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CLEAN ENERGY PROJECT ANALYSIS:
RETSCREEN® ENGINEERING & CASES TEXTBOOK

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BIOMASS HEATING PROJECT ANALYSIS
CHAPTER

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BIOMASS HEATING PROJECT ANALYSIS CHAPTER

Clean Energy Project Analysis: RETScreen® Engineering & Cases is an electronic textbook for professionals and university students. This chapter covers the analysis of potential biomass heating projects using the RETScreen® International Clean Energy Project Analysis Software, including a technology background and a detailed description of the algorithms found in the RETScreen® Software. A collection of project case studies, with assignments, worked-out solutions and information about how the projects fared in the real world, is available at the RETScreen® International Clean Energy Decision Support Centre Website www.retscreen.net.

1 BIOMASS HEATING BACKGROUND[1]

Biomass heating systems burn plant or other organic matter—such as wood chips, agricultural residues or even municipal waste—to generate heat. This heat can be transported and used wherever it is needed—for the ventilation and space heating requirements of buildings or whole communities, or for industrial processes. Biomass heating systems differ from conventional wood-burning stoves and fireplaces in that they typically control the mix of air and fuel in order to maximize efficiency and minimize emissions, and they include a heat distribution system to transport heat from the site of combustion to the heat load. Many biomass heating systems incorporate a sophisticated automatic fuel handling system. ***Figure 1*** shows a small commercial biomass heating system.

Figure 1:
Small Commercial Biomass Heating System.

Photo Credit:
Credit: Grove Wood Heat

1. Some of the text in this "Background" description comes from the following two Natural Resources Canada (NRCan) supported reports: ***Buyer's Guide To Small Commercial Biomass Combustion Systems***, NRCan, 2002, and, McCallum, B., ***Small-Scale Automated Biomass Energy Heating Systems: A Viable Option For Remote Canadian Communities?,*** NRCan/CFS's Great Lake Forestry Centre and NRCan's CEDRL, 1997.

Biomass heating technology is not new. For many years people have used stoves and furnaces, fed with cut roundwood, for space heating. The development of automated biomass heating systems began in Scandinavia in the 1970s, when oil prices skyrocketed. Today, there are thousands of these systems in operation around the world, using a multitude of different types of biomass fuels, or "feedstock". Despite this, much of the general public and many heating professionals are unaware of the benefits of this cost-effective, proven, and reliable source of energy. The recent emphasis on renewable energy resources as replacements for conventional fuels, spurred by concerns about greenhouse gas (GHG) emissions, is causing a resurgence of interest in biomass heating, where the biomass is harvested in a sustainable manner.

Biomass heating offers a number of compelling advantages, both for the system owner and, in the case of district heating systems, for the local community. It can supplant expensive conventional energy sources such as fossil fuels and electricity with local biomass resources, which is often available at little or no cost as waste or low-value by-products from various industries (e.g. forestry and agriculture). In doing so, overall levels of pollution and greenhouse gases are reduced, the purchaser is insulated from fossil fuel price shocks, and local jobs are created in the collection, preparation, and delivery of the feedstock. In addition, the heat distribution system of the biomass heating plant facilitates the use of waste heat from on-site power generation or thermal processes (i.e. waste heat recovery, or "WHR") and can be extended to service clusters of buildings or even whole communities in a "district energy system".

Biomass heating systems tend to have higher initial costs than conventional fossil fuel-burning systems. Furthermore, the quality of biomass feedstock is highly variable in comparison with the relatively standardized commercially available fossil fuels. Feedstock delivery, storage, and handling are more complex as a result, and often more physical space is required. All these factors require a high level of operator involvement and diligence.

Therefore, biomass heating systems are most attractive where conventional energy costs are high and biomass feedstock costs are low. This occurs when: electricity or some other costly form of energy is used for space and water heating; and biomass residues are available on-site or nearby at zero cost or, if there is a disposal fee for the biomass residues, at a discount.

Because of their size and complexity, the use of automated biomass combustion systems is largely limited to the industrial, commercial, institutional and community sectors. They tend to be located in rural and industrial areas, where restrictions on the types of pollutants they emit may be less severe, truck access for feedstock delivery may be in place, feedstock-handling equipment such as loaders may already be available, and the labour and expertise required to operate an industrial type boiler system may be easier to find.

Biomass combustion systems are often well suited to industrial process loads. Many industrial process loads have constant heat requirements and biomass heating systems operate most efficiently, and with the fewest operational challenges, when they supply a relatively constant quantity of heat, near their rated capacity, throughout the year. This also maximizes fuel savings by displacing a large amount of expensive conventional fuel, justifying the higher initial capital and ongoing labour costs of the system.

This background section describes biomass heating systems, discusses the biomass heating markets including community energy systems, individual, institutional and commercial building, and process heat applications, and presents general biomass heating project considerations.

1.1 Description of Biomass Heating Systems

A biomass heating system consists of a heating plant, a heat distribution system, and a biomass fuel supply operation. These three parts are described in detail in the following section.

1.1.1 Heating plant

Biomass heating plants typically comprise a number of different heating units. This ensures that there will be sufficient heating capacity to meet the heating load (by turning on additional units when the load increases), reduces the risk that a fuel supply interruption will endanger the supply of heat (other units can compensate for the lack of fuel in the primary unit), and maximizes the use of the lowest-cost heat sources (by using the least expensive sources first, and activating more expensive sources only as needed). As described by Arkay and Blais (1996), the four types of heat sources that may be found in a biomass heating plant are, in increasing order of typical cost per unit of heat produced:

1) **Waste heat recovery:** The lowest-cost heat will typically be that provided by a waste heat recovery system. Some biomass heating plants can be situated near electricity generation equipment (e.g. a reciprocating engine driving a generator) or a thermal process that rejects heat to the environment. This heat, which would otherwise be wasted, can often be captured by a waste heat recovery system, at little or no additional cost.

2) **Biomass combustion system (BCS):** The BCS is the unit that generates heat through combustion of biomass feedstock, and is thus by definition the heart of a biomass heating plant. If a low-cost feedstock is used, and the system is operated at a relatively constant loading near its rated capacity, the unit cost of heat produced by the BCS will be relatively low; the BCS will supply the portion of the heat load that is not met by waste heat recovery, up to the capacity of the BCS.

3) **Peak load heating system:** Due to its operational characteristics and higher capital costs, the biomass combustion system may be sized to provide sufficient heat to meet typical heat loads, but too small to satisfy occasional peaks in the heating load. The peak load heating system will provide that small portion of the annual heating load that cannot be furnished by the BCS. Often it will rely on conventional energy sources, and be characterized by lower capital costs and higher fuel costs. In some cases the peak load heating system is also used during times of very low heat load; under such conditions, the biomass combustion system would be very inefficient or generate unacceptable levels of emissions (smoke).

4) **Backup heating system:** Used in the case where one or more of the other heat sources are shutdown, either due to maintenance or an interruption in the fuel supply, the backup heating system will tend to share the peak load system's characteristics of lower capital costs and higher fuel costs. Often the peak load system serves as the backup to the biomass combustion system, and no additional backup heating system is included.

In the biomass combustion system (BCS), the principal interest in a heating plant, the biomass fuel or feedstock moves through the BCS in a number of stages, many of which are illustrated in ***Figure 2*** and described here:

- **Biomass Fuel (Feedstock) Delivery:** if not available on site, the biomass fuel is delivered to a fuel receiving area, which must be large enough to accommodate the delivery vehicles.

- **Biomass Fuel (Feedstock) Storage:** the biomass fuel in the storage area must be sufficient to fire the plant over the longest interval between deliveries. The fuel can be stored in an outdoor pile, a protective shed, or inside a bin or silo. Outdoor storage, though inexpensive, permits precipitation and dirt to contaminate feedstock.

- **Biomass Fuel (Feedstock) Reclaim:** this refers to the movement of the biomass fuel from storage to the combustion chamber. It can be effected manually, as in the loading of outdoor furnaces with cut logs; fully automated, using augers or conveyors; or rely on both operator and machinery. Fully automatic systems can be vulnerable to biomass fuel variability and detritus, such as frozen or irregularly shaped clumps, wire, or gloves.

- **Biomass Fuel (Feedstock) Transfer:** this is the movement of the biomass fuel into the combustion chamber. In automated systems, a screw auger or similar device moves the biomass fuel and a metering bin measures the flow into the combustion chamber.

- **Combustion Chamber:** the biomass fuel is injected into an enclosed combustion chamber, where it burns under controlled conditions. To this end, a control system regulates the inflow of air in response to heat demand; in automated BCSs, biomass fuel flow is also regulated. Refractory materials keep the heat of combustion inside the chamber. Many combustion chambers support the burning feedstock on a grate, enabling airflow up through and over the burning biomass fuel, facilitating complete combustion. In more sophisticated systems, the grate moves in order to evenly distribute the fire bed, convey the biomass fuel through zones of different under-fire airflow, and to push the ash to the end of the combustion chamber. Hot exhaust gases exit the combustion chamber and either pass through a heat exchanger, into a secondary combustion chamber containing a heat exchanger, or, if the heat exchanger is in or around the combustion chamber, directly into an exhaust system.

- **Heat Exchanger:** the heat from combustion is transferred to the heat distribution system via a heat exchanger. In simple outdoor furnaces, an insulated water jacket around the combustion chamber serves as the heat exchanger. Larger BCSs use boilers, with water, steam, or thermal oil as the heat transfer medium.

- **Ash Removal and Storage:** this involves voiding the BCS of bottom ash, which remains in the combustion chamber, and fly ash, which is transported by the exhaust gases. Bottom ash may be removed manually or automatically, depending on the system. Fly ash may deposit in the secondary combustion chamber or the heat exchanger (necessitating cleaning), escape out the flue, or be taken out of suspension by a particulate collection device (exhaust scrubber).

- **Exhaust System and Stack:** this vents the spent combustion gases to the atmosphere. Small systems use the natural draft resulting from the buoyancy of the warm exhaust; larger systems rely on the fans feeding air into the combustion chamber to push out the exhaust gases, or draw the exhaust gases out with a fan at the base of the chimney.

In addition to the equipment described above, instrumentation and control systems of varying sophistication oversee the operation of a BCS, modulate the feed of air and, in automated BCSs, fuel, in response to demand, and maintain safe operating conditions.

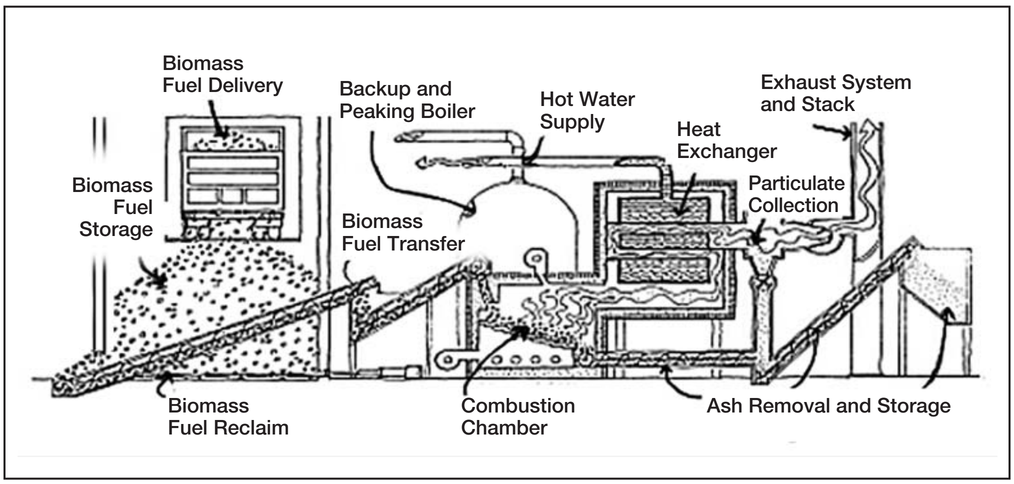

Figure 2:

Biomass Combustion System – General Layout

[adapted from NRCan's Buyer's Guide To Small Commercial Biomass Combustion Systems, 2002].

Biomass combustion systems cover a wide range of equipment, distinguished by variations in fuel and air delivery, design of combustion chamber and grate, type of heat exchanger, and handling of exhaust gas and ash. Other than very large heating plants, BCS installations can generally be classified within three broad feed system categories, based on their capacity:

- **Small manual feed systems (50-280 kW):** typically are outdoor furnaces burning blocks of wood and distributing heat with hot water.

- **Small automatic feed systems (50-500 kW):** use particulate biomass fuel (feedstock), typically utilising a two-stage combustor (i.e. with a secondary combustion chamber) and incorporating a fire-tube hot water boiler (i.e. a tube that carries hot combustion gases through the water that is to be heated).

- **Moderate-sized feed systems (400 kW and up):** have fully automated feeding of particulate biomass fuel (feedstock), typically utilising a moving or fixed grate combustor with integral or adjacent fire-tube boiler for hot water, steam or thermal oil.

In addition to these general types, there is a wide variety of specialty biomass combustion systems configured to meet specific fuel characteristics or specific heating requirements.

The sizing of the biomass combustion system relative to that of the peak load heating system is a crucial design decision. The overriding objective is to minimize the total life-cycle cost of the heat supply. There are two common approaches to BCS system sizing: base load design and peak load design. The choice of design method will depend on the variability of the load, the cost of biomass and conventional fuels, the availability of capital, and other factors specific to the application. Peak load sizing is more common in large installations with high continuous energy demands. Base load sizing is often applied to smaller installations serving exclusively space heating or variable loads. The two approaches to system design are compared in ***Table 1***.

For applications exhibiting strong seasonal variation in the heat load, such as year round process loads augmented by space heating requirements in the winter, two BCSs may be used. A small unit operates in the summer, a larger unit sized for the typical winter load runs during wintertime, and both units operate simultaneously during periods of peak demand. This arrangement facilitates the operation of each BCS at a loading close to its rated capacity, raising efficiency and reducing emissions. Moreover, it is still possible to provide some heat when one system is shut down for maintenance.

1.1.2 Heat distribution system

The heat distribution system transports heat from the heating plant to the locations where it is required. This may be within the same building as the BCS, in a nearby building, or in a cluster of buildings located in the vicinity of the plant in the case of a district heating system. In most systems, a network of insulated piping conveys water at temperatures up to 90°C away from the plant and returns the cooled water back to the plant for reheating; in some industrial systems, heat is distributed by steam or thermal oil.

Approaches To Biomass Combustion System Sizing	
BASE LOAD DESIGN	**PEAK LOAD DESIGN**
Description (Design philosophy)	
Maximise cost effectiveness by 'undersizing' the BCS to handle only the major (or base) portion of the heating load. Use a lower capital cost, smaller fossil fuel system to handle peaks.	Determine the peak (or maximum) heating load, then oversize the system by a contingency factor to ensure that unanticipated extreme loads can be satisfied.
Advantages	
▪ BCS is running at or near its full (optimum) capacity most of the time, which will provide highest seasonal efficiency; ▪ Capital costs significantly reduced; and ▪ Better system control for efficient performance and lower emissions.	▪ Minimizes use of fossil fuel; ▪ Maximizes use of biomass; ▪ Provides the possibility for increased energy use at marginal cost (if biomass fuel cost is low); and ▪ Provides a built-in capacity surplus for future load expansion.
Disadvantages	
▪ A conventional system is required for peak heating loads; ▪ Fossil fuel use will be increased; ▪ Future load expansion will affect base load; and ▪ Increased energy use must be supplemented by more expensive conventional fuels.	▪ A larger system greatly increases capital cost (and labour operating costs); ▪ With variable loads (as in heating applications), the BCS must be operated at part load much of the time. This reduces operating efficiency, resulting in an increase in biomass fuel consumption; and ▪ When operated at low load, BCSs are prone to higher emissions (smoke) and often unstable combustion.

Table 1: Approaches To Biomass Combustion System Sizing
[adapted from NRCan's Buyer's Guide To Small Commercial Biomass Combustion Systems, 2002].

Within a building, heat is typically distributed by baseboard hot water radiators, under-floor or in-floor hot water piping, or hot air ducting. Between buildings, a network of insulated underground piping transports heat. Small distribution networks utilize low cost coils of plastic pipe. In larger networks, a pipe-within-a-pipe arrangement is common: the inner carrier pipe is generally steel, the outer casing is polyethylene, and the cavity between the carrier pipe and the casing is filled with polyurethane foam. Piping is usually buried 60 to 80 cm below ground surface, as depicted in ***Figure 3***; it is not necessary to bury the pipes below the frost line since the pipes are insulated and circulate hot water.

Figure 3:
Water Pipes in District Heating System.

Photo Credit:
SweHeat

In a district heating system, a central biomass plant provides heat to a number of consumers located around the area near the central plant. The consumers will often be grouped in clusters of public, commercial, and residential buildings located within a few hundred meters of each other. District heating systems offer a number of advantages over the use of individual heating plants in each building. A single, large plant will have a level of sophistication, efficiency, and automation that would not be possible in the smaller plants. In addition, individual consumers will not need the equipment or expertise needed to successfully operate their individual biomass combustion system, further encouraging the substitution of biomass over fossil fuels. Additionally, fuel consumption, labour requirements, and emissions will be reduced, waste heat may be used more effectively, and the system will be operated more safely, all because the plant is centralized.

Heat distribution systems can often be expanded to accommodate new loads if the main distribution piping has sufficient capacity. Additional buildings within a reasonable distance can be connected to the system until its capacity is reached. If sufficient space is allocated in the heating plant building, additional burners can be installed at a later date to increase capacity.

Since the initial costs of a district heating system are high, it is cheaper to be integrated into newly constructed areas. Finally, a biomass combustion and district heating system requires a high level of dedication and organization than simple fossil fuel-fired systems.

1.1.3 Biomass fuel supply operation

The biomass fuel supply operation is the sequence of activities that results in the delivery of biomass fuel (feedstock) to the heating plant. Since the proper functioning of the plant is intimately related to the timely supply of appropriate biomass fuel, and since this operation often entails local activity rather than decisions made at a distant refinery, the fuel supply operation is considered a "component" of the plant.

A reliable, low-cost, long-term supply of biomass fuel is essential to the successful operation of a biomass heating plant. Fossil fuel products are relatively standardized, generally available, and easy to transport and handle. In contrast, many biomass fuels are highly variable in terms of moisture content, ash content, heating value, bulk consistency, and geographical availability. Biomass combustion systems—and especially their fuel handling sub-systems—may be designed to operate with only one type of biomass of a certain quality, and may require modification or operate poorly when used with a different biomass fuel. Thus, the installation of a biomass heating plant must be preceded by a thorough assessment of the quality and quantity of the biomass resource that is available, the reliability of the suppliers, the fuel handling requirements imposed by the characteristics of the available biomass fuel, and possible changes in the future demand for the targeted biomass resource. For example, if an alternative use is discovered, that may increase the price of the biomass resource. Therefore, long-term supply contracts should be negotiated whenever possible.

A wide range of low-cost material can be used as biomass fuel such as wood and wood residues in chunk, sawdust, chip, or pellet form; agricultural residues such as straw, chaff, husks, animal litter, and manure; fast-growing energy crops planted specifically for biomass combustion, including willow, switchgrass, and hybrid poplar; and municipal solid waste. ***Figures 4*** and ***5*** show two examples of low-cost biomass fuel. Whatever the biomass resource, it can be considered a renewable resource only if it is harvested in a sustainable manner.

Figure 4:
Walnut Shells for Biomass Combustion.

Photo Credit:
Warren Gretz/NREL Pix

The price of the biomass fuel depends on the source. If the biomass fuel is a waste product that must be disposed of, it may have a negative cost since tipping fees are reduced. Residuals, such as bark from a sawmill, which do not need to be disposed of but have no alternative use, are often available at no cost. By-products, such as shavings and sawdust, have a low-value alternative use and therefore will typically be available at a low cost. Plant biomass, which is harvested or purpose-grown specifically for use as a biomass fuel, will normally have higher costs, and prepared fuels, such as briquettes, may cost more than fossil fuels. These prepared fuels may have stable, uniform characteristics, however, making them convenient for use in small systems with simple fuel handling systems, where minimum operator involvement is a necessity. For example, prepared wood pellets have achieved considerable success in Europe.

Figure 5:
Bagasse for Biomass Combustion.

Photo Credit:
Warren Gretz/NREL Pix

In many countries that have embraced biomass heating, woodchips and other wood products are the principal biomass resource. The goal of every forestry operation should be to maximize the utilisation of harvested trees and to provide for the establishment of a new crop of productive trees. In the forestry industry, harvested trees should be sorted so that a range of products reflecting the quality of the trees can be produced: timber from the boles of spruce or pine and firewood or woodchips from small diameter, dead, diseased and otherwise unusable trees. A community logging operation can integrate woodchip fuel production into their product offering. ***Figure 6*** shows a wood biomass fuel supply being harvested in a commercial operation.

Figure 6:
Wood Biomass Fuel Harvesting.

Photo Credit:
Bruce McCallum [1995]

The size of wood that can be chipped is limited by the size of the chipper selected. Large-diameter trees require a large chipper with a powerful engine. Because of the high costs for large chippers, most small-scale chipping operations employ small-scale chippers, often powered by farm tractors that can chip trees up to about 23 cm (10 inches) in diameter. Larger, second-hand industrial chippers are sometimes available at a reasonable cost.

Chipping can take place at the logging site. However, in isolated areas where winter roads may be used for transport, a significant quantity of chipping material can be stockpiled near the heating plant and chipped as it is required. If there is no logging operation nearby, a stand-alone operation to supply wood and produce chips will need to be established.

Woodchips must be of good quality, and free of dirt and oversized sticks, which are produced when chipping knives get dull. Sticks can cause jamming and shutdowns of the fuel-feed system; dirt causes excessive wear as well.

1.2 Biomass Heating Application Markets

Biomass heating markets can be classified by the end-use application of the technology. The three major markets are community energy systems, institutional and commercial buildings, and process heat applications.

1.2.1 Community energy systems

Community energy systems make use of a biomass heating plant and a district heating system to service clusters of buildings or even an entire community, as seen in ***Figure 7***. Such community energy systems can provide space heating, heating of ventilation air, water heating, and process heat. These can be supplied to individual buildings, such as institutional (e.g. hospitals, schools, sports complexes), commercial (e.g. offices, warehouses, stores), residential (e.g. apartments) and industrial buildings. They can also provide heat to individual homes, especially if the houses are newly constructed and in groups.

Small community energy systems employ fully automated, highly sophisticated, "small-industrial" biomass heating plants, usually with a capacity of 1 MW or higher. They have large fuel storage bins, computerized control systems, burners with automated de-ashing augers, and smoke venting systems that are usually equipped with particulate collectors and induced draft fans.

RETScreen® International Biomass Heating Project Model

The RETScreen® International Biomass Heating Project Model can be used world-wide to easily evaluate the energy production (or savings), life-cycle costs and greenhouse gas emissions reduction for biomass and/or waste heat recovery (WHR) heating projects, ranging in size from large scale developments for clusters of buildings to individual building applications. The model can be used to evaluate three basic heating systems using: waste heat recovery; biomass; and biomass and waste heat recovery combined. It also allows for a "peak load heating system" to be included (e.g. oil-fired boiler). The model is designed to analyse a wide range of systems with or without district heating.

Note that the RETScreen Combined Heat and Power Project Model can also be used to evaluate these and a large number of other project types.

1.2.2 Individual institutional and commercial buildings

Individual buildings can satisfy their heating requirements with biomass combustion systems, as seen in ***Figure 8***. Since substantial fuel savings must be achieved in order to offset the higher initial costs and annual labour operational requirements of the biomass system, it is rare that a building as small as an individual house would use a biomass heating plant as described in the previous sub-section. Rather, biomass heating is found in institutional buildings such as schools, hospitals, and municipal buildings; commercial buildings like stores, garages, factories, workshops, and hotels; and even agricultural buildings, such as greenhouses.

Figure 7:
Biomass-Fired District Heating System at the Cree Community of Oujé-Bougamou in Northern Quebec, Canada.

Photo Credit:
NRCan

The biomass heating plants in individual buildings tend to be of the “small-commercial” or “commercial” variety. For plants with capacity of 75 to 250 kW, small-commercial systems are common. These automated, relatively simple plants have low initial costs compared to larger, more sophisticated systems. Fuel hoppers are typically quite small, and the operator must fill them about twice a day. The ash must also be raked off the grate once a day; larger systems use automatic ash handling systems. Electronic controls regulate airflow and fuel feed.

Commercial (also called “intermediate-scale”) biomass heating systems, sized from 200 to 400 kW, have characteristics of both small-commercial and industrial biomass heating systems. They employ larger fuel storage bins and have more elaborate fuel feeding mechanisms than small-commercial systems, but they have simple low cost control panels—some have fixed burner grates that require manual de-ashing. Usually they do not have dust collectors or induced draft fans. They are common in countries such as Sweden and Denmark, where they are found in institutional buildings and small industry, such as sawmill kilns.

Figure 8:
An Institutional Building Heated with Biomass.

Photo Credit:
ECOMatters Inc.

1.2.3 Process heat

Small industrial biomass heating plants are also used to provide process heat to industry, especially in those sectors where biomass waste is produced. These include sawmills, sugar plants, alcohol plants, furniture manufacturing sites, and drying sites for agricultural processes. Industrial processes will usually require substantial quantities of heat year round, thus justifying the higher capital costs of biomass heating through substantial savings in fuel costs. ***Figure 9*** depicts an industrial application of biomass heating. These applications benefit from having skilled labour on-site, loading and storage infrastructure, and free feedstock material.

Figure 9:
A Brazilian Mill that Makes Use of Bagasse, a Byproduct of Sugar Refining.

Photo Credit:
Ralph Overend/NREL Pix

Figure 10:
A Specialized Biomass Feedstock Handling System.

Photo Credit:
Ken Sheinkopf/Solstice CREST

1.3 Biomass Heating Project Considerations

Selecting a conventional gas or oil heating system is relatively straightforward. Bids from different suppliers are comparable because fuel quality is standardised, systems are simple and designs are similar. Different bids often offer the same quality of heat service and the same level of operating convenience, leaving price as the sole deciding factor.

Biomass combustion systems, on the other hand, are more complex than conventional systems and offer wide variations in design, leading to different feedstock and operating requirements (see ***Figure 10***). Comparing BCSs to conventional plants requires a careful evaluation of life-cycle costs and savings; even comparing bids from different biomass heating system suppliers calls for diligence.

In such comparisons, the following particularities associated with biomass heating systems should be considered:

Physical size	Biomass fuel systems are much larger than conventional heating systems. They often require access for direct truck delivery of fuel, space for fuel storage, and a larger boiler room to house the mechanical fuel delivery and ash removal systems.
Fuel	Unlike gas and oil, biomass fuels are generally not standardised, homogeneous fuels backed by large national suppliers. As a result, fuel quality, consistency and supply reliability are concerns. Energy content varies significantly depending on the type of biomass used for fuel.
Operation	Biomass combustion systems typically require more frequent maintenance and greater operator attention than conventional systems. As a result, operator dedication is critical.
Mechanical complexity	Biomass combustion systems are more complex than conventional heating systems, especially when it comes to fuel storage, fuel handling and combustion. The complexity arises due to the different characteristics of biomass fuel compared to fossil fuels. The increased complexity means capital costs that are both higher and more difficult to estimate.
Local pollution	Biomass combustion generates emissions that can affect local air quality and that may be subject to regulation. These include particulates, also known as soot, gaseous pollutants such as carbon monoxide, sulphur oxides, nitrogen oxides, and hydrocarbons, and low levels of carcinogens. The emissions generated by the system will depend on the type of fuel as well as the size and nature of the combustion system. Local emission regulations may be different depending on the fuel type and combustion system. In addition, ash must be discarded according to local regulations.
Combustion hazards	Biomass combustion systems often require additional fire insurance premiums and special attention to general safety issues.

These special considerations must be weighed against the many advantages of biomass heating systems. In addition to those already described, such as reduced life-cycle costs, the following may be important:

Local economic benefits	Biomass fuel (feedstock) is often harvested, collected, and delivered by local operators; in contrast, fossil fuels are generally imported from outside the community. Furthermore, the preparation and delivery of biomass fuel is more labour intensive than is the case with fossil fuels. As a result, expenditures on biomass have a stronger “multiplier effect” for the local economy: money tends to stay within the community rather than leave, creating local jobs and improving the local tax base.
Heating comfort	Low-cost biomass fuels make raising thermostats a more welcome proposition than with more expensive fossil fuels, resulting in warmer, more comfortable buildings.
Flexibility	Biomass combustion systems are highly flexible. Solid-fuel systems can be easily converted to burn almost any conceivable fuel (solid, liquid or gaseous) thus providing the user with great flexibility for the future.
Environment	Plant material that is harvested in a sustainable manner is considered a renewable energy resource since it will last indefinitely. Since growing biomass removes the same amount of carbon from the atmosphere as is released during combustion, so there is no net increase in the greenhouse gases that cause climate change. Most biomass fuels have negligible sulphur content and thus do not contribute to acid rain.
Price stability	Biomass fuel prices tend to be relatively stable and locally controlled; this is in marked contrast to the price for fossil fuels, which fluctuates widely and unpredictably in response to worldwide supply and demand.