Estimate layout of distribution network, type of pipe, and installation costs 	<ul style="list-style-type: none"> Refine network design and pricing 	<ul style="list-style-type: none"> Issue RFP & select vendors Construction Testing and commissioning 	<ul style="list-style-type: none"> Manage the distribution network
	Financing & Governance	<ul style="list-style-type: none"> Consider governance and financing / funding options & preferences Develop approximate business case 	<ul style="list-style-type: none"> Develop business plans options and conduct sensitivity analysis Detailed assessment of governance and financing / funding options 	<ul style="list-style-type: none"> Confirm budget & governance structure Apply for financing / funding Develop organisational structure 	<ul style="list-style-type: none"> Ongoing financial monitoring and reporting
	Regulatory & Policy	<ul style="list-style-type: none"> Identify regulatory requirements that may be required Identify potential community planning / policy measures 	<ul style="list-style-type: none"> Specify regulatory requirements with appropriate authorities / legal advisors Confirm community planning / policy measures 	<ul style="list-style-type: none"> Acquire permits / approvals Design contract structure Implement supportive planning / policy measures 	<ul style="list-style-type: none"> Air quality monitoring, if required Consider expansion opportunities Manage rate reviews Stay current on evolving regulations

Vision: Pre-feasibility

Pre-Feasibility

Vision, excitement, and possibility tempered with reality-checks define this stage. The objective is to determine if there is sufficient potential to warrant going to the next stage.

The Pre-feasibility Stage is an initial survey of district energy options and potential within key areas or across the community. It includes a high-level review of the community priorities, followed by all of the Elements necessary for successful implementation of a biomass DH project. This Stage can be quick and visionary or involve further investigation. A consultant may be used for this Stage, or a community may choose to conduct a proportion or all of the work themselves.

A suggested sequence of Steps is outlined below. Relevant Elements are shown to the left of each Step. The sections on the Elements in this Guide contain further discussion on many of the Steps and the context for them.

Community

1

1 Frame the opportunity

- a. Include investigation of biomass DH in any overarching community strategy or visioning documents, e.g., Community Energy and Emissions Plan, Integrated Community Sustainability Plans, Official Community Plans, Economic Development Strategies. Consider all of the potential options and benefits including biomass DH with the community priorities, to highlight the level of importance for the community to proceed with investigation of biomass DH. A basic economic assessment will provide insight into the employment and economic benefits to the community.
- b. Talk with local government staff such as the planner and chief administrative officer as well as council to raise the level of support for investigating a biomass DH system. It is important to identify potential project champions / spokespersons.
- c. Determine the area of the community that would benefit from the introduction of DH. What is the potential for growth, new development, expansion, etc that would support the future system.

Customer

2

2 Identify and contact likely customers

- a. Within the designated area of the community undertake a scan of building clusters with strong and preferably diverse heat load profiles. Tour the community. The most attractive buildings have a large heat consumption (schools, municipal offices, maintenance facilities, recreation centres, hospitals, hotels, pools, seniors care home, etc) and ideally require heat at different times of the day or season from other buildings that may be on the system. Make contact with the building owners / operators. Consult the customer, distribution network and finance and governance sections of this Guide for further discussion of the implications of selecting potential customers.
- b. Determine if any new buildings will be built nearby that could connect. Assess the risk of the new building being delayed or not proceeding before including in the business case.
- c. What concerns do any of the potential customers have about connecting to a biomass district heating system? Discuss how to address these.

Customer

3**Conduct heat load scan**

- a. Estimate potential customers' annual heating and hot water consumption, and maximum demands.
- b. For local government buildings, the municipality or regional district is likely to have information on annual consumption included in their annual Climate Action Revenue Incentive Program (CARIP) reporting. Accounting staff often have this data.
- c. For public sector buildings, annual consumption information may be available through their annual carbon neutral reporting. An energy manager, if they have one, is a good contact.
- d. Private buildings may be willing to provide energy information.
- e. If it is difficult to obtain information, estimates can be derived by using the Comprehensive Energy Use Database published by Natural Resources Canada's Office of Energy Efficiency or the RETScreen software program.

Customer

4**Estimate heat load profile**

- a. Consider variability in the heat loads of the potential customers. Different types of buildings have different load profiles, which are determined by several factors, including what proportions of the heating profiles are comprised of space heating, hot water, or process heating. Space heating will follow a seasonal profile but hot water and process heating may follow different profiles (e.g., seasonal hotels, outdoor pools, or industry). Also consider variation in daily profiles. At this Stage this is an approximate estimate based primarily on local knowledge.
- b. Estimate base load and peak load that energy centre will have to meet.

Fuel Supply

5**Identify waste heat**

- a. Identify sources of waste heat available in town as an alternative to purchasing wood fuel. Mills often burn biomass for steam systems to dry wood.
- b. Consider proximity of the plant to customers, as the distribution network is a large part of the total costs. Capital cost of the distribution network may outweigh the value of the waste heat if the location is not close to the customers.
- c. Make contact with the facility. Do an estimated heat load profile to see if heat available from the facility matches well.

Fuel Supply

6**Estimate fuel needs**

- a. Based on the high level heat estimate from the customer analysis Step, calculate how much biomass is needed.
- b. Consider that not all wood fuels are created equally. Dry, dimensionally consistent and contaminant free is better, though all these have to be weighed with the practical realities of what is available.

Fuel Supply

7

Identify biomass sources and pricing

- a. For fuel security (and potentially for financing), it is important to have a primary supply and also ensure that fuel needs can be met by an alternate supply.
- b. Armed with your estimates by type, start calling locally. Note that many sources may consider the estimated volume to be small considering the volumes they deal with. Investigate:
 - i. Waste wood from secondary wood product manufacturers (e.g., furniture).
 - ii. Pulp chips, sawdust, and hog fuel from mills.
 - iii. Clean demolition, land-clearing, and construction (DLC) wood waste diverted from landfill, from Regional District.
 - iv. Wood pellets from local suppliers, or from nearest pellet plants (wood pellets can economically travel greater distances, so do not have to be local).
 - v. Slash if 'FireSmart' applications planned.
 - vi. Slash from harvesting. Companies / organisations may contact local tenure holders regarding access, including community forest and wood lots, if slash is not currently being utilised. If agreement cannot be reached and slash is not being utilised tenures for access can be reached with the Province. The project proponent may wish to do this themselves, or encourage another organisation to do so.
- c. Longer term commitments are better than short term, but a long-term contract may be difficult to procure at the outset.
- d. Consider fuel quality and pricing.
- e. Consider fuel pick-up, delivery and storage logistics. Is there a local delivery agent, what about long and short term storage?

Energy Centre

8

Identify potential sites for energy centre

- a. Evaluate land that the system proponent already owns or space adjacent to one of the anchor customers of the system. Ideally the energy centre is as close as possible to the customers to minimize the capital cost of the distribution network. At \$500-2,500 per meter range for distribution network installation costs (including supply & return pipes), 100 meters can make a significant difference.
- b. Consider future growth of the system and potential future development, optimizing location for the long term but without compromising current loads.
- c. Access for trucks to deliver the fuel will be required.

Energy Centre

9

Estimate size and type

- a. A consultant or biomass boiler supplier / installer can assist with this Step.
- b. From base and peak load estimates, estimate sizes for biomass boiler and peaking / backup boiler(s).

- c. Consider most likely fuel type(s).
- d. Rough estimate of the size of energy centre, including space and logistics for fuel delivery and storage, and other items.
- e. Consider staffing requirements that may be necessary, and if these can be met locally.

Energy Centre

10 Develop ballpark pricing

- a. Conduct research, call biomass boiler distributors / installers, and / or use consultants to refine ballpark pricing of biomass boiler, fuel storage, and other components.

Distribution

11 Estimate layout of distribution network, type of pipe, and installation costs

- a. Based on the initial potential customers and potential location of the energy centre, draw the distribution piping network on a map. Try to minimize the network length, and avoid rail line and major road crossings if possible as these add to the civil engineering costs. Supply and return pipes are required which can usually be installed in the same trench. For small systems, pipes will likely be 6 inches or less in diameter.
- b. Once the network is drawn, ask the Public Works staff how much they'd estimate for the civil engineering component, and obtain an estimate for welding (for steel pipe) or plumbing (for PEX pipe). This, along with ballpark cost ranges obtained from suppliers will give an order of magnitude cost for the network. Compare to cost ranges in the distribution section of the appendix.

Financing & Governance

12 Consider governance and financing / funding options and preferences

- a. Discuss governance among staff and elected representatives. Depending upon their community priorities some local governments or First Nations are comfortable with adding a heat utility to their operations whereas others do not see it as their role and have concerns about both staff and financial capacity. The latter communities would prefer that a private entity initiate, own, and operate the system.
- b. If private sector involvement is being considered, the community may contact companies that have expertise in owning and operating DH systems. There are several of these in BC.
- c. The governance option selected affects how the system may be financed or funded. Consider financing and funding options, including available grants and risks, with pros & cons of each option.

Financing & Governance

13 Develop approximate business case

- a. Contact financial advisors and open discussions on possible financing mechanisms. Raise their level of awareness of potential community benefits in terms of employment and economic development. Get the advisor to outline the various degrees of public and private operations and the responsibilities of each partner in such an agreement.
- b. Develop a simple financial model that includes the ability to easily change assumptions so that sensitivity analysis and what-if scenarios can be run given the amount of uncertainty involved at this Stage of analysis.

Regulatory & Policy

- c. Include assumptions about capital costs, operating and renewal costs, revenue and community benefits. Financial measures including Net Present Value, Internal Rate of Return, and Payback Period are useful to include as well as a simple cashflow chart.

14 Identify regulatory requirements that may be required

- a. Contact BC Utilities Commission or seek legal advice.
- b. Contact Ministry of Environment regional office (or Metro Vancouver for systems based in their area) on air quality or seek legal advice.
- c. Contact BC Safety Authority on workers safety or seek legal advice.

Regulatory & Policy

15 Identify potential community planning / policy measures

- a. Planning & policy measures can support biomass DH in the community, particularly with new buildings. Discuss options among staff and elected representatives.

Community

16 Assess community interest in benefits and identify potential concerns

- a. Undertake an open house to discuss the benefits of biomass DH early in the process and solicit feedback from community members and experts. Emphasise community benefits, and how concerns can be mitigated.
- b. Establish a single point of contact for the initiative that the public can recognise – an office (preferably a site office), an address, a website, phone number or person.

Resources

- FIRST Heat modeling tool, provides estimate of potential wood fuel supply from community wildfire mitigation activities, and also estimate of business case, environmental, and socio-economic benefits from biomass DH implementation:
<http://www.communityenergy.bc.ca/resources-introduction/first-heat>
- Revelstoke Community Energy Corporation on community benefits:
<http://www.revelstokecommunityenergy.ca/>
- City of Prince George on community benefits, and community outreach materials:
<http://princegeorge.ca/cityservices/utilities/districtenergy/Pages/Default.aspx>
- City of Revelstoke district energy expansion prefeasibility study:
<http://www.cityofrevelstoke.com/DocumentCenter/Home/View/180>
- City of Kelowna district energy pre-feasibility study: <http://www.kelowna.ca/CM/page2238.aspx>
- District of Lillooet wood pellet heating system case study by David Dubois for the Green Energy as a Rural Economic Development Tool Project, on project concept and process:
<http://www.ruralbcgreenenergy.com/project-case-studies>
- NRCAN's [RETSscreen](#) tool can help define technical and financial options, and customer heat loads.
- The Comprehensive Energy Use Database published by Natural Resources Canada's Office of Energy Efficiency can assist with estimating heat consumption of buildings:
http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/list.cfm?attr=0
- Research such as this Guide, the **Local Government Green Energy Project and Utility Investment Guide**, and others exist to help you at this Stage. Consult the Appendix for a listing of information sources that the authors found useful. Depending on staff knowledge and capacity, consultants can be useful at this Stage and throughout the development of the project.

Precision: Feasibility

Feasibility & Design Precision, engineering, planning, financial analysis and detail orientation inform system design and long-term investment decisions.

The Feasibility Stage builds on the Pre-feasibility Stage, exploring key selected option(s) in each Element. The Elements covered in the Pre-feasibility Stage for these option(s) is further explored in greater detail. It clarifies all Elements of the DH solution in sufficient detail to make an investment decision. Use of a qualified consultant is recommended at this Stage.

A suggested sequence of Steps is outlined below. Relevant Elements are shown to the left of each Step.

Community

1 Confirm project goals, and staff capacity

- a. Confirm that project goals and objectives align with community priorities.
- b. Ensure that the local government / Band has sufficient capacity to deal with the project. Even if project will be privately owned, staff time with the proponent and the community will be required.
- c. Confirm communications and decision making process for feasibility study.

Customer

2 Refine heat load profiles

- a. Confirm energy use of the selected building clusters over several years including seasonal and daily variability, and trends.
- b. Combine analysis of individual building heat load profiles to develop an aggregated load duration curve which can assist in sizing energy centre components.
- c. Identify potential customers and heat loads for consideration for future expansion.
- d. Encourage or require significant potential customers to conduct an ASHRAE Level 1 energy audit to identify opportunities to reduce heat requirements. This can avoid overestimating heat loads, revenues, and heat plant size.

Customer

3 Identify connection requirements and costs

- a. Review current energy systems in potential customer buildings to determine retrofits that will be required to connect to the DH system including changes if necessary.
- b. Develop cost estimates for those retrofits.

Fuel Supply

4 Conduct wood fuel supply analysis

- a. Conduct detailed review of local and regional wood fuel supply options including validating moisture content, dimensional consistency, contaminants, costs and key terms of purchase.
- b. Ensure wood volume & quality matches requirements. (For a quality test, consider sending a sample to biomass boiler suppliers / installers.)
- c. Confirm delivery / pick-up logistics, including transportation distance (the greater the distance, often the more the cost).

Energy Centre

- 5 Refine energy centre design options and size of base and peaking boilers**
- a. Based on aggregated heat load profile and available wood fuel, identify biomass boiler options.
 - b. Conduct analysis to size boiler and optimally balance between
 - i. the biomass boiler which is high capital cost and low operating cost, so higher utilization helps business case and
 - ii. the back-up / peaking fossil fuel boiler which is low capital cost but higher operating cost which favours usage as required.
 - c. Develop plant room, fuel store design, and costing options.
 - d. Confirm boiler space and logistics requirements, and confirm specific site location.
 - e. Consider building aesthetics, budget, and potential to act as a community showcase.

Distribution

- 6 Refine network design and pricing**
- a. Confirm pre-feasibility distribution network configuration and length – adjust if opportunities to further optimize or with new information.
 - b. Based on customer heat requirements, geography and system configuration determine design characteristics (flow, temperature, pipe size and pressure, customer heat exchange equipment, etc) to deliver required heat. Also consider future load requirements.
 - c. Verify cost for pipe options and installation.

Financing & Governance

- 7 Develop business plan options and conduct sensitivity analysis**
- a. Develop high level work plan, timing, and costing for construction.
 - b. Develop plan for overall system operations and maintenance including staff / service costs, responsibilities, workload, and authority for key decisions.
 - c. Detail costing of all components from Steps above.
 - d. Estimate fixed (connection) and variable (consumption) heat charges required for a viable business plan. Compare to existing customer costs.
 - e. Differentiate initial connection costs and those for potential future build-out.

Financing & Governance

- 8 Detail assessment of governance and financing / funding options**
- a. Determine ownership model through a structured decision making process that compares the needs of the community with the capital and cost commitments of the undertaking. Ownership models can range from community-owned, private, and various types of public-private partnership. Ownership can be split between components (heat plant, distribution).
 - b. Evaluate the financing opportunities in light of the ownership model discussions.
 - c. Determine authorities and rights for key decisions as well as approach to decision making / governance such as rate setting, decisions on future connections, business performance monitoring and decision-making.

Regulatory & Policy

9 Specify regulatory requirements with appropriate authorities / legal advisors

- a. Contact relevant agencies or engage legal advice to confirm understanding and requirements of regulations as system design options are considered. Ensure technical systems and business model meet requirements.

Regulatory & Policy

10 Confirm community planning / policy measures

- a. Confirm what planning / policy measures may advance or affect the development of the system. E.g., refer to the local government’s zoning bylaw to determine whether the potential locations for the Energy Centre conform to the bylaw or require a rezoning application and approval. There may also be restrictions on building setbacks, the height of the chimney stack, and outside storage.
- b. Identify what community planning / policy measures will be used to help the system expand, encouraging or mandating connection to new buildings.

Customer

11 Test market and develop marketing plan

- a. Test the market. Talk to potential customers, and see what benefits they are interested in, and what may concern them.
- b. Based on the test, develop a marketing plan for potential customers. Develop a checklist for building owners to examine their buildings to verify suitability.

Fuel Supply

12 Soft commitment from potential fuel suppliers

- a. Obtain a letter of intent or similar soft commitment from potential wood fuel suppliers, including discussion of term of commitment, pricing, and delivery logistics.

Customer

13 Soft commitment from potential customers

- a. Obtain a letter of intent or similar soft commitment from potential customers, particularly the key anchor loads.

Community

14 Articulate and quantify benefits

- a. Extend benefit analysis from pre-feasibility study, including local economic development and GHG reduction based on the design options being considered.

Community

15 Conduct consultations and confirm next actions

- a. Engage public, stakeholders and decision makers to provide information on the feasibility study options and recommendations, and seek feedback and innovative ideas. This may happen during the Steps above and it is a critical part of the overall process. Stakeholders may include local government staff, elected officials, customers, suppliers, local experts, neighbours and other interested parties.
- b. Media releases can help position the project positively in the community mindset, generate interest among potential customers, and encourage attendance at public open houses.
- c. Confirm next actions.

Resources

- Biomass inventory assessment for bioenergy industry in Cranbrook area:
<http://www.sibacs.com/wp-content/uploads/2009/02/Pilot-Review-of-Available-Biomass-Inventoryx.pdf>
- Biomass availability study for district heating systems in Lower Mainland:
<http://www.bcbioenergy.ca/wp-content/uploads/2012/02/Complete-Biomass-Availability-Study-Feb-7-2012-Final.pdf>
- City of Prince George staff report to Council on recommendation to pursue system, with rationale including financials:
<http://princegeorge.ca/cityservices/utilities/districtenergy/Pages/Default.aspx>
- Several BC district energy feasibility studies including Revelstoke (x2), City of North Vancouver Lonsdale Energy Corporation (minor biomass component), and Prince George:
<http://www.fcm.ca/home/programs/green-municipal-fund/funded-initiatives.htm>

Build

Build

Managing risk through construction management and contracting is the objective of this stage. Deliver on time and budget while entrenching governance, financing, and contracting.

The Build Stage implements the chosen solution in the manner prescribed in the Feasibility Study. The community probably should choose to use a consultant to manage all or parts of this Stage.

Detailed work in the Pre-feasibility and Feasibility Stages will pay dividends at this Stage by helping to smooth the process. Work with experienced companies and ensure that there is sufficient contingency.

A suggested sequence of Steps is outlined below. More so than with the other Stages, this sequence may vary depending on the type and size of system, customer attributes, and other relevant considerations. Relevant Elements are shown to the left of each Step.

1 Prepare for Build

- a. Revisit feasibility analysis.
- b. Confirm plan for procurement, construction, commissioning including risk analysis and mitigation strategies.
- c. Confirm DH system accountabilities and roles.
- d. 2For projects that will be owned by the community, consider engaging an experienced consultant to act as an ‘owner’s representative’ to oversee activities in this phase if staff do not yet have the capacity or the experience to actively manage the system.

Financing & Governance

2 Confirm budget & governance structure

- a. Engage accountants and lawyers and media representatives.
- b. Refine business case and confirm budget.
- c. Refine and confirm governance considerations and structure.

Regulatory & Policy

3 Acquire permits / approvals

- a. Ensure that regulatory requirements are being met with BC Utilities Commission (if applicable).
- b. Ensure that requirements for air quality are being met with Ministry of Environment (or MetroVancouver for projects in that area).
- c. Ensure that safety requirements are being met with the BC Safety Authority.
- d. Ensure that the construction is consistent with the community’s planning policy, and that all permits and a business licence (as applicable) have been obtained.

Regulatory & Policy

4 Design contract structure

- a. Design structure of customer contracts with lawyers.
- b. Set monthly, or annual or volume rates.

- Customer

5

Marketing

 - a. Deliver marketing plan to engage customers, particularly the anchor loads.
 - b. Engage media to prepare / deliver regular updates of the initiative.
- Customer

6

Sign customer contracts

 - a. Sign contracts with customers.
- Fuel Supply

7

Confirm fuel supply

 - a. Contact chosen fuel supplier(s).
 - b. Confirm fuel quantity and quality, and delivery logistics, again.
 - c. Check again that fuel needs can be met by an alternate supply. This may be needed for fuel security (and potentially for financing).
 - d. Design & sign long-term fuel supply contract if possible, with assistance of lawyer.
- Financing & Governance

8

Apply for financing / funding

 - a. Apply for financing / funding and monitor process.
- Energy Centre

9

Issue Request for Proposals (RFP) & select vendors

 - a. Engage engineering consultants to develop detailed specifications and drawings for system.
 - b. Refine cost estimates as required.
 - c. Establish selection criteria, define requirements carefully, confirm qualified vendors, develop preferred contract terms, release RFP(s), evaluate responses, conduct further negotiations as required, refine business case if required, and negotiate final terms.
 - d. Select vendors for energy centre and components, distribution pipes, energy transfer stations, civil works, welding / plumbing of pipes.
- Distribution

10

Continue engagement with stakeholders

 - a. Continue engaging stakeholders regarding the process, e.g., impacts on the area of the community to be affected during construction, including traffic management. Continue communicating benefits of the system.
- Customer

11

Construction

 - a. Manage construction, including energy centre, excavation of pipe trenching, pipe connections, & restoration, and customer energy transfer stations.
 - b. Coordinate among parties, and time inter-related tasks.
- Community

12

Develop organisational structure

 - a. Develop organisational structure including job descriptions, reporting structures, performance monitoring and management, and decision making authorities.
 - b. Hire and train staff.

Fuel Supply

13 First fuel delivery for testing / commissioning

- a. A delivery of wood fuel is required for testing / commissioning of the boiler.

Energy
Centre**14 Testing and commissioning**

- a. Testing and commissioning of the energy centre, including wood fuel boiler and backup / peaking boiler.
- b. Conduct inspection, testing, cleaning and flushing of pipe network.
- c. Testing and commissioning of customer energy transfer stations.

Distribution

Customer

Regulatory &
Policy**15 Implement supportive planning / policy measures**

- a. Implement the selected community planning and policy measures to encourage or mandate DH connections among new buildings.

Resources

- Revelstoke Community Energy Corporation, information on construction of the Energy Centre, distribution network, and on local wood fuel supply: www.revelstokecommunityenergy.ca
- City of Prince George, energy supply agreement bylaw with local mill, including background information: <http://princegeorge.ca/cityservices/utilities/districtenergy/Pages/Default.aspx>
- District of Lillooet wood pellet heating system case study by David Dubois for the Green Energy as a Rural Economic Development Tool Project, on project development, and building upgrades & retrofits: <http://www.ruralbcgreenenergy.com/project-case-studies>

Reliability and Cost: Operation & Maintenance

O&M

Utility operations are optimized to be lean, reliable, safe, and low cost. This requires fine tuning from experience, quality control, established procedures, and billing efficiency.

The Operations & Maintenance Stage is where the project proponent takes full charge of the project. If the proponent has carefully conducted the earlier Stages it will reap the rewards at this Stage. Teething problems and a steep learning curve can be expected initially, but ultimately the project will enter into a rhythm of operations & maintenance while the community enjoys the benefits.

A suggested sequence of Steps is outlined below. More so than with the other Stages, this sequence may vary depending on the context. Relevant Elements are shown to the left of each Step.

Fuel Supply

1 Manage wood fuel deliveries

- a. Monitor fuel quality as required, initially with each delivery, to confirm that specifications are being met, including: moisture content, dimensional consistency, contaminants, bark content (which affects ash volume), or dry fine particles / sawdust (which can increase air emissions).
- b. Ongoing management of contingency plans for poor/no fuel delivery.
- c. Process payments to supplier.

Energy Centre

2 Manage the energy centre

- a. Document operational procedures so that any new staff can quickly understand and execute processes.
- b. Manage regular periodic maintenance and emergency maintenance.
- c. Plan and conduct regular re-commissioning and continuous optimization.
- d. Monitor ongoing performance of system components and overall system including customer heat load profiles, and adjust the relevant sections of the business plan if required.
- e. Manage disposal of ash on a regular basis in the prescribed manner.
- f. Maintain oversight on the contingency plans.

Regulatory & Policy

3 Air quality monitoring, if required

- a. Monitor air quality regularly if required for compliance with air quality permits.

Distribution

4 Manage the distribution network

- a. Inspect drains and vents to assure their condition and operability.
- b. Inspect vaults for water ingress and corrosion and maintain as required.
- c. Monitor water quality for evidence of corrosion or fouling. Take corrective actions when required.
- d. Exercise valves once a year at a minimum.

Customer

5 Manage customer billing and support

- e. Arrange for a location provider to identify location of underground piping when requested.

Regulatory & Policy

6 Consider expansion opportunities

- a. Identify opportunities for system expansion including consideration of location of future civic, public sector facilities and other building development.
- b. Consider changes to existing policy / planning levers to encourage / require connection to the DH system, or consider additional measures.

Financing & Governance

7 Ongoing financial monitoring and reporting

- a. Manage ongoing financial monitoring, reporting, and management including long-term financial health of the system, and apply asset management practices including funding the renewal of capital assets.

Regulatory & Policy

8 Manage rate reviews

- a. Plan and manage rate reviews. This may need to be done with the approval of the BC Utilities Commission (BCUC).

Community

9 Promote the successful system

- a. Report to the community on the benefits being achieved.
- b. Apply for recognition through awards and other programs.
- c. Integrate into your community’s identify (e.g., branding), including providing information on community website.
- d. Take tour groups around system.
- e. Conduct presentations at conferences.
- f. Provide information for case studies.

Regulatory & Policy

10 Stay current on evolving regulations

- a. Regulations will evolve, and it is important to remain up-to-date.

Resources

- Revelstoke Community Energy Corporation, information on district energy system operation and financials: www.revelstokecommunityenergy.ca
- Overview of eight BC district energy systems (and one distributed energy system) with regulation, finances, and operations issues discussed in the Pacific Institute for Climate Solutions (PICS) funded report, ‘The Regulation of District Energy Systems’: http://pics.uvic.ca/sites/default/files/uploads/publications/WP_District_Energy_May2012.pdf
- District of Lillooet wood pellet heating system case study by David Dubois for the Green Energy as a Rural Economic Development Tool Project, on operations and permitting issues, operating costs, project finances, fuel quality and handling: <http://www.ruralbcgreenenergy.com/project-case-studies>

Appendix

A: Elements Basics

This section provides an overview of the basics regarding each biomass district heat consideration, repeated below for convenience.

Community	Taking the time for dialogue on local government priorities , stakeholder considerations, and co-benefits
Customer	Identifying, understanding, evaluating, contracting, connecting, serving, and billing customers
Fuel Supply	Understanding and monitoring short and long term availability, type, moisture content, cost, consistency
Energy Centre	Sizing, selecting, costing, configuring, operating and maintaining
Distribution	Optimizing type, length, and cost of pipe and customer connection
Finance & Governance	Grants, ownership models, decision-making and rate-setting, business case / model and risk management
Regulatory & Policy	Protecting customers, air, and workers. Local supportive policies and regulations

Community

Consider benefits such as greenhouse gas reduction and local economic development. The local government can influence the success of a DH solution. Consider talking to staff and elected officials early.

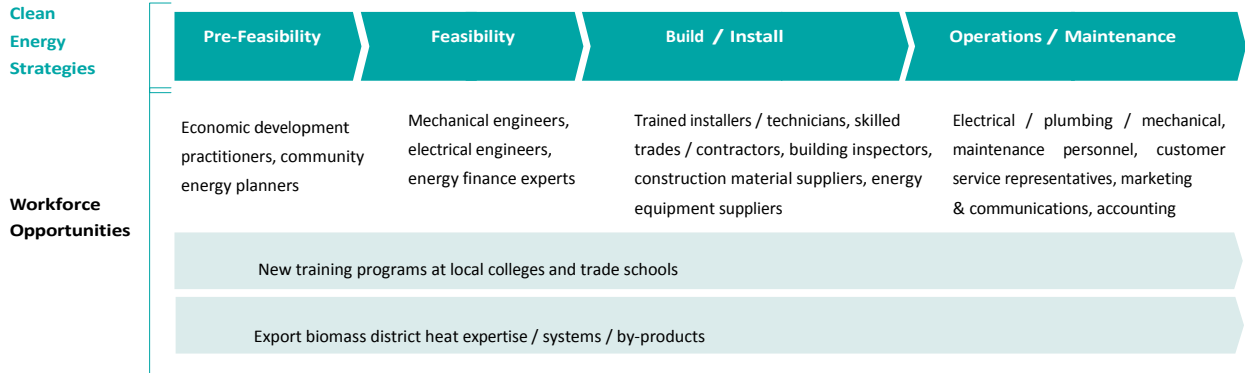
Communication

One of the first things to consider related to community is ‘who is the community’ that are important to communicate with and what might be important from their perspective. (Source: *Clean Energy for a Green Economy*, Community Energy Association)



Local Economic Development Benefits

A biomass district heat solution can help to encourage rural economic diversification, and the creation of a range of green job options for workers. As the biomass district heat solution moves through its Stages, there will be needs for technical, professional, and general assistance as well as the potential to train and develop expertise which can then be exported to other communities as shown in the table below. (Source: *Clean Energy for a Green Economy*, Community Energy Association)



When calculating local economic development potential, do not forget to consider the impact of economic multipliers. Multipliers indicate how much of an impact an investment in a given sector will have on employment and GDP growth. Constructed from economic models and maintained by government departments such as Statistics Canada, they are the basis on which governments and industry make announcements like “This project will create 400 new jobs.” When an investment is made in an industry, there are employment effects at three levels: direct, indirect and induced.

- **Direct** effects are the jobs created in the industry where the investment is made.
- **Indirect** effects are the jobs created in industries that supply the inputs to the industry where the investment is made.
- **Induced** effects are the jobs created by spending of the workers noted above on other goods and services.

Multiplier tables provide employment numbers measured in “person-years.” There is no standard for converting person-years of employment into jobs, as different employment positions last for different periods of time. Often, one person-year of employment is referred to as one job. (Source: *Jobs, Justice, Climate: Building a Green Economy for BC*, Columbia Institute).

Customer

It is imperative that there is success in developing a customer base for the DH system.

The technical viability of the connection with the customers is often best dealt with by an experienced engineer or installation firm, in communication with the customer.

Customers that have bigger heat consumption closer together are easier to economically serve, especially if they need heat at different times from each other. Understanding the aggregated heat load profile, costs, and energy saving opportunities can be helpful before finalizing design. Not everyone has to be connected at once.

Small loads can be served through pellet stoves or boilers until the conditions develop to connect them to the district heat system.

A communications and marketing strategy would help to ensure success in building a customer base. Maintaining community support and being open and forthcoming with information will help with attracting potential customers. Understanding customers, their behaviour and technical constraints is

also key. It may be important to emphasise value over price, and to ensure that the contract is well-designed.

Local government and Provincial buildings are the most likely anchor loads from which the solution can be expanded to other buildings. Attracting customers may be difficult at first given that energy is often not a top priority for building owners. Obtaining contracts from anchor customers prior to DH construction is recommended to manage risk. Supportive municipal policies can also help with encouraging connections to new buildings.

For the ongoing viability of the DH system, it is important to carefully consider contracts, including pricing mechanisms (we recommend levelized cost of service with regular reviews). Cooperation agreements on the customer’s equipment can also be beneficial to ensure that their equipment behaves in the way that is anticipated.

Fuel supply

The best fuel is dry, clean, guaranteed and consistent. Moisture content varies widely and will affect total energy and cost as depicted in the diagram at the side.

Guaranteeing long term fibre supply can be difficult so consider risk management and understand what prices will work for the system and its customers. A community forest could be a backup supply if the spot market tightens.

The following table provides general guidance on common wood fuel sources. It is difficult to provide general guidance regarding the compatibility of various scales of biomass

boiler with different wood fuels, and so consultants or biomass boiler suppliers / installers must be consulted. Samples of fuel can also be sent to biomass boiler suppliers / installers for testing, so that it can be verified that both the boiler and fuel handling systems can use the fuel. Usually, the greater the capacity of the bioenergy system, the more flexible it can be with the fuel it accepts. In addition, the tighter the specifications and consistency required for wood fuel, the more expensive it will likely be.

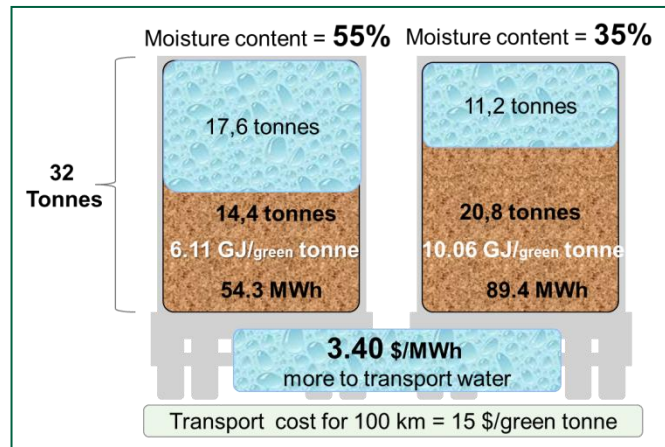


Figure 4 Impact of moisture content on wood fuel transportation cost. Source: FPInnovations

	Pellets	Small dimension chip (e.g., 1 & 1/6" minus)	Pulp chip or equivalent (e.g., 2" minus)	Hog Fuel, or waste wood
\$/BDt, delivered	\$150-310	\$50-100	\$50-100 Cost likely < G30.	\$30-100 Cost likely < G50.
\$/GJ	\$8-18	\$4-8	\$4-8	\$2-5
Consistency	Excellent		Consistency will vary depending on supplier	
Supply	Wood pellets on small scale available almost throughout BC. Larger scale deliveries may be expensive to procure locally. Delivery distance affects cost.	Hard to procure in BC. Some wood chippers can produce a high quality small dimension chip, but unlikely that any European specifications can be precisely met in BC. Delivery distance affects cost.	Often available from sawmills, or many wood chippers can produce an equivalent sized chip. Delivery distance affects cost.	Suppliers should be able to deliver hog fuel throughout BC. Can be produced by chippers or grinders. Delivery distance affects cost.

Sources: multiple sources, including FPInnovations, Wood Waste 2 Rural Heat, and Biomass Availability Study For District Heating Systems, by BC Bioenergy Network and Envirochem.

Energy centre

Since biomass boilers have higher capital costs and operating costs than fossil fuel boilers, the recommended approach is to size the biomass boiler for base load and use a fossil fuel boiler for peaking. Major components of the Energy Centre are described in the table below.

Component	Description
Biomass boiler	The central component of the entire biomass DH system. Various types of boiler are available, although most biomass boilers at this scale of ~100kW to ~3MW are likely to be a variation of a grate type furnace with a fire tube or water tube boiler. (Source: FVB Energy) Grate type furnaces have a wider tolerance of fuel type compared to some other boiler types (e.g., plane grate, or stoker burner).
Back up / peaking boiler	A critically important component is a boiler for backup and/or peaking. These are generally heated by natural gas, propane, or heating oil. Having sufficient backup may be a condition for financing the system.
Wood fuel store, and fuel transfer / feed system	<p>Wood fuel will be unloaded into the store, where it's automatically fed into the boiler. The wood fuel store needs to be appropriately located to allow a delivery vehicle to easily manoeuvre and deliver.</p> <p>Appropriate design of the fuel store and feeding mechanism are critical. They must be designed so that fuel can be delivered with a minimum of time and effort on the part of the wood fuel supplier (e.g., the store should be able to easily accept a full load delivery from the fuel supplier), and the fuel feed mechanism must be as reliable and simple as possible and be suited to the wood fuel that will be delivered. Some fuel feed / transfer systems are better able to handle a range of particle shapes and sizes than others, e.g., walking floor and ram stoker.</p> <p>The size of the fuel store is also important. If it is too small then logistical problems may result. If it is too large then there is the risk of biological activity, particularly with higher moisture content wood fuels.</p> <p>Fuel delivery and storage can be designed differently for wood pellets versus wood chips because of their different properties, e.g., pellets can flow more easily.</p>
Flue gas cleaning	<p>In some cases flue gas cleaning may not be required, but generally it is recommended. Three technologies are available:</p> <ul style="list-style-type: none"> • Cyclone filter – cheapest but least effective. Robust. Efficient for large particles. Suitable for smaller systems. For chip, reduces particulates to 70-80 mg/MJ depending on fuel ash content. For pellet, to ~40 mg/MJ. • Bagfilters – most effective, but sensitive to high temperatures. Efficient for large and small particles. Relatively high maintenance. For chip, reduces particulates to 1-10 mg/MJ. For pellet, to ~5 mg/MJ. Ranges depend on bag type and fuel ash content. • Electrostatic precipitator – most expensive, but very effective. Relatively resistant to high temperatures. Efficient for large and small particles. Likely too expensive for smaller plants. Reduces particulates to 1-20 mg/MJ depending on fuel ash content. <p>(Source: FVB Energy)</p>
Ash handling system	Ash handling is mainly determined by the size and type of boiler, as well as flue gas cleaning equipment. Most systems use an auger to move the ash to a bin, which needs to be manually emptied periodically.
Burn back safety device / Fire protection system	Necessary to stop fire from burning back from the boiler's combustion chamber along the fuel feed mechanism to the fuel store. This can take the form of dousing with water, and/or automatic fuel feed shut off mechanisms.

Distribution network

Installed cost per meter of pipe can vary between \$500 and \$3,000 per meter (source: multiple sources and research including FVB Energy, district energy utilities and pipe suppliers). The cost of physical pipe is often as low as 10% to 50% of the installed cost with mechanical and civil works being the remainder. These civil costs are driven by length, roads (including traffic management while installing, resurfacing), and the presence of other utilities that have to be worked around. Savings are possible if you are planning a small system on flat ground where the buildings are close together and are not planning significant expansion, when flexible insulated PEX could be used. This is easier to install than steel insulated pipe.

The capital cost of the heat distribution system often limits the buildings that can be connected economically to the system. The example below illustrates this simple economic limitation, regardless of how the pipe connection would be financed. The average natural gas annual usage per connection for residential and commercial customers was calculated from the Community Energy and Emissions Inventories compiled by Province of BC. While this overstates total heat consumption somewhat due to the inclusion of other natural gas uses such as cooking, it is useful for the purposes of an order of magnitude calculation. An average cost of \$1,000 per meter of pipe was used for illustrative purposes since it is lower than most large systems and higher than the lowest cost system seen in BC. For this calculation, each building is assumed to be 15 meters (about 50 feet) from the closest part of the distribution network, requiring a service line run of 15 meters specifically for each building. A simple assumption was made that the owner of the system would want to recover the initial capital on the distribution network over 20 years. For simplicity, this calculation does not include interest cost or establishing a fund to renew the service line at end of life.

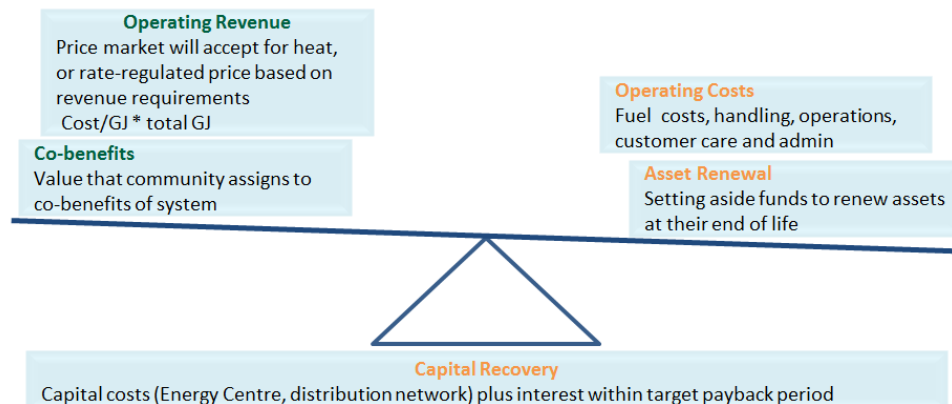
Customer Type	Average natural gas		20 yr use, GJ	Service line			
	GJ/yr	MWh/yr		Length	\$/meter	Total	\$/GJ
Commercial	582	162	11,640	15	1000	\$ 15,000	\$ 1.29
Residential	90	25	1,800	15	1000	\$ 15,000	\$ 8.33

When the capital cost as described above is divided by the energy use over 20 years, it results in \$1.29 to \$8.33 per GJ to recover the capital for the service line related to each building. In addition, the capital cost of the energy centre and distribution network would need to be recovered, as would annual fuel and operating costs.

As a comparison, natural gas is delivered in the \$10/GJ range and propane is delivered in the \$23/GJ range with variations depending on specific location in BC, customer type, and market conditions.

Finance and Governance

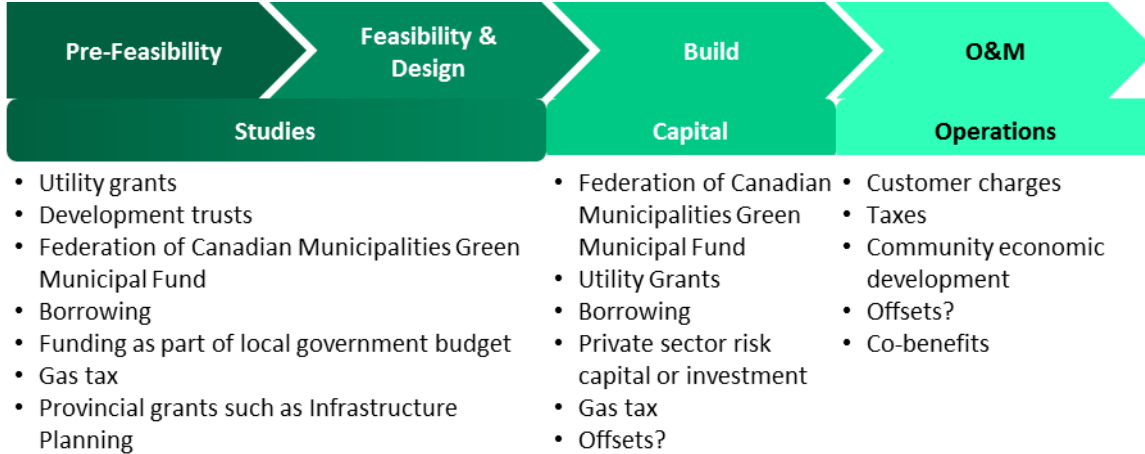
Money more than technology is the limiting factor for most DH solutions. The graphic at the side depicts the balancing that's required between operational revenue and costs to result in



sufficient operating profit to recover capital. Be clear on assumptions and sensitivity to changes in the situation. Small changes in assumptions can have large impacts over 20 years or more of system life.

Financing

The graphic below illustrates some of the funding opportunities available at each stage of a DH initiative. This is not meant to be a comprehensive list but rather to identify a sample of funding opportunities.



Governance

Ownership affects what funding is available and who takes what risks. There is no one right answer for everyone. The table below outlines the trade-offs between common ownership models.

In the table green is relatively better than alternatives, orange is worse, and yellow is moderate.

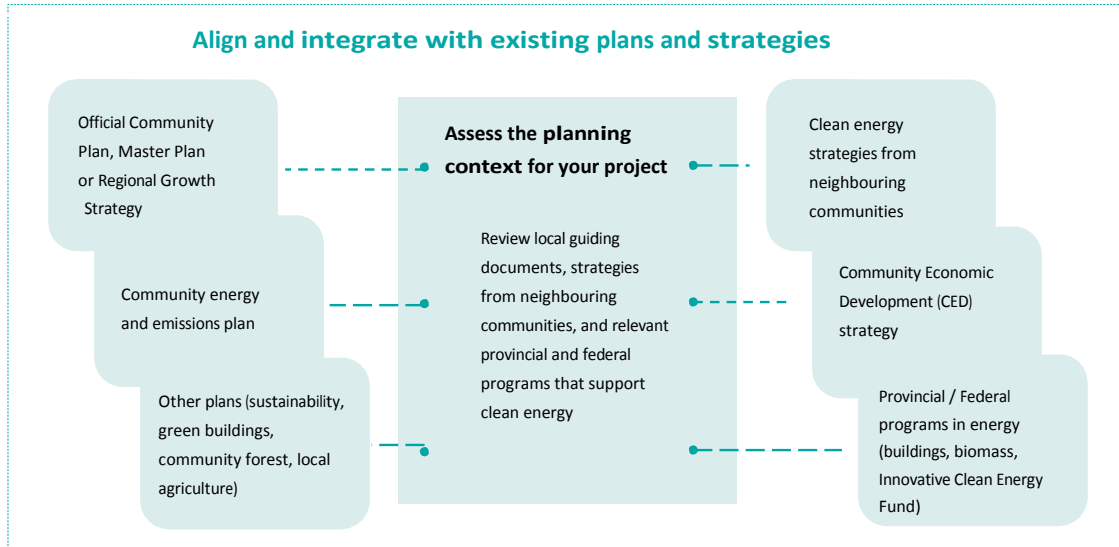
(from Green Energy Projects and Utilities: An Investment and Governance Case Study Guide for BC Local Governments and First Nations 2012)

Consideration	LG / FN 100% department	LG / FN 100% owned company	100% private Utility owned	Joint Venture / P3
Financial				
Access to capital – initial build	Yellow	Yellow	Green	Green
Access to capital – expansion	Orange	Orange	Green	Green
Cost of borrowing	Green	Green	Orange	Yellow
Non-tax revenue source	Green	Green	Orange	Yellow
Access to grants	Green	Green	Orange	Yellow
Local government financial risk	Orange	Yellow	Green	Yellow
Can withstand years of losses	Yellow	Green	Green	Yellow
Ability to capture offset attributes	Green	Green	Orange	Yellow
Operational				
Technical expertise	Orange	Orange	Green	Green
Operational flexibility	Orange	Yellow	Green	Yellow
Admin and monitoring scale	Orange	Yellow	Green	Yellow
LG/FN insulation from oper. risk	Orange	Yellow	Green	Yellow
Alignment with public interest	Green	Green	Orange	Yellow
Simplicity				
Complexity of structure	Green	Yellow	Yellow	Orange
Overall simplicity for LG/FN	Yellow	Orange	Green	Orange
Other				
BCUC regulation burden	Green	Green	Orange	Yellow
Transparency of rate setting	Orange	Orange	Green	Yellow
Limits political interference	Orange	Yellow	Green	Yellow
LG/FN political risk	Orange	Yellow	Green	Yellow

Policy and Regulation

The regulatory environment is changing; get legal advice or talk to the appropriate authorities. Local government policies can encourage connection to a DH system and these can be considered for system future growth.

Integration of biomass district heat as one part of an integrated energy solution into community plans can set the conditions to accelerate adoption. An overview of some of the integration that could be considered is outlined below. (from *Clean Energy for a Green Economy*, Community Energy Association 2010)



District energy should be integrated into local growth plans, encouraging development in areas serviced by the system, and planning for future expansion. Ideally, timing of laying of district energy pipes should coincide with other subsurface infrastructure work, to save costs

Understanding current applicable regulations and considering these in system design are critical to avoiding costly surprises at a later date.


Policies and regulations change. Seek legal advice or check with the regulatory authority early in the design of the project.

Municipal zoning should allow for construction of the Energy Centre close to heating loads. In addition, supportive municipal policies can provide significant assistance to the growth of a DH system over time, by encouraging or mandating new customers.

Regulations to consider include BC Utilities Commission, BC Safety Authority, Air Quality Management Branch, and local issues such as zoning, permits, and rights of way.

B: Case Studies

Fink Enderby District Energy Utility

System Overview		System Governance	
Community: Enderby	Population: 2,900	Venture Partners	No
Owner: Fink Machine Inc.	Operator: Fink Machine Inc.	Operating Agreements	No
Year Started: 2011	Connections: 8 current customers	Other Investment Sources	Financed, owned and operated by Fink
Generation Source: Biomass – local sawmills, diverted wood waste and local businesses		Rate Setting/Project Oversight	Basic utility contracts with customers
Generation Technology: Viessmann KOB Pyrot 540 kW wood-fired boiler with back up 300 kW gas-fired boiler.		Billing Method	On-line billing. Monitored by Schneid Control System
Generation Capacity: 540 kW		Legal Structures	N/A
Energy Produced: Heat ✓ Electricity x			
Distribution System: Urecon Insulated Pex Line (3 inch main) for district loop of 640 metres			
System Financing			
Phase	Cost	Funding	
Planning	Minimal: technical evaluation	Privately funded	
Construction	\$1.2 Million	Privately funded	
Operation	\$8,000/yr	\$60,000/yr average operating revenue	

1. Background

Fink Machine Inc. received approval from the City of Enderby in May 2011 to install the privately financed, owned and operated Fink Enderby District Energy System. The first customer was the City of Enderby for their outdoor pool. Fink Machine will supply ‘carbon light’ renewable energy from wood biomass to 12 individual customers, providing space heating, domestic hot water and pool heating. The underground grid supply line is 640 m. The Fink Machine biomass district energy system is the first of its kind operating as a private utility under 1 MW in western Canada. There are over 1,300 biomass systems of this kind in Austria.

2. Cost/Benefit

Private funds were used to evaluate feasibility for the system but this was not a feasibility study in the current sense. Cost and consumption data, type of buildings and their heat loss and current energy costs were assessed. Technical costs depended upon the size of buildings and the capacity of pumps to maximize efficiencies. The cost of completing this work was negligible.

District heating lines have been installed at \$400/meter. The cost to a customer interested in a system like this is around \$1.2 million. This is an affordable system that has changed the dynamics of the industry. Payback is around 10 years providing that all customers are on-line.

3. Governance

The system is owned and operated by a private utility. City of Enderby senior staff and Council embraced the proposal by Fink Machine and helped expedite the process. Time between concept to operation was

less than two years. Representatives from Lumby, Vernon and Peachland have visited the Fink Enderby District Energy System and are now seriously comparing this form of renewable energy and all the benefits it brings to the local economy. Fink Machine has basic utility contracts arranged with customers. A Schneid system measures flow and bills customers. The learning curve for customers is reasonable. Fink Machine provides training at installation and ongoing support when needed. Interaction with the system is computerized and billing is on-line.

4. Operation

A Viessmann Pyrot KRT-540 kW wood-fired boiler was commissioned as the system's primary source of space heating, domestic hot water and pool heating. The fully-automatic Pyrot achieves efficiency of up to 85% while keeping emissions to a minimum. A 300 kW gas-fired boiler provides backup and additional capacity during peak loads. A custom-built timber frame boiler house includes a district fuel bunker with a capacity of 50 tonnes, which allows two 53-foot trailers to unload simultaneously. An automated walking floor delivers fuel from the storage bunker to the Pyrot's feed auger. When fuel gasification and combustion are complete, an automated de-ashing system extracts ashes from the combustion chamber and transfers them to a bin. An ash removal auger extracts the ashes into a large external container once they have cooled. The Pyrot boiler feeds an 8,400 L water buffer tank before distributing heated water to transfer stations and customers through a 640-metre main line consisting of three-inch insulated Urecon PEX pipe.

Fink Enderby District Energy's 'carbon light' wood biomass fuel is supplied by local sawmills, wood product manufacturers and wood waste diverted from landfills and businesses within a two-hour radius. Area landfills are now modifying their material recycling facilities to create wood biomass fuel. Once fully operational, the system is expected to consume 800 tonnes of renewable wood fuel annually while helping to mitigate approximately 425 tonnes of greenhouse gases. Customers save 10-18% on utility bill from improved heating efficiency, avoid payment of carbon taxes (reducing costs by 10-12%), and no longer need to purchase or repair their own heating systems.


5. Lessons Learned

- The project is successful. Biomass district energy systems are not overly complicated in terms of design.
- Goal is to replicate the system in different communities using Enderby as a benchmark, which will provide cost savings on system design.
- It is important to monitor work being performed by contractors and subcontractors so that costs stay in line. Ensure that the boiler room is built large enough to support system expansion.
- Communities who are updating utility lines should consider installing district energy infrastructure at the same time, this will eliminate the cost of retrenching, reducing the cost of the system further.
- Fink Machine has demonstrated that a biomass district energy system can be installed and operated effectively for less than \$1 million in an area where natural gas is a preferred fuel. Project done well by setting new benchmark for biomass DE systems. Smaller communities in particular may wish to consider avoiding the high costs of detailed technical and economic feasibility studies.

6. References and Links

Stephen Bearss, Renewable Energy Representative, Fink Machine Inc. www.finkmachine.com

Revelstoke Community Energy Corporation Utility

System Overview		System Governance	
Community: Revelstoke	Population: 7,300	Venture Partners	No
Owner: Revelstoke Community Energy Corporation (RCEC)	Operator: RCEC	Operating Agreements	Operating Service Agreement with Downie Timber for shared cost of an operator. 20 year wood fuel supply agreement with Downie. Agreement to supply steam for sawmill dry kilns. 20 year energy supply agreements with each customer.
Year Started: 2005	Connections: 10 buildings	Other Investment Sources	Loan from Revelstoke Community Forestry Corporation, \$1.25M
Generation Source: Biomass (sawdust) from the Downie sawmill		Rate Setting/Project Oversight	Rates are based on each customer's avoided cost, with a goal of setting rates 5% less than these costs (i.e., estimated energy costs and maintenance and amortization of boiler over 20 years)
Generation Technology: 1.5 MW biomass boiler with 1.75 MW backup propane boiler		Billing Method	Billed according to metered energy use
Generation Capacity: 3.25MW		Legal Structures	City of Revelstoke established wholly owned subsidiary for energy corporation
Energy Produced: Heat ✓ Electricity x		<p>Figure 6 RCEC energy centre. Photo Credit: RCEC</p> 	
Distribution System: Steam for Downie's dry kilns and hot water for district energy system are distributed through 2.3 km of insulated piping			
System Financing			
Phase	Cost	Funding	
Planning	\$10,000 (heat only feasibility study)	Federation of Canadian Municipalities grant, 2003	
Construction	\$6,990,000	Towns for Tomorrow: \$380,000 FCM GMF grant: \$1.8M Revelstoke Credit Union: \$1M FCM GMF Loan at ~3.5%: \$1.35M City Preferred Share Purchase: \$1.2M	
Operation	2011 operating cost: \$577,000 (amortization of \$153,500 included in expenses) 2012 operating cost: \$620,000 (amortization of \$157,600 included in expenses)	Annual revenue: \$641,000/yr Cost Savings: Energy rates are indexed to the cost of living and customers are relieved from volatility of propane prices.	

1. Background

Air quality was a serious concern for the citizens of Revelstoke, in part because of emissions from the annual incineration of about 70,000 tonnes of wood residue in a beehive burner at the Downie Mill. Various studies and plans completed throughout the 1990s suggested that a district heating system could be a solution to both Downie's wood residue disposal costs and the community's reliance on propane as a heating source.

The City initially considered a combined heat and power solution which proved not to be economically feasible. The City decided to pursue a heat only project, and construction began in late 2003 with operation starting in June 2005. The first six buildings were connected over the next two years and in 2009-2010 four buildings were added. The City is now considering expanding the plant and adding co-generation capacity.

In 2004, RCEC received the Energy Aware Award from the Community Energy Association. In 2005, it received a Sustainable Communities Award from the Federation of Canadian Municipalities. RCEC is considered a valuable community asset.

2. Cost/Benefit

Funds of nearly \$7 million were required to design/build the plant and initial distribution pipes: \$3M for the central plant and equipment; \$2M for various construction phases; \$1.1M to install energy transfer stations and \$0.9M for construction financing, developer's costs, etc. This was funded and financed by a combination of grants, debt, and equity, as shown in the table above.

The system displaces 3,400-3,700 tonnes/year of greenhouse gas emissions while providing a non-taxable, non-tax source of City revenue, improving local air quality, and saving customers money on their heating.

Simple payback for the project is 13 years, return on investment is 5.3%, and return on equity is 8.8%.

3. Governance

RCEC is a wholly owned subsidiary of the City of Revelstoke. The City appoints a Board of Directors to run the corporation, which includes three City Councillors, one City staff member and three appointed community members. The plant is located at the Downie mill, and RCEC and the City jointly fund an experienced Downie employee to operate the energy plant part-time. RCEC has a secure 20 year biomass fuel supply agreement with Downie Timber and an agreement to supply steam for the sawmill dry kilns.

Contracts are for 20 years and are linked to inflation. The price of energy specified in newer contracts will be 85% dependent on BC's consumer price index and 15% on the energy price index.

4. Operation

Boilers heat the heating medium (oil) which is passed through a steam generator for delivery of steam to Downie's dry kiln, and passed through heat exchangers generating hot water that is distributed into 2.3 km of insulated district energy pipes. 50% of the heat generated is used as steam for Downie's dry kilns and 50% for heating and domestic hot water for major buildings in the city. Each building connected to the system has a heat exchanger that extracts the heat from the hot water and transfers this heat to the building heating systems, which usually includes space heating and domestic hot water. Each building also has a meter to monitor use for billing. The propane boiler provides backup and peaking capacity for the coldest times of the year. The project aims to use 85% of heat from biomass and 15% from propane annually.

There is a cyclone and electrostatic precipitator on the system to ensure clean effluent gases. The fuel bin holds a 2-3 day supply of fuel.


5. Lessons Learned

- Ensure that the original projections have lots of contingency built in and that all project timelines are reasonable.
- Having all customers connected to the system from the beginning would have been beneficial.
- There was a learning curve on boiler operation including fuel feed modifications (from hog fuel to sawdust) and adjustments for variations in the sawdust over the year.
- Unforeseen operational issues included: original heat exchangers failed and had to be replaced; water for heating was contaminated with thermal oil, originating from leaking tubes in the steam generator; steam generator and combustor pipe corrosion occurred despite following prescribed water procedures; replacement of an inferior quality refractory was required in year 4; and there was a fire in the hydraulics room in December 2009, justifying the existence of the propane backup boiler.
- Qualified backup staffing is a problem in small communities.
- Small plants lack economies of scale.
- Concluding energy supply agreements is challenging because seasonal boiler efficiency is difficult to explain and energy pricing for customers is based on “avoided costs,” which can lead to disagreements. Energy supply contracts with customers must provide means to recover unexpected costs. This led to the modification of the price adjustment clause in our newest energy supply agreements.
- Awareness of DE lacking in key Federal and Provincial government departments, but it is growing due to legislative requirements now in place in BC.
- Important to have a committed Council with a will to complete the project over an extended period of time and a Community Energy and Emissions Plan to give future direction.
- Other important items were: broad support from an informed, confident community; a project champion; hiring of proven, effective staff & consultants; luck and timing.

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 CEA "Clean Energy for a Green Economy"

Dockside Green Community Energy System

System Overview		System Governance	
Community: Victoria	Population: 84,000	Venture Partners	Vancity, Corix Utilities, Terasen Energy Services (now Fortis)
Owner: Dockside Green Energy (DGE) LLP	Operator: Corix Utilities	Operating Agreements	Multi-year contract: Corix Utilities contracted by Dockside Green Energy for operation, maintenance and customer service
Year Started: 2009	Connections: 200 customers now; 1,100 at completion	Other Investment Sources	Natural Resources Canada, Technology Early Action Measures (TEAM) \$1.5 million FCM Green Municipal Fund \$350,000
Generation Source: Biomass (locally sourced, clean urban wood residue)		Rate Setting/ Project Oversight	Rates are governed by the British Columbia Utilities Commission (BCUC). Corix developed the initial rate design and will review and update it as required by BCUC. Corix will make regular filings to BCUC after approval by DGE
Generation Technology: Nexterra biomass gasification process creates syngas for boiler, with 3.4 MW natural gas backup system		Billing Method	Meter Reading and billing; Customer Service Agreements
Generation Capacity: Biomass rated capacity of 2MW – at peak capacity consumes 1.1 tonnes of wood fuel/hour		Legal Structures	Dockside Green Energy LLP Hydronic Energy Services Terms & Conditions
Energy Produced: Heat ✓ Electricity x		<p>Figure 7 DGE energy centre. Source: Nexterra</p> 	
Distribution System: District energy system			
System Financing			
Phase	Cost	Funding	
Planning			
Construction	\$6.1 million (total development project) \$1.5 million (utility only) Total system construction costs, including project management \$8.27 million	Natural Resources Canada, Technology Early Action Measures (TEAM) \$2.45 million FCM Green Municipal Fund \$350,000	
Operation	Confidential	Cost savings (building energy needs reduced by 80%)	

1. Background

Dockside Green was built on a 15 acre (6.1 ha) brownfield site in Victoria’s Inner Harbour. Victoria City Council required numerous sustainable community features as a condition of sale, including development of a district heating system. The resulting “micro-utility,” Dockside Green Energy LLP (DGE) is an investor-owned DE utility and Canada’s first urban gasification facility.

This utility is one of 16 founding projects in the Clinton Climate Initiative’s Climate Positive Development Program. Currently the biomass gasification plant provides more than enough heat for the development.

In the future, if off-site energy sales were increased, the treatment plant could be modified to capture heat for sale to the district energy grid. This would allow the recovery of yet another valuable resource, further offsetting GHG emissions and potentially offsetting costs for utility customers.

2. Cost/Benefit / Finances

Dockside Green secured federal funding to offset some capital costs of the Dockside Green Energy system through Technology Early Action Measures (TEAM). TEAM is primarily led by Natural Resources Canada, Environment Canada and Industry Canada. TEAM funding of \$2.45 million was used to offset capital costs of constructing the DGE. A grant from the Federation of Canadian Municipalities was used, amongst other things, to offset regulatory costs, including amendments to the BC Waste Management Act.

Vancity Credit Union provided \$20 million in equity to the Dockside Green project and has first right of refusal for financing all buildings and utility systems. Vancity also posted a \$25 million guarantee for the project to the City for the various commitments made by the developer. Dockside Green Limited Partnership set aside \$1.5 million towards the biomass system with no expectation of return on investment (ROI) to assist overcoming the barriers of utilizing a central biomass system.

CO₂ savings per year are expected to be 2,361 tonnes when the plant is at full operation.

3. Governance

DGE is a utility established to provide space heating and hot water through joint partnership of Vancity Capital Corp, Terasen Energy Services Inc. (now Fortis), and Corix. Corix is also contracted by DGE for operation, maintenance and customer service. DGE initially considered entering into a partnership with the City of Victoria to avoid BC Utility Commission (BCUC) regulation, but was advised that partial municipal ownership would still be subject to BCUC jurisdiction.

DGE bills each strata corporation a monthly fee based on the total area of the space in the building, measured in square metres, and for the amount of energy used by each strata as measured by the consumption meter located in each building complex. The strata for each building complex in turn charges residents. In-suite meters are owned and operated by the strata.

To keep rates competitive, DGE proposed to:

- extend the system to serve off-site buildings, particularly a large hotel;
- Enter into a fixed price turnkey contract for the Nexterra system;
- Create a 50% fixed/50% variable rate design;
- Develop a 20 year levelized rate structure, to provide a reasonable rate in the early years and a deemed capital structure of 60% debt and 40% equity;
- Enter into a fixed price, long-term biomass contract;
- If operating cash flows are less than the principal and interest payments on the utility's debt, the developer will make up the shortfall by way of non-interest bearing contributions repayable over six years beginning in year 15; and
- Defer depreciation for the first seven years, and depreciation over 50 years starting in year eight.

The BCUC approved utility rate for 2011 was \$0.24/m²/month (fixed) plus \$14.07/GJ (variable), escalating at 3% per year through 2018. The annual bill for a 100m² condominium is around \$600 per year.

4. Operation

The system 'gasifies' biomass to create 'syngas'. Burned in a boiler just like natural gas, syngas will create heat for space and hot water needs for the 1.3 million square feet of Dockside Green's

residential, office, retail and industrial space. As of 2012, the system provides heat and hot water to four residential and two commercial buildings.

The system requires only 3,000 tonnes of bone dry waste wood per year, the equivalent of 110 B-train truckloads of wood. Air emissions from the system are 50% below BC's most stringent requirements for particulate matter.

5. Lessons Learned

- The property development market is unpredictable. DGE has experienced several challenges in its first few years of operation. Soft market conditions slowed construction, resulting in lower than forecast loads and revenues. With a much smaller load factor, running the biomass plant was not practical, and the plant has been using the natural gas boilers to supply customers. An expected contract with the Delta Hotel will provide the new load needed to run the biomass system, once a reliable biomass source is found.
- Ensure availability of suitable local wood waste before building the energy plant. The original provider of biomass failed to deliver. DGE continues to seek alternative supply sources, with moisture content, foreign objects, and contaminants (e.g., nails, glue) providing challenges.

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FortisBC

Nexterra Project Profile, "Dockside Green Biomass Gasification System"

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C: Survey of District Heating Systems in BC – 2012

Through research conducted as part of the “PROVINCE OF BC INTEGRATED COMMUNITY ENERGY SOLUTIONS PROGRESS REPORT”, the following list of district (multiple clients) and discrete (single client but multiple buildings) systems was developed. It is provided here for reference. The systems listed below have diverse fuel sources including some with biomass. Many more DH systems are progressing through visioning, planning, and development.

Location	Project – both biomass and non-biomass systems	D, C, O - Development, Construction, Operating
Burnaby	BCIT	O
Burnaby	Simon Fraser University / UniverCity	O
Colwood	Juan de Fuca Pool, Arena and Curling Club	O
Enderby	Fink Machine in Enderby - Biomass	O
Gibsons	Geo-Exchange DEU for Upper Gibsons	O
Kelowna	Okanagan College District Heating from Sewage	O
Kelowna	UBC - Okanagan	O
Kitimat	Sam Lindsay Aquatic Centre/ Tamitik Arena	O
Langford	Westhills Langford DE Sharing System	O
Langley, Surrey	Kwantlen Polytecnic university	O
North Vancouver	Lonsdale Energy Corporation Hydronic Service Bylaw	O
Prince George	Baldy Hughes Therapeutic Community (BHTC) - Biomass	O
Prince George	City of Prince George - Biomass	O
Prince George	UNBC Turnkey Gasification Heating System - Biomass	O
Revelstoke	Revelstoke Community Energy System - Biomass	O
Richmond	River Green (Olympic Oval) "waste heat and water recovery"	O
Richmond	Alexandra District Energy Utility	O
Surrey	Surrey Memorial Hospital	O
Tofino	Ty Histanis DE energy geoexchange (Tla-o-qui-aht First Nation)	O
Vancouver	Southeast False Creek Neighbourhood Energy Utility (NEU)	O
Vancouver	Downtown Vancouver heating, a.k.a. "Central Heat Distribution"	O
Vancouver	UBC - Biomass	O
Vancouver	Pacific Health Services Authority's Min -District Energy System	O
Vancouver	River District Energy (south-east Vancouver, "River District")	O
Victoria	University of Victoria	O
Victoria	Dockside Green Community Energy System - Biomass	O
Victoria	Dockside Green Wastewater Treatment Plant (WWTP) in Victoria	O
Whistler	Whistler Athlete's Village District Energy Sharing System (WAVDESS)	O

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E: List of Acronyms and Conversion Factors

Acronyms

Acronym	Definition
BC	British Columbia
BCUC	BC Utilities Commission - regulator of public utilities including heating companies
CARIP	Climate Action Revenue Incentive Program - a conditional grant from Province of BC to Local Governments who have signed on to the climate action charter and report progress. The grant is the equivalent of the carbon tax paid by local governments in their operations for the preceding year.
CEA	Community Energy Association
CEEP	Community Energy and Emissions Plan (or Planning)
CHP	Combined heat and power
DE	District energy – the delivery of one or more of heating, cooling, and electricity to two or more buildings
DH	District heating – the delivery of heat to two or more buildings (a subset of DE)
FCM	Federation of Canadian Municipalities
GHG	Greenhouse gas (in carbon dioxide equivalents)
GJ	Gigajoule (10^9 joules)
kW	Kilowatt (10^3 watts)
kWh	Kilowatt hour (10^3 watts x 1 hour)
LFG	Landfill gas
MOU	Memorandum of understanding
MC	Moisture content – the percentage of moisture present in wood by weight
MW	Megawatt (10^6 watts)
MSW	Municipal solid waste
NRCan	Natural Resources Canada
ODt	Oven dried tonne (also known as bone dried tonne or bdt) – wood in a state such that further heating does not reduce moisture content
OCP	Official Community Plan
RETSscreen	Renewable energy and energy efficiency project analysis software

Conversion factors

Measure	Converts To
1 oven dried tonne (ODt) of wood	5,300 kWh
1 tonne of wood pellets (~9% MC)	4,800 kWh (net)

Terms

Term	Definition
Biomass	Biological material, usually plant-based. In this Guide Biomass refers predominately to wood and waste wood materials which may be processed or unprocessed. This includes but is not limited to pellets, pucks, chips, hog fuel, sawdust, shavings, and slash.
Briquettes / pucks	See Pellets. Similar to pellets but larger.
Chip	Wood that has been cut with a 'chipper'. This generally avoids stringy material associated with grinding.
Chipper	A machine that wood is fed into and cut into small pieces.
Firesmart	A process for reducing fire interface risk. See https://www.firesmartcanada.ca/resources-library/becoming-a-firesmart-community
Grinder/ Hogger	A machine that wood is fed into and hammered into small pieces.
Hog Fuel	Wood that has been processed by a grinder / hogger, or wood fuel of a similar standard
Levelized cost of service	The levelized cost of service is defined as the constant price per unit of energy that causes the investment to just break-even: earn a present discounted value equal to zero. In other words, present discounted value of energy produced times the levelized cost equals the present discounted value of the fixed and variable costs over the life of the investment.
Pellets	Wood that has been processed into dry, consistent small forms and is typically used as a fuel. Most of the BC pellet production is exported to Europe.
Sawdust	Particles of wood resulting from the act of sawing
Slash	Woody material piled in the forest, often at the roadside, that is left after logging operations have selected all materials that are of a sufficiently high value for logging operators to retrieve. Slash is often burnt to mitigate fire risk resulting in air quality degradation in the local area during the burn.